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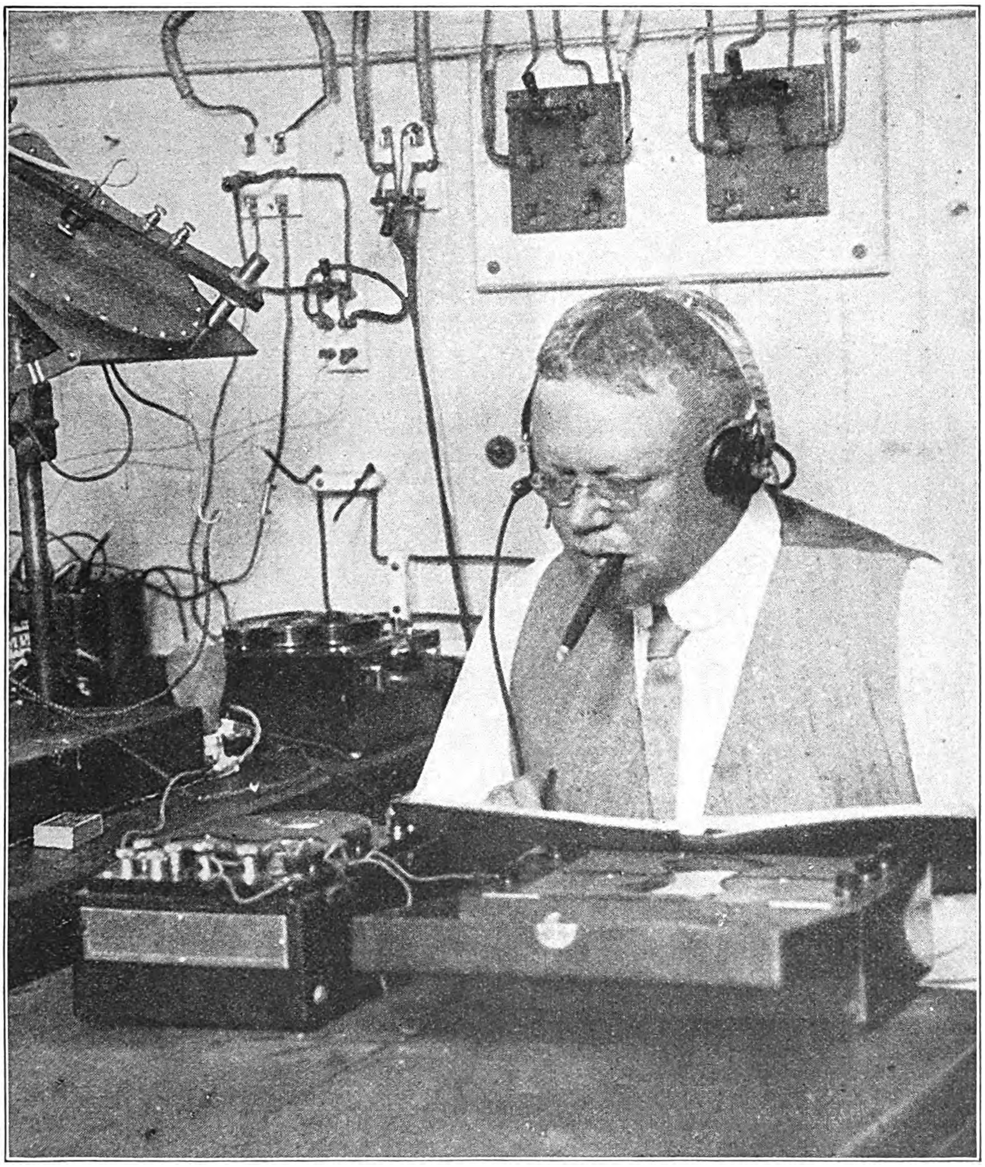

Reginald A. Fessenden

PROFESSOR REGINALD A. FESSENDEN has been awarded the SCIENTIFIC AMERICAN Medal for Safety at Sea by the American Museum of Safety, who appointed an extremely technical committee composed largely of naval officers, captains of vessels, and naval architects. Eighty competitors from 13 countries strove to win the famous gold medal which is so rarely bestowed. Professor Fessenden's achievement in devices for protection to life at sea won overwhelming recognition. Born in the Province of Quebec on Oct. 6, 1866, Professor Fessenden was employed at the Edison machine works in 1886 and 1887 and for three years thereafter was head chemist of the Edison laboratory. Later he was Professor of Electrical Engineering at Purdue University and Western University of Pennsylvania. He was special agent of the Weather Bureau from 1900 to 1902 and general manager of the National Electric Signaling Company from 1902 to 1910. Since then he has been consulting engineer of the Submarine Signal Corporation of Boston. Owing to illness, Professor Fessenden was unable to receive the medal personally at the Union League Club on November 7th, so his son officiated in his stead. Everyone will wish Professor Fessenden a speedy recovery and long life.

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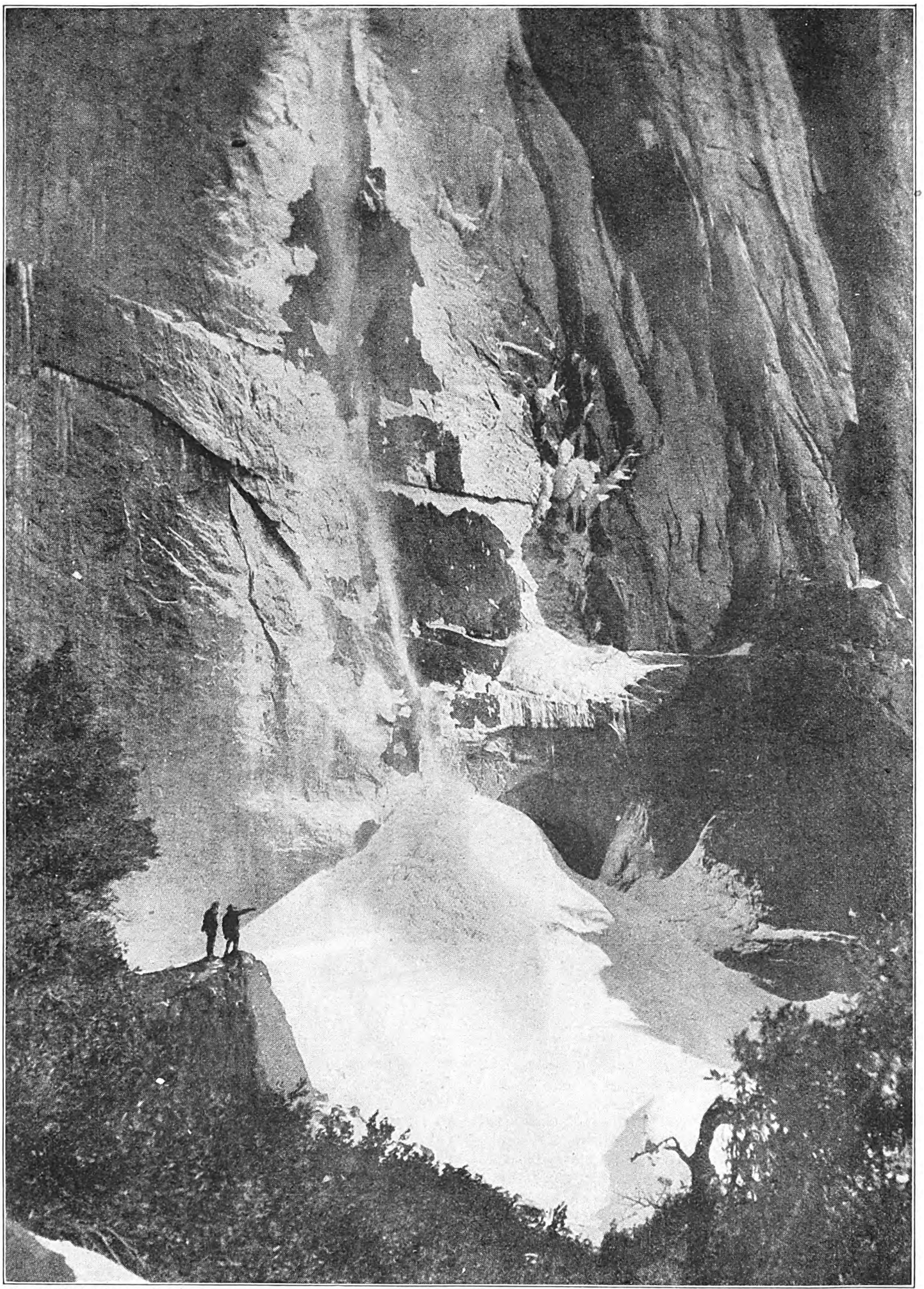

James V. Lloyd photograph, Yosemite

Yosemite's Winter Finery

THE cold of winter evenings turns the spray of Upper Yosemite Falls, which has a drop of 1430 feet, into ice that coats the entire cliff face. When the sun strikes this section of the canyon walls, the ice melts off in chunks that accumulate at the base of the falls. The ice piles up during the winter so that sometimes by March 15, the ice talus cone is 250 feet high.

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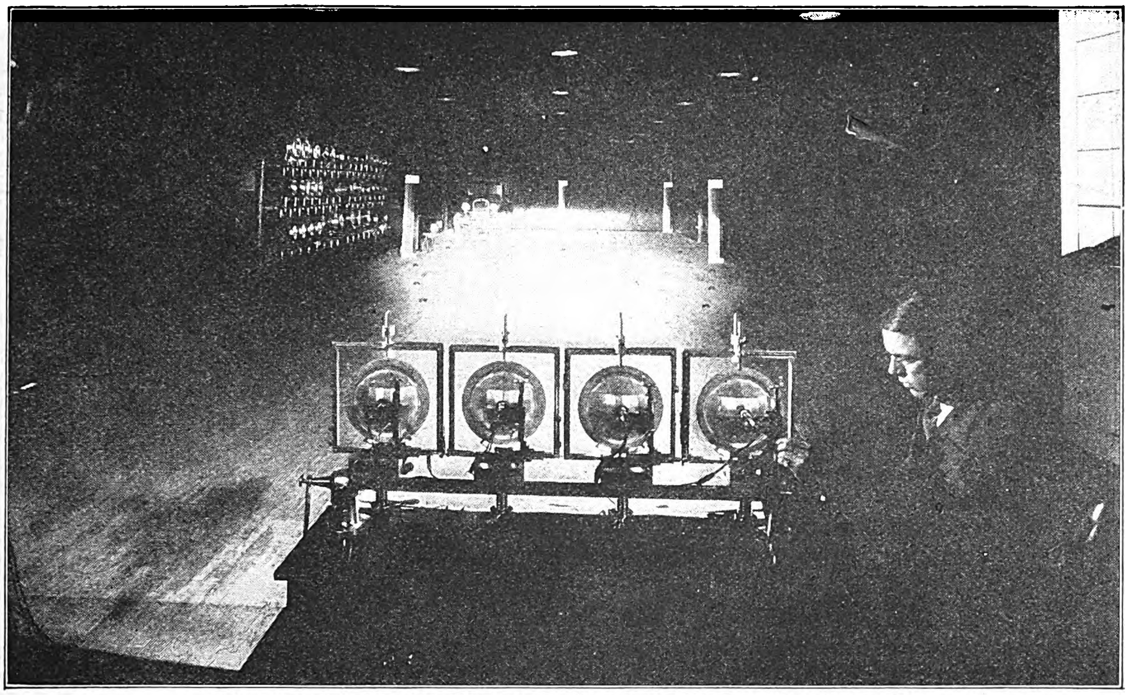

"HOW FAR THAT LITTLE CANDLE THROWS ITS BEAMS"

Unlike Portia's candle, automobile lights must be controlled. Here we have the interior of a headlight testing room where reflector types are tested for glare, strength and direction of beam, height above ground, et cetera. An actual car, in laboratory background, is used here

Research Made Your Motor Car

The Car of Today Is a Vast Improvement Over That of 1920. Constant Research and Development Made It Possible

By C. F. KETTERING*

Vice-President of General Motors Corporation, and General Director of the Research Laboratories

SUPPOSE that ten years ago a brand new automobile, 1920 model, had been sealed up in a glass case. Suppose also that the seal was such a good one that nothing at all has happened to the car with time, but that it is in perfect condition today—not a speck of rust; not a bit of tarnish. The price of the car was 1500 dollars in 1920. What would you give for it now?

Before you decide, look the car over pretty carefully. You will see that it does not have four-wheel brakes, nor balloon tires, nor Duco finish. It is painted all in black, with no relieving color, except for some stripes of yellow. It has no air cleaner, no oil filter, no ventilator in the crankcase, no fuel pump, and no shock absorbers. You should know also that, although the engine is almost the same size as that in the present model of the equivalent make, its power is much lower; the car will not pull hills as well nor run as fast. But then you would not want to drive it so fast anyway, for it does not steer as easily, the engine does not run as smoothly, and the whole car does not ride nearly as comfortably as the up-to-date model does.

Now that you know all this, what do you bid for the car? It is safe to say that you would not pay over 500 dollars for it. But why not? This is not a "used" car. It is just as good as it was the day it was made. This car sold readily for 1500 dollars in 1920. Why is it worth only one third as much to you today?

THE answer is that that differential of 1000 dollars is the figure at which you, as a representative customer, reckon the value of the research and the engineering work of the past few years. The difference is not that the early car is any worse today than it was in 1920, but that the present car is so far superior to it that people think it is a thousand dollars better. And in that judgment they are not mistaken.

The National Research Council recently sent a questionnaire to a large number of American manufacturers, asking about their activities in research. An analysis of nearly 600 of the replies received showed that 52 percent of the manufacturers do some industrial research. Now it is certain that, if such a census were taken within the automobile industry alone, the percentage would be much higher. The motor car industry is unique in that *every* manufacturer who expects to stay in the business must be constantly experimenting and improving his product. And therein lies one of the outstanding reasons why the automobile industry has gone forward by leaps and bounds. It is certainly true that so far as the motor car business is concerned there are no park benches for it to rest on. There is only one place where park benches may be found, and that is immediately in front of the undertaker's office.

The opinion is sometimes heard that the yearly bringing out of new and improved models of cars is a bad thing for the public, and therefore for the industry. This opinion was expressed to me not long since by a man who had just been into an automobile sales-room to look at a new model of the car he had been driving.

"I was tremendously impressed with the new car," he said. "It was beautiful. The advance made was quite marvelous. The only thing that made me sore was that they would not allow me within 200 dollars of what I expected on my old car. The thing that you did in bringing out that new model was to depreciate 200 dollars worth every one of the cars you made last year."

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*See "Among Our Contributors," page 5.

"You are wrong in that," I replied. "Did we put so much as a scratch on the paint of your present car? Did we harm a bearing or score a cylinder? Did we break a spark plug? Did we punch a hole in your gasoline tank between last night and this morning?"

"No, I'll admit that you didn't do any of those things," he answered.

"But you say we depreciated your car to the extent of 200 dollars between yesterday and today," I continued. "No, we did not *de*-preciate your car. What we did was to *ap*-preciate to the extent of 200 dollars' worth your idea of what a car ought to be. All we did was to show you an automobile so far superior to your old one in several particulars that, despite the fact that you are complaining about the allowance on your old car—which, after all, is merely what someone else is willing to pay for it—you are going to buy the new car anyway, aren't you?"

"Sure," he replied.

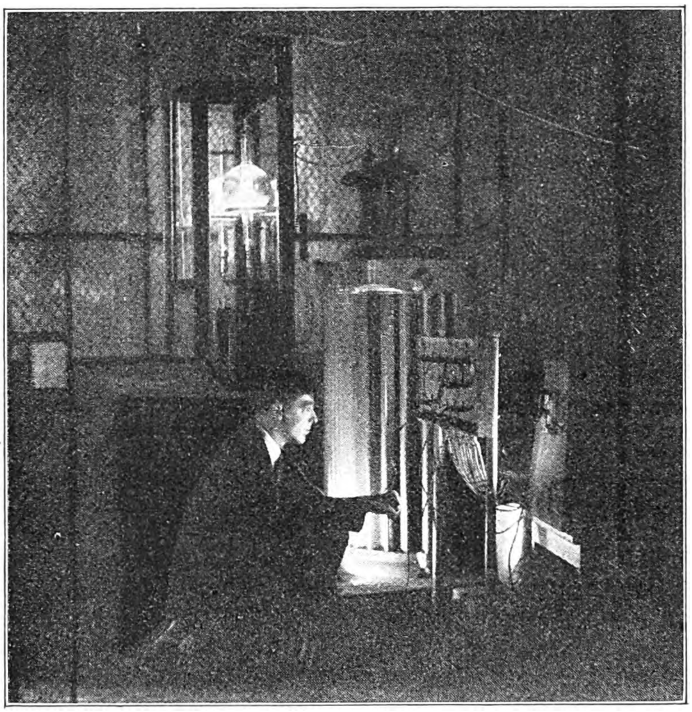
"THEN you have learned that it is worth 200 dollars to have a change of mind," I said. "If we had not elevated your mental idea of what an automobile should be, you would not have bought a new car, would you?"

"No."

"Then, we would not make the new car, the steel mill would not produce the steel, the paint factory would not make the paint, the textile mill would not weave the cloth, the tire factory would not manufacture the tires, the glass mill would not make the glass, the railroad would not haul the freight—and then business would not be so good."

The relationship of industrial research to the automobile is a very intimate one, for it is only as a result of an immense amount of research and experimentation that we have the automobile at all. The motor car is said to have been made possible by three things: rubber, alloy steels, and petroleum. That is the truth, perhaps; but it is not the whole truth, for the scientific and practical developments that have made the up-to-date automobile possible came from a great many sources. Electric lights, for instance, are certainly very essential to the utility of the motor car, even though they do glare at us too much sometimes. But without the single development of ductile tungsten it would not have been possible for us to put electric lights on automobiles.

We all take electric lights on cars and everywhere else as a matter of course. So some of us may have forgotten that the long research conducted by Dr. W. D. Coolidge and his helpers, which resulted finally in the discovery of how to make ductile tungsten wire, was one of the great classics of scientific as well as of practical research. And probably none of us has computed, nor can compute, how much we owe to that one development. Ductile tungsten has meant much to the motor car, because carbon filament lamps were too inefficient to be practical for automobile headlights, and the early tungsten filaments were so fragile that on a moving vehicle they would quickly have shaken to pieces.



DANGER—100,000 VOLTS

A wire cage grounded on pipes is used in automobile research laboratories to shield experiments from electrical disturbances

IT was the search for smokeless powder that constituted the first of the long series of hard-won battles which have made possible the durable and attractive lacquer finishes on cars today. The grandfather of Duco was gun-cotton. One of the principal problems that had to be solved in connection with the use of lacquer finishes on automobiles was that of securing suitable solvents for nitrocellulose, and of providing them cheaply enough and in adequate amounts. This problem was finally solved by the combined efforts of the bacteriologist, the synthetic chemist, and the chemical engineer; but it was not solved without a great deal of patient research.

Many of the essential contributions to the motor car have come out of research and development in other industries apparently remote from it, such as in ceramics, storage batteries, abrasives, synthetic resins, celluloid, glue, pulp products, leather and coated textiles, electro-chemistry, and even such an apparently unrelated thing as the setting of diamonds. The automobile draws upon almost every industry in the country, and upon some of them in a large way. Immense amounts of glass, leather, rubber, lumber, steel, aluminum, copper, tin, lead, zinc, nickel, chromium, cotton, wool, glue, paint, varnish, and goodness knows what are used in making motor cars. The motor car, being the ultimate consumer of many types of manufactured goods, naturally benefits from the research done in the industries that supply it.

If it had not been for just one of the developments in alloy steels, namely, high-speed cutting tools, it would scarcely be possible to make automobiles, or at least it would not be possible to make them as cheaply and as accurately as is done today.

WITH the aid of these tools, the more than 10,000 parts that every automobile consists of can be shaped with the greatest rapidity, and at the same time with the utmost precision. So hardy are these teeth of steel that they tear away on one piece of metal after another at such a terrific rate that they get very hot at the task. But that does not make them one whit the less effective. The finished pieces they turn out so speedily are always "interchangeable." They are every one exactly alike; and, with the exception of just a few pieces, the man who assembles them into the final product need make no selection whatever. Generally he can use one of the pieces just as well as another. And even in the case of those few parts where, in order to get a perfect fit, a selection is sometimes made, the choice lies between parts that differ in size by the fraction of a hair's breadth only.

Anyone who has ever had to "run in on the rim" has a pretty good idea of how large has been the contribution of rubber to the automobile. The slow and bumpy progress that he had to make then was just a little taste of what the automobile would be like without the pneumatic tire, or of what it would be like if he had to run *all* the time on *four* unyielding rims. By making it possible to glide smoothly along on a cushion of air, the rubber tire has done more to make the motor car a satisfactory and useful vehicle than people usually give it credit for. But the rubber tire is altogether a product of research, of research which has been long and persistently pursued, and which is still being carried on intensively.

Likewise, it is only as a result of much research and experimentation in the petroleum industry that the constantly mounting numbers of automobiles have been kept on the roads. Research in the geological location of oil deposits has enabled more and more petroleum to be found. But this alone would not have been enough. If the oil refiner had not found out how to make more gasoline out of the petroleum that passed through his refinery than he made 20 years ago, it would have taken nearly four times as much crude oil as it did to yield the gasoline consumed during the past year. It is true that there is plenty of petroleum today. But where would we get four times as much as we consume now?

THE large improvement in yield of gasoline, and the consequent lesser consumption of petroleum per car, came about as the result of an immense amount of research and experimentation, first, on making gasoline by "cracking" heavier oils; second, on extracting gasoline from natural gas and from the gases produced in refineries; and, third, on improving the means of separating from petroleum the gasoline present in it as it is removed from the oil pool. The result of all this research has been that during the past 20 years the amount of gasoline produced from each barrel of petroleum pumped into the refinery has gone up from 4.5 gallons to more than 17 gallons.

In the engineering features of automobiles there has been, of course, an immense amount of persistent experimentation from the very outset. In the matter of engines, for example, constant experiments have been made on the best ways to construct them, on how to lubricate them and to cool them, on improving the balance of engines and the smoothness with which they run, on valves and means of opening and closing them, on shapes of combustion chambers, on means of getting ignition and of controlling it, on carburetion and atomization of the fuel, and on means of equalizing the distribution of charge to the various cylinders.

Much experimentation has also been carried out on such features as transmissions, differentials, axles, brakes, steering gears, and closed bodies. As a result of this constant research and experimentation, the gradual evolution of the automobile has all been toward more useful, more beautiful, and more economical cars, as well as cheaper ones.

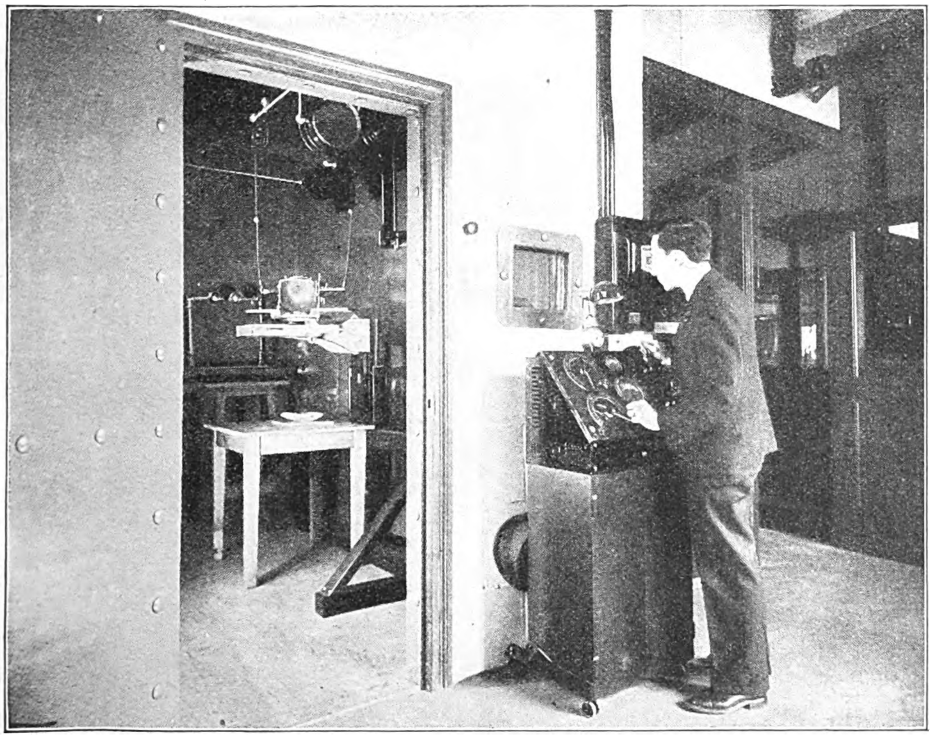
The researches that have resulted in putting a motor car into nearly every American family have not all been confined to the fields of science and engineering. Research, whether it be strictly scientific or both scientific and practical—and it is scarcely ever one without the other—consists simply in getting the facts. In order to make automobiles cheaper and cheaper as well as better and better, it has been necessary to get the facts on materials, engineering, purchasing, manufacturing, sales, service, advertising, and many other things.

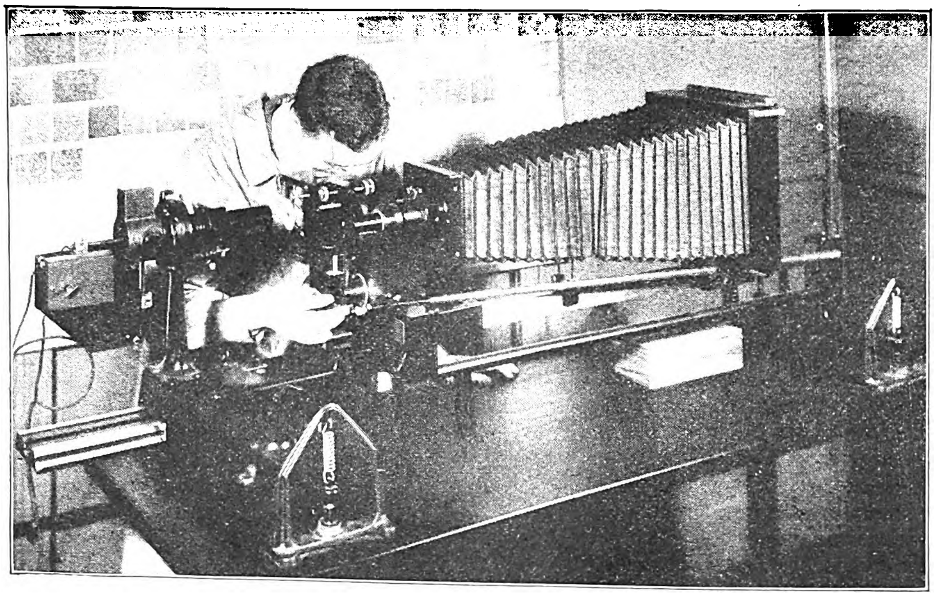
And so the motor car is quite definitely a product of research. It represents a result of the application of scientific and practical discoveries to everyday life. The huge automobile industry has arisen largely through commercial research having acted as a translator of scientific ideas to a traveling public.

SCIENCE in general needs an interpreter to translate its discoveries into products that are useful to ordinary people, and that is one of the principal functions of industrial research. The general purpose of research in industry is to discover, analyze, and recommend improvements in products and methods, and in the automobile industry there is an immense amount of this kind of experimentation going on. Such experimentation is not what is called fundamental research, but it is research, nevertheless, and a very useful form of research as well.

The results of research that have gone into the automobile have meant much to the ordinary man. The first way in which it has benefited him is in his ability to buy a valuable means of getting about the world, which, if it had not been for the large amount of research and experimentation put into it, he could not possibly have. Twenty-five years ago the man who had an

DOES IT WEATHER?
A series of lacquered plates passes through water and then under a powerful light to test lacquer weathering


IS IT UP TO THE STANDARD?
At intervals, castings of various parts that are to go into automobiles are examined by means of the X ray. The X-ray room is shielded to protect the operator from dangerous rays



FOR STRUCTURALLY PERFECT METAL

It is necessary to know the crystalline structure of metals used in the production of finished parts. Here a metallurgist is examining a piece of metal with a powerful photo-microscope

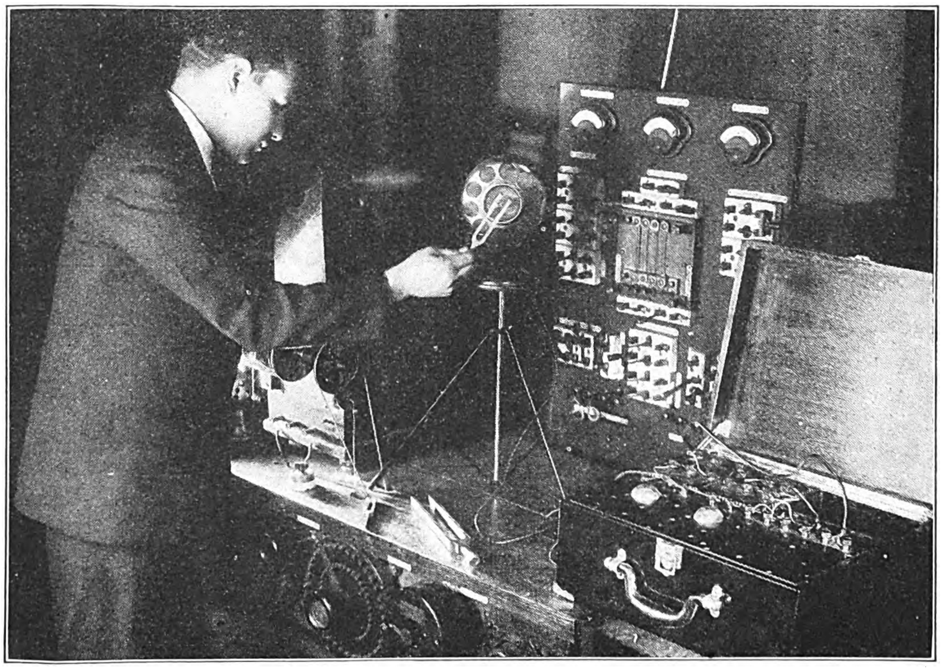
automobile was on a par, from the viewpoint of transportation, with the man who had a chariot 2500 years ago. Now nearly every family has a car, even the worst of which is so far ahead of the ancient chariot—or of the early automobile, for that matter—that the carriage of the ordinary working man is one the like of which the ancient king never even dreamed of having. That the ordinary man today has a multitude of things the ancient king could not command with all his wealth has come about altogether as a result of that persistent experimentation, which of recent years has been organized and called industrial research.

THE second way in which the continual research on the motor car has benefited the ordinary man is in the relatively lower price he has to pay for his automobile than for most other things he buys. Although the cost-of-living dollar is now worth but 62 cents as compared with 1914, the automobile-purchasing dollar on the same basis is worth $1.13. So, as a result of much persistent experimentation and consequent development within the automobile industry, a dollar will go nearly twice as far in the automobile salesroom today as it will on the average in other places where goods are sold. If the cost of cars had been allowed to follow the cost-of-living curve since 1914, the people who bought automobiles last year would have had to pay 3,000,000,000 dollars more for them than they did. This saving does not take into account the marvelous improvement in cars which did not cost the customer anything.

The third way in which the constant experimentation that gave us the motor car has helped people is in the fact that at least one out of every five or six people who now have a job owes it to the motor car. The automobile industry itself either directly or indirectly gives employment to 4,500,000 people. The petroleum industry employs more than a million people, the motor car having caused it to expand 15-fold since 1900. Partly on account of the iron and steel needed for cars, for roads and bridges, and for buildings to serve the automobile, the iron and steel industry has expanded to more than 10 times its size in 1900, so that it now employs about 3,500,000 people. Besides the workers mentioned, there are all those who are employed on railroads, in telephone exchanges, in stores, in offices, in schools, and in fact everywhere, who would not have jobs if it were not for the stimulus that the motor car has given to industry. And remember that, without research, we would not have had the motor car at all.

How much improvement in automobiles will be made within the next ten years? It is impossible to tell exactly, for as the automobile keeps getting better, more and more effort is required to improve it further. But the motor car has not yet reached the final stage of perfection by any means, and more research and experimentation are going on in the automobile industry now than ever before. This research is also better organized than at any time in the past. Hence, there is every reason to suppose that, if one of the best of our 1930 motor cars were to be sealed up in a glass case now, the customer of 1940 would not think it worth any more by the standards which will have been set for automobiles by that time than we today think the 1920 car is worth.

¶ *Of the researches necessary to produce and constantly improve modern cars, the foregoing discusses a varied but principally pre-production class. Elsewhere in this issue, other researches vital to the industry are discussed. The article on page 18 outlines the value to the automotive engineer of the races on the Indianapolis Speedway, the front-drive car described on page 28 having been conceived there. Exhaustive "proving-up" tests of new improvements, such as those discussed on page 46, are necessary. On page 60 are described the researches in gasoline that have made possible the design of higher powered engines and have assured for the motorist fuel of a definite high quality.*—The Editor.



A TROUBLESOME NOISE IN YOUR CAR?

Automobile research engineers not only locate the noise but must also measure exactly how loud it is and determine its frequency and character. Radio is a tool in this difficult work

OUR POINT OF VIEW

Game Bird Laws

ATTACKING the Bureau of Biological Survey for its policies relative to duck hunting seems to have become the favorite indoor sport of certain individuals and a section of the outdoor press. And, unfortunately, their clamor has a quality of apparent plausibility which readily deceives the uninformed.

Recent criticisms of the Bureau by these too-conservative conservationists and sentimentalists might lead us to infer that our water fowl are practically extinct, were our credulity not tempered with judgment. They would have us believe that the only way to save them is to do away with duck clubs and increase other phases of duck-shooting "verbotens." They threaten to force federal legislation to carry their point.

Incongruous with these criticisms is the fact that hunters in various sections report greater numbers of water fowl this year than have been seen before for many years. Instead of nearing extinction, ducks are apparently increasing; and, while we, also, protest *needless* slaughter of them, they are, after all, game birds.

The Bureau of Biological Survey, after sane consideration, may consider justifiable the modification of certain regulations relative to the shooting of these birds. If so, any policy agreed upon by the Biological Survey and its advisory board should be sustained. It has demonstrated its worth and ability as an institution and has gained the confidence and respect of every game department in the United States. We do not believe its policies are now, or ever will be, open to thoughtless criticism, or should be menaced by any clique seeking merely "their way."

We Get Bumped

SUPPOSE one were to request the first half dozen people he encountered to name the most inventive nation. Suppose about six of these half dozen were to reply, "Why, we are, of course—haven't you ever heard of Yankee inventiveness?" And then suppose you were to reply that we rank twelfth among the nations in this particular quality.

Facts are facts, despite the natural bias of all humans in favor of whatever is their own. Professor Mark Jefferson, well-known writer and authority on the distribution of population and on other statistical studies of the human race, has published in the *Geographical Review*, quarterly journal of the American Geographical Society, the interesting outcome of his research on the "geographical distribution of inventiveness." His findings do not flatter our national self love. He has found that the leader in inventiveness is Switzerland. "The facts," he says, "are overwhelming." Switzerland, he adds parenthetically, is a world leader in broader respects than inventiveness, a fact which he attributes largely to that country having long been an asylum which has received thousands of the persecuted intelligentsia of other lands. Such people usually possess the quality of originality, for various manifestations of which they are or were persecuted. Originality finds one outlet in invention.

A Worthy Cause

AT the time this issue reaches you, a few days before Christmas, the joyous spirit of the holidays will be upon you, your petty troubles will be forgotten, and the chances are that you will be happy. In the vast majority of homes, gayety, laughter, and song will reign for days, but in a not inconsiderable number where reside the families of men in prison there will be desolation, heartaches, cold, and hunger.

The tremendous social problem of re-making criminals into useful citizens has been too often discussed to necessitate analysis here. We believe, to paraphrase a familiar quotation, that reformation of the criminal begins at home—his home. Kindness shown to members of his family is more likely to touch him than any amount of preaching; and sympathy and aid for them would do more toward inspiring him with hope and courage than the fear of prison bars.

The Volunteer Prison League of the Volunteers of America, Inc., are therefore performing a worthy service in extending practical help and kindly friendship, and in giving warm clothing, money, food, and toys to the families of prisoners. We heartily approve their work and urge that you do what you can to help, especially for the Christmas season, by sending contributions of the nature noted above to the League at 34 West 28th Street, New York City.

Getting down to concrete figures Professor Jefferson finds the Swiss people, man for man, more than three times as inventive as the Germans, four times as inventive as the French, five times as inventive as the British, and nearly six times as inventive as we Americans.

It may harm us little in the long run thus to have our complacency bumped. "Yankee inventiveness" is a well established term and in itself it is an accurate one. But the noun is not the exclusive possession of the adjective.

Unhealthful Noises

NOISES loud and screeching, noises strident, discordant, sporadic, and unrhythmic—the innumerable, nerve-racking noises of New York City are to be scientifically studied and, if possible, a solution for the problem outlined. The city health commissioner has appointed to perform the task a notable group composed of lawyers, physicians, engineers, builders, and neurologists.

In the sense that this problem has been studied in many places for decades, mainly as a nuisance problem for the police to handle, it is not a new one; but this is the first serious attempt to cope with it as a social problem. Old police regulations had to do with noises of horse-drawn street cars, carts rumbling over cobblestones, peanut-stand whistles, hucksters' cries, piano practicing, and singing. New regulations will have to consider such modern torturers as radio loudspeakers which make both day and night hideous with their cacophony of booms and shrieks from radio stores and a dozen nearby apartments, the riveting hammer, "rheumatic" motor trucks which rattle in every joint, sirens, and the thoughtless motorist who sounds his horn continually.

The influence on human health of the din assailing our ears has not been definitely established but it is generally agreed that insomniacs and neurotics suffer more acutely because of it; and it is logical to assume that it may cause such people to have nervous breakdowns. Likewise, noise may reasonably be said to cause nervousness and insomnia in people otherwise healthy. In either case, the result will be—aside from considerations of the effect of jarring sound waves impinging on the auditory nerves which is yet to be determined—a lowering of the vitality and powers of resistance to disease of the person concerned.

While there is no way of foretelling what results may come of the study now being conducted in New York City, we believe the efforts of the experts will not be in vain. Other urban centers would do well to follow suit in this worthy cause.

Air

About Good Air and Bad—Good and Bad Ventilating Systems. How Certain Not Very Ancient "Scientific" Ventilating Principles Are Already Out of Date

By DONALD A. LAIRD, Ph.D., Sci.D.
Director, Colgate Psychological Laboratory

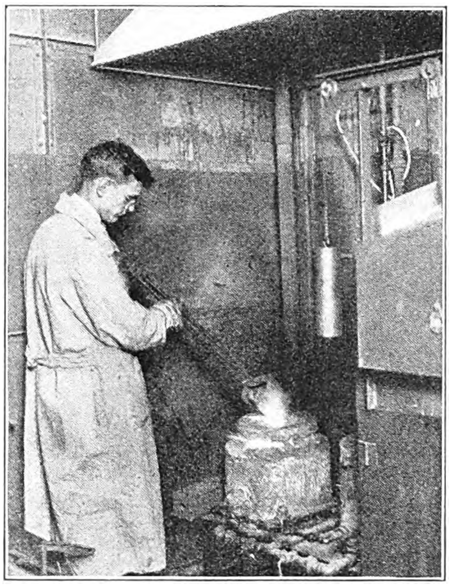
CITIZENS in about half of the United States are forced by law to live in air that is harmful. Recent laws, based upon half formed scientific theories of a century ago, keep hundreds of thousands of Americans breathing and living in air that injures health and diminishes working capacity. Theaters, public schools, and factories in nearly half of the states are required by statues to use systems of ventilation which are not only wasteful in money but in vitality and efficiency as well.

Colds, circulatory disorders, catarrhal conditions, and even digestive disturbances are traced rather directly and surely by scientists to bad air conditions. Air does not contribute to these by carrying germs, for it is well proved that one of the best ways to kill germs is to get them into fresh air. There are no air-borne germs that should be seriously considered. It is something more complicated than simply germs that is responsible for the ill-effects of much of the air with which we are surrounded.

In observations on 5500 school children under different air conditions, for example, it was found that those spending the school day in rooms with temperatures from 59 to 67 degrees had 70 percent fewer colds than pupils of the same age and status who were in mechanically ventilated rooms with a temperature from 68 to 69 degrees. The children with fewer colds were in the colder rooms, and in rooms with only natural window ventilation.

AT a temperature of 80 degrees school children are reported as "restless, dull, and incapable of continued mental effort." At a slightly cooler temperature of 76 degrees they are dull, sleepy, and have poor penmanship. When the temperature is reduced to 70 degrees they are reported as "doing excellent work, and with cheerfulness in class." Best work is reported at a temperature of 68 degrees. When the temperature is lowered to 66 degrees splendid work is still done, but they begin to complain about the cold, while 60 degrees is too cold for good work.

When the room temperature rises above 68 degrees the body becomes feverish, we breathe more rapidly, the heart beats faster, and in a short time the blood-vessels become weakened. The temperature does not have to rise much above this level for these ill-effects to become apparent. Why, then, is not summer the most hazardous time of the year? The answer which soon will be clear is that, for many, it *is* the most hazardous.



ILLEGAL THOUGH EFFECTIVE

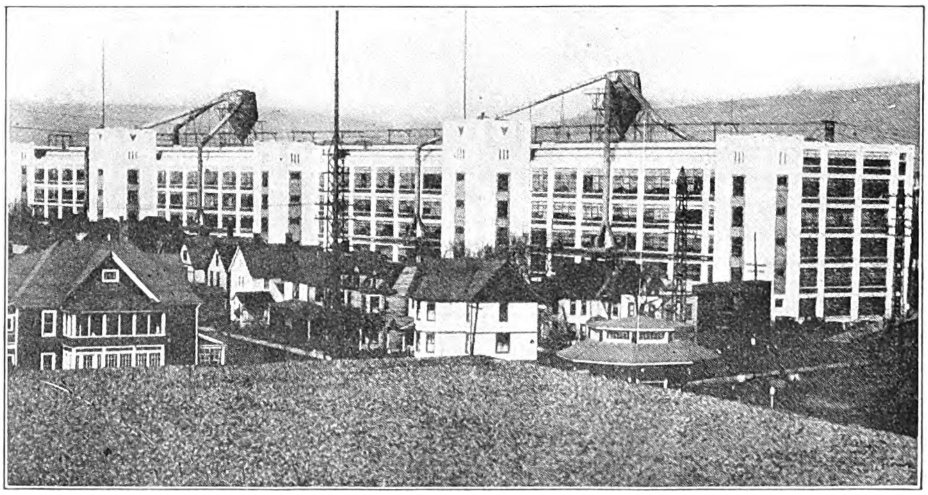
This exhaust hood would be illegal in some states, though it removes the gases

What is there about air that causes all this, and more too? We have seen that it is not germs and bacteria. Are there poisons in the air?

There is the famous and appalling case of the ship *Londonderry* which was bound for Liverpool with 200 passengers on board shortly before the Civil War. They ran into a severe storm and the captain ordered the passengers into the steerage cabin, no larger than an ordinary living room, where presumably they would be safe below decks. Shortly after the episode a writer, Edward Jarvis, described the ensuing events as follows:

"Into this small space the passengers were crowded; they would have suffered inconvenience if the hatches had been left open but the captain ordered these closed, and ordered a tarpaulin to be thrown over the entrance to the cabin and fastened down. The wretched passengers were now condemned to breathe over and over again the same air. This soon became intolerable. Then occurred a horrible scene of frenzy and violence, amid the groans of the expiring and the curses of the more robust; this was stopped only by one of the men contriving to force his way on deck and to alarm the mate who was called to a fearful spectacle. Seventy-two were already dead, their bodies were convulsed, the blood starting from their eyes, nostrils, and ears."

ALMOST a century before the *Londonderry* tradegy another catastrophe of bad air occurred. The Nawab of Bengal has just captured Fort William in Calcutta and his men forced 146 European men as prisoners into a guard room scarcely 20 feet



AIR CONDITIONING AND DUST REMOVING EQUIPMENT

At a plant of the Endicott-Johnson Shoe Company. Modern industrialists install modern protection for workers to get larger output; also because of an enlightened point of view square, provided with only two small, strongly barred windows. A description of the outcome runs:

"Very soon after they were crowded in, an almost incredibly profuse perspiration broke out upon them, which was followed by consuming and increasing thirst. They became furious and goaded their guards with insults to provoke them to fire, in which they failed. They made furious cries for water; a little of it was brought to them in hats and forced through the bars. The stronger forced their way to the window and bore down and trampled to death the weaker ones. By half-past eleven the living were outrageous and quite ungovernable. At six in the morning the order arrived for their release. At that time only 23 were left alive!"

THESE two tragedies gave rise to the belief that human beings give off a poison which contaminates air. In all scientific grandeur the name of "anthropoxin" was given to this mysterious toxin. Now it is definitely known that air does not become poisoned by being rebreathed. It does have seriously bad effects, but not from being poisoned. There is no "air-borne infection," and there is no "crowd poison," to consider in obtaining the right kind of air to promote health and diminish fatigue.

The mythical anthropoxin gave way to a very real carbon dioxide in 1863 when the German scientist Pettenkofer announced that he had devised a method of measuring the carbon dioxide in air exhaled from the lungs. A century before this demonstration the French scientist Lavoisier had discovered the presence of atmospheric carbon dioxide, and with Pettenkoffer's actual measurement of carbon dioxide in the air exhaled from the lungs and finding 100 times as large a percentage in the lung air as in outdoor air, it began to appear as if carbon dioxide were the culprit. But carbon dioxide is not the culprit.

CARBON DIOXIDE:

In pure, outdoors air	0.040 percent
In air in lungs	5.0 percent
In air in worst ventilated rooms	0.40 percent

SUGGESTED TEMPERATURE STANDARDS:

Offices, drafting rooms, sedentary tasks	67 to 69 degrees F.
Rooms where workers are moderately active and move about	65 to 67 degrees F.
Foundries, blacksmith shops, carpenter shops	55 to 65 degrees F.

NOTE: These temperatures are high unless the air is also in motion.

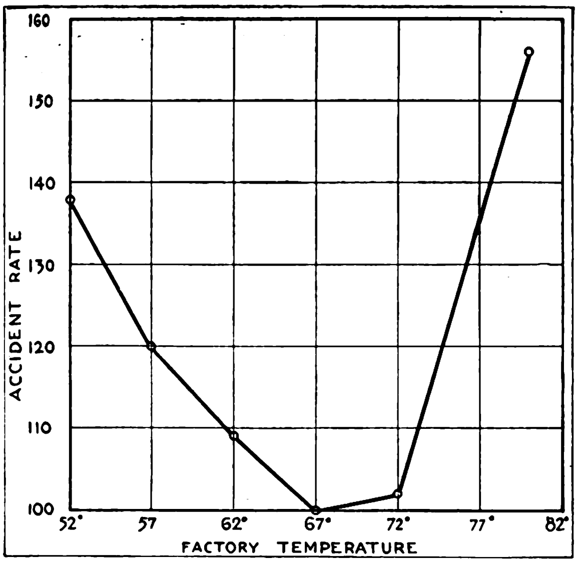
TEMPERATURES OBSERVED IN WORK PLACES:

Bakeries	90 degrees F.
Laundries	95 degrees F.
Sugar refinery	110-115 degrees F.
Copper reduction	100 degrees F.

SCHOOL-ROOM TEMPERATURES IN 278 ROOMS IN 31 CITIES:

Temperature	*Percent of rooms*
Below 66	6
66-70	40
71-75	37
Over 76	17

It is true that outdoor air contains less than one tenth of one percent of carbon dioxide, while after the same air is exhaled from the lungs it may contain as much as five percent of the gas. However, it looked suspiciously as though crowd poison was carbon dioxide, and at the turn of the century a wave of legislation started which required public and work places to be mechanically ventilated with exhaust ducts near the floor. Carbon dioxide being heavier than air mixture, it was evident that it would be near the floor and that exhaust ducts pumping out the air from near the floor would quickly remove any excess carbon dioxide. All this is true, but is very unsound ventilating practice for two vital reasons.



TEMPERATURE AND ACCIDENTS

The curve shows that the optimum temperature is 67 degrees; above this and below accidents increase

FOR one thing, never in the course of ordinary events is carbon dioxide a menace, not even in the Black Hole of Calcutta or in the steerage cabin of the *Londonderry;* in fact more than 2 percent of carbon dioxide must be in the bottoms of the lungs to stimulate the respiratory center in the base of the brain which starts and stops the breathing action. The air in even poorly ventilated mines seldom has more than 3 percent of carbon dioxide in it. If carbon dioxide is a poison, then our lungs perpetually are filled with the most poisonous air.

For the second reason; having the exhaust ducts close to the floor results in pumping down to breathing level the air in the room which actually *is* harmful. If any air in a room is harmful to a human being it is the air near the ceiling. A floor-level duct brings this more harmful air directly to the inhabitants of the room. Yet Massachusetts and more than 20 other states demand by statute that their public buildings and work places be ventilated by mechanical systems which exhaust the air at floor level. Thereby they actually add to the perniciousness of the condition.

We are now closer to what has been demonstrated amply as the really undesirable conditions that make air bad for us. The demonstrated truth now is that it is not the air in our lungs but the air next to our skin which is responsible for the effects, whether they be good or bad.

One of the first scientific demonstrations of this fact was dramatic. An airtight room just large enough to accomodate one adult man was built in a German laboratory. Three rubber-covered port-holes were built into the side walls about five feet from floor level. An assistant in the laboratory was placed inside this experimental chamber where he had to breathe the same air over and over again. He gradually became fatigued, drowsy, slightly sick to his stomach, and finally was on the verge of fainting. Then he stuck his head through one of the rubber-covered port holes to breathe the fresh outside air. At the same instant two other assistants who were on the outside of the test chamber stuck their heads through portholes into the chamber, so they were breathing the chamber air into their lungs—one man in the stuffy chamber breathing fresh outside air and two men outside breathing the stuffy air of the experimental chamber. The two breathing the "poisoned" chamber air rich in carbon dioxide did not suffer at all, but the man breathing the fresh air while his body was enveloped in the stuffy, hot damp air of the chamber fainted dead away! His lungs were getting fresh, pure air, but his body was encased in air which it itself had made hot and humid.

IT is the cooling power of the air surrounding our bodies, rather than the purity of air within our lungs, that causes the damage.

In maintaining life and in doing work the body is the scene of ceaseless chemical reactions. Calories of heat are produced and lost. Through it all is the miracle of the body automatically keeping its own temperature close to 98.6 degrees. Whenever the temperature of the air surrounding the body rises it throws an excess load on the mechanisms within the body which regulate the loss of bodily heat, so that the normal 98.6 temperature is maintained. Whenever the room temperature goes even slightly above 68 degrees, normally clothed individuals have a taxing burden thrown upon the mechanisms which dissipate their self-formed heat.

When the room temperature becomes 75 degrees the following happens in the struggle of the body to maintain its internal temperature regulation: the heart rate is increased, the walls of the blood vessels relax, the delicate linings of the nasal and throat passages are noticeably and unfavorably affected, the body is more susceptible to whatever poisons actually may be within it and, according to Dr. Leonard E. Hill, it demands an excess expenditure of nervous energy by the autonomic nervous system which keeps up the body tone and co-ordinates the activities of the glands and bowels. Air above 68 degrees cuts down the flood of oxygen-rich arterial blood in the nose and throat, diminishing the resistance of these tissues to the germs of respiratory disease which lodge there. This is largely why colds and pneumonia are more common among those who live in rooms which are heated to more than 68 degrees in winter. It is not the cold, bracing winter air that causes colds and pneumonia deaths; it is the over-heated rooms in which people live.

THAT does not mean that the wisest thing is to go with light underwear and no overcoat into a blizzard, as some health faddists claim. Cold outdoor temperatures are usually less injurious, however, because one can add clothing which will conserve the heat the body is producing, while temperatures above 68 can not be compensated for by clothing.

The brain and muscles suffer fatigue under temperatures above the critical point of 68—except for exceptional air conditions to be noted shortly—since the blood supply is automatically shunted largely to the skin where it will have the most cooling effect. With an increase in room temperature muscular strength decreases, the ability to memorize is diminished, and the rate of performing arithmetical calculations is slowed down, according to the experiments of A. Lehmann and R. H. Pederson. Records reported by H. M. Vernon to the Industrial Fatigue Research Board in England show that there is a 60 percent increase in accidents among men workers in the metal trades when the temperature reaches 80 degrees. The errors made by clerical workers also increase disastrously with rises in the room temperature.

The best air to work in is cool air. The healthiest air to live in is cool air.

Temperature alone does not tell all about air being cool. Probably everyone has had the experience of standing beside a radiator or hot air register and actually shivering with the cold, although the temperature was almost enough to scorch him. The heat causes a rapid evaporation of surface moisture, and this has a cooling effect. A handful of gasoline feels cold because it is evaporating rapidly; a handful of ether feels colder because it evaporates still more rapidly. Dry heat is more cooling than moist heat, but the paradox is that a moist cold feels colder. The amount of moisture in the air affects its cooling power. Relative moisture content, or humidity, as well as temperature, is essential in gaging the cooling power or desirability of room air conditions. A fairly useful index of the effect of air conditions upon efficiency is to multiply temperature by humidity.

SCIENTIFIC EXHAUST FAN

The fan (note arrow and circle) is near the ceiling where it draws off bad air

AIR in motion is also cooling air. That is where the electric fan has its beneficial effect. It is also to the credit of summer weather that the high temperature is usually offset to a considerable extent by the cooling power of the air which is in motion. The draft from the electric fan is not as injurious as most persons believe; if, in truth, it is injurious at all. It is only the aged, tiny infants, and invalids that need to be worried in the least about drafts. It is not the engineer and fireman on the railway passenger train who catch cold from their draughty cab on the locomotive, it is the passengers in the draft-free and overheated coach that acquire colds for reasons we have already seen.

The more people shut themselves up in overheated houses to "avoid colds" the more likely they are to acquire the very thing they think they have shut out.

Temperature, humidity, and motion are the chief factors in refreshing air. It should be cool air rather than warm air; it should be slightly dry rather than damp; it should be moving rather than still air; and it should vary somewhat from time to time.

This last factor of variability was attained excellently by pioneer heating apparatus—perhaps too well attained. Thermostatically controlled heat which maintains a temperature uniform to a half degree may be comforting, but it is lacking in stimulation. It presents the opposite extreme to alternately roasting and freezing in front of a log fire.

The lassitude known as "spring fever" is seriously attributed by many workers in these fields to be due to the lack of variability. A variability up and down the thermometer of five degrees is invigorating to health and stimulating to efficiency. Office workers in artificial climates kept at a uniform precision by thermostatic controls are half-way on the way toward spring fever. A walk outdoors at the noon hour, or throwing the windows wide open at intermittent periods, introduces some of the benefits of variabilty. A drop in temperature from 75 degrees to 64 degrees reduces the death rate by 10 percent!

"ELEPHANT AIR" is not necessarily bad air, although it is unpleasant and depressing air. Elephant air derives its name from the anecdote about the small boy who was invited to a birthday party a few weeks after having seen his first circus. Upon entering the home to which he had been invited he shouted with glee, "Oh! They're having a circus. I can smell the elephants."

The smell of the air is socially vital but it has no demonstrated health effects. Apparatus has been developed for infusing the air of a room with ozone to offset other odors, but to many the odor of ozone itself is distasteful. The claims that ozone also kills bacteria is not warranted, at least when in the concentrations at which it can be used in breathable dilutions. Chemists have developed perfumes with a multitude of scents to offset odors which are likely to occur under any ventilating system.

In replenishing the air in a room the most effective general plan is to arrange for room air to be exhausted from the top of the room. For the average room, to open one window at both top and bottom will provide a current system whereby outside air enters at the bottom, and the superheated air at the ceiling is exhausted from the top of the window. To reverse the direction of this stream is to bring the most ennervating air on to the inhabitants. Yet this is exactly what most legislation demands.

Hearing Without Ears

Bone-Conduction Equipment to Aid Partially Deaf Persons

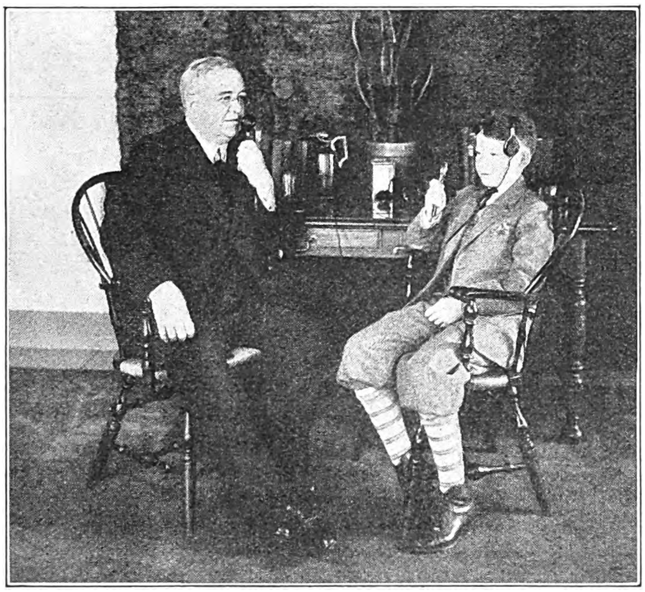
By GEORGE BARTON FRENCH

MANY children with defective hearing have been regarded by both parents and teachers as being dull mentally, the real cause being deafness which remains unsuspected until perhaps 30 percent of the hearing capacity has been lost.

No effort seems to have been made to date to provide hard-of-hearing public school pupils with an efficient mechanical hearing-aid at a reasonable price to enable them to receive not only the benefit of education but also the benefit of the companionship of their fellow-pupils. These children are not only embarrassed during their training period but the affliction, uncared for, will increase with advancing years and interfere to a large extent, if not wholly, with their ability in later years to earn a comfortable livelihood.

Deafness, in the case of a pupil in school is one of life's greatest handicaps. The desire to help a blind pupil is uppermost in the heart of every other pupil not similarly afflicted, but no such consideration goes out to the hard-of-hearing pupil from his or her school-mates.

VERY frequently, in the attitude of companions toward a deafened boy or girl, there is an exhibition of impatience, even resulting sometimes in a manifest desire to shun his or her society. In turn, the effect on these unfortunates is to make them impatient, suspicious, and fearful that they are objects of ridicule. The inevitable outcome is a sense of extreme despair. And these same truths apply with increased force to people who have advanced further in life with this same handicap.



VOICE COMPARISON: TEACHER AND PUPIL

The author, at left, shows manner in which the bone-conduction equipment is used to teach "voice" to a deaf person

Surveys show that there are in excess of 10,000,000 people in the United States with defective hearing, including 3,000,000 school pupils in need of treatment and of an efficient hearing aid to enable them to keep up with their classes.

Provided the acoustic nerve terminals of the inner-ear are intact, people afflicted with middle-ear deafness may now hear perfectly by a method of sound-transmission referred to herein as bone-conduction, this statement applying even to those whose ear-drums have been extirpated. While the principle behind this method is known to every otologist (ear-specialist) who uses a tuning-fork to test audition, its application as a practical aid to hearing is new.

To explain the principle of bone-conduction, a brief reference to the human auditory apparatus is necessary. The inner-ear—the business end of hearing—begins its process with a membrane called the oval window, on the inner side of which lies the labyrinth, a bony structure enclosing a colloidal fluid. The normal and sole purpose of the outer-ear and middle-ear is to cause this labyrinthine fluid to vibrate with the same frequency which existed in the original sound-waves impinging on the ear-drum of the outer-ear.

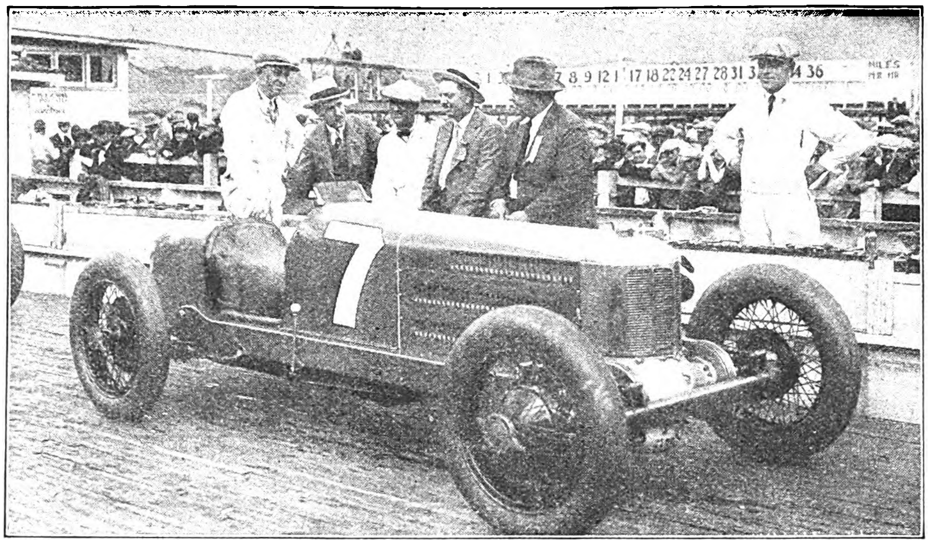
With a properly constructed bone-conduction receiver, it is now possible to vibrate this labyrinthine fluid without the use of any of the functions of the outer or middle-ear—practically a case of hearing without ears! The instruments employed are an electrical transmitter which replaces the outer-ear as a collector of air sound-waves, a bone-conduction receiver of special form which duplicates the functions of the middle-ear, an induction coil, and a dry battery, all of small size and weight.

The bone-conduction receiver may be placed in contact with any part of the head, preferably on the temple or mastoid bone. Its cover being thin and elastic, the vibrations of its diaphragm are transmitted with a minimum of loss through the skull to the bony structure of the labyrinth which, in turn, transmits the vibrations to the enclosed fluid.

In hearing by bone-conduction, there is no possibility of damage to the auditory apparatus by reason of the sonority of sound-waves, such as always is present when the ear is closed by the pressure of a telephone receiver which leaves no path of escape to the outside air for the sound-waves reflected back from the ear-drum. Such a path is provided by nature in normal hearing. Deafened people should never allow the ear to be completely closed by a telephone receiver, especially if it is equipped with a tip or nipple which enters into and closes the ear-channel.

The most important application of the bone-conduction method of aiding audition is in the teaching of articulate speech and intonation to so-called deaf-mutes. These unfortunates, although in full possession of a normal vocal apparatus, are unable to speak words correctly for the simple reason that they do not hear the sound of their own voices and therefore are unable to make a comparison between the sounds of their own voices and those of their teachers' voices speaking the same words or sentences.

DEAF-MUTE children, however, except in rare cases where the acoustic nerve itself is impaired somewhere in its central course, have some degree of residual hearing. The problem has been how to reach it. Today this special bone-conduction receiver, transmitting sonorous wave vibrations through the skull, is able to vibrate the labyrinthine fluid to the extent of forcing the hitherto dormant acoustic nerve terminals of deaf-mutes to receive and to transmit the sensation of sound to the perceptive center of the brain. Recently the writer, using a special bone-conduction receiver, was able in less than a half-hour to teach a boy, who never before had heard the sound of human voice, how to pronounce correctly the entire alphabet, also several short sentences, including intonation of the latter. A new world was opened to him and his delight over being able, through his own efforts, to speak correctly by a comparison of sounds would, in itself, be a sufficient reward for the efforts of any teacher.



MILLER FRONT-DRIVE RACING CAR
Taken at the Altoona track, this photograph shows the Miller car and its designer, Harry Miller, second from the right; in the center is Dave Lewis, at left Harry Hartz, famous drivers

Developments Born of the Speedway

Perfection of Racing Cars and the Terrific Tests They Undergo Teach Many Lessons to the Manufacturer

By WILLIAM F. STURM *

WHEN the Indianapolis Motor Speedway Corporation put out its edict directly after the 1929 500-mile race, that the rules for the 1930 event would be changed radically, there arose a great deal of discussion, pro and con. This discussion took place, not only among the racing drivers, but among the personnel of the automobile factories and extended in ever-widening circles into public channels, for the Indianapolis race is one of the outstanding sporting events of the world.

The new rules are, briefly: That the piston displacement of the engines for the 1930 race shall be limited to a maximum of 366 cubic inches; that valves of the poppet type shall be limited to two per cylinder; that the centrifugal type of supercharger which has been used at Indianapolis and elsewhere on the racing circuit for six years (since it was first introduced at Indianapolis by the Duesenberg brothers) shall be dispensed with altogether; that not more than two carbureters shall be used on the engine; that the bodies of the racing cars shall be not less than 31 inches in width at the cockpit and shall be two-seaters; that the car shall weigh not less than 1750 pounds, with a minimum weight of 7½ pounds for each cubic inch of piston displacement.

These new rules mean that the present type of racing car will have to be sent to the scrap heap. In order to get the proper picture, it is necessary to compare the 1930 car specifications with those that have been in vogue at Indianapolis and elsewhere in organized racing, which is controlled by the Contest Board of the American Automobile Association.

Since and including the 1926 Indianapolis race, the piston displacement limit has been 91½ cubic inches; any type supercharger was permissible; there was no mention as to the number of carbureters; there was no specification as to the width of bodies; and there was no specification that compelled the driver to have other than a single-seater car, which all the racing pilots have had for years. The weight limit was fixed at a minimum of 1450 pounds, although there were few cars that weighed that little, even without gasoline, oil, water, and the driver, as the rules called for.

THE great question: "Why are all these changes necessary?" was hurled by the drivers into the supercharged discussional air that surrounded the Indianapolis motor speedway and the pilots. And in the answer to the question lies the primary reason for the change—a reason that has no bearing on the likes and dislikes of the drivers, nor on the attitude which the race-going public will take on the change. That these two sides of the question — which at first thought would be considered paramount— were not even considered by the men who drafted the rules, gets right at the root of the matter, as the officials of the Indianapolis Motor Speedway Corporation view racing.

According to Edward V. Rickenbacker, former speedway racing driver, war-time ace, and now the president of the Speedway Corporation and an automobile and airplane executive, "the 500-mile race has not been considered as a sporting event, per se, but as an effort on the part of the Speedway Corporation to aid the automobile industry to solve the problems that progressively confront it. It is for that reason that we are making the radical changes in the rules for the coming race. The rules, however, were not drafted by the speedway officials; they were written by members of the Contest Board of the A.A.A. and a group of other men selected from the automobile industry—men who would look at the problem in the light of the greatest good to the industry that made the speedway possible."

The Speedway Corporation has always put up rich purses for the drivers, first place being worth in prize and accessory money, from 30,000 to 40,000 dollars. It has always been a good investment for the driver to spare no expense to design and construct his car so that it would win the 500-mile race.

The motorist who switches on the ignition in his car at the curb, never gives a thought to it. Yet the well-nigh perfect ignition on the car of today is due in part to the demand of the racing driver that he have a type of ignition that would stand up under the grueling test of the 500-mile race. It is no secret at all that more than one Indianapolis race has been lost because of ignition trouble. And it is no secret, either, that one of the most successful types of ignition used in the automotive industry today was freed of many of its "bugs" through the extreme demands of racing.

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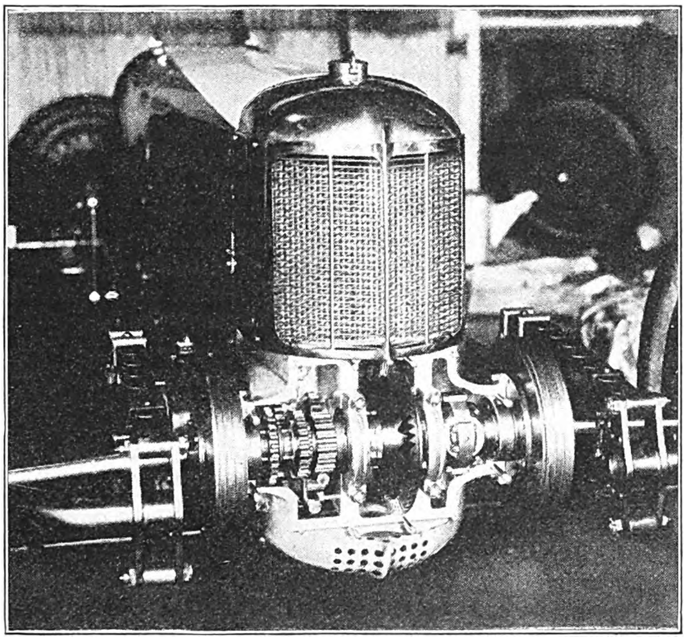
* See "Among Our Contributors," page 5.

The average car owner feels aggrieved if he can not take his car out on the paved highway and run it at high speed for hours. And he can do it, because much was learned from speedway racing concerning lubrication. A great part in the automobile engine of today is played by proper lubrication. The speedway races did much to develop the pressure-feed oiling systems that are found on the cars of today that go blithely on their way, day in and day out. The automobile industry profited through the racing driver's necessity, for the pilot had to have a system that would make lubrication positive.

Crystallization of metal used to play a certain amount of havoc with the automobile driver on the road. But if the man on the road had his troubles, what about the driver in the 500-mile race, hurtling along at 100 miles an hour over the rough two-and-a-half-mile course, with four corners to be negotiated in each lap of the track and with the rough brick course setting up more vibration in 500 miles than an ordinary road would in 5000 miles?



FRONT-DRIVE MECHANISM

Front end of the racing car in which Lewis finished second, 58 seconds behind the winner, at the Indianapolis Speedway in 1925

STEERING knuckles, steering arms, and front axles are three vital parts of an automobile, for if they get "fatigued" at the wrong spot in the journey the motorist may wind up in the hospital or the cemetery. For years the Indianapolis track was strewn with the wreckage of cars whose steering apparatus had failed. Today it is unusual for a wreck to be caused by such a fault. Why? Racing drivers have to have fatigue-proof metal, and what they have to have they eventually evolve or have evolved for them. The lessons learned in racing age for any one who cares to apply them.

Time was when a man thought he was "in clover" if he got 3000 miles of wear from his tires. Today tire factories promise ten times that distance and think little of it. The Indianapolis motor speedway has been one of the best testing grounds the factories have had. Tires that were developed for the 500-mile race have been of great aid in making a tire for commercial use that will withstand the high speed and the rough usage it receives at the hands of the driver of today's passenger car.

The difference between poor and good carburetion on the race course is often the difference between failure and success. Acceleration, an important function of the carbureter, is highly important at Indianapolis, with its four corners where the speed falls off and where it must be picked up again rapidly once the corners are negotiated.

IF one is inclined to doubt that carburetion and acceleration play an important part in the selling and using of cars on the street he need only "ask the man who owns one." No one wishes to run the risk of getting run over while driving across a street intersection by some up-to-date car with the proper acceleration; nor does he wish to be "left at the post" when the "GO" sign flashes.

The high-compression motor used by many factories today is a result of the need of the racing driver for an engine that would deliver the maximum of speed and not complain about the compelling power by vigorous knocking.

The "straight-eight" engine got its real test on the Indianapolis motor speedway, and its introducers in America, the Duesenberg brothers, actually combined their racing and passenger car engineering so successfully that their racing car still holds the 500-mile record at Indianapolis, while their passenger cars are recognized as among the fastest on the road. Other eights came along after the Duesenberg and one manufacturer even went to the extent of advertising that his eight was "born of the race track."

While four-wheel brakes are not so essential on the speedways as they are in road racing, Duesenberg, first American engineer to use four-wheel and hydraulic brakes, had his Indianapolis speedway cars equipped with them and gained much knowledge from their use there.

Racing cars, since the speed has risen higher and higher, have been designed with an eye to keeping them right side up. One of the essentials is a low center of gravity. A low center of gravity on the passenger car of today keeps it right side up on the road, where car speed now is faster than racing speed was only 20 years ago.

The Indianapolis Speedway did much for the present-day * front-drive automobile, which was first introduced in a race there in 1925 by Harry Miller, Los Angeles engineer. The first front-drive ran as faultlessly as could be, but as others were built and used they developed several bad "bugs" which it took years to eliminate. But the problems that confronted the front-drive were gradually solved under conditions much more rigorous than ever would be confronted on the road, and it was a racing engineer who developed the first passenger car of the breed. After two years of trying out, the front-drive has developed so far along the primrose path of automobile perfection that one of the most beautiful production cars of the present era is a front-drive. Another front-drive is now far on the road to success and production is expected to be started on it in a few months.

FOR all the years there has been an Indianapolis 500-mile race, there have been automobile factory engineers in attendance on it—car designers who come for a week before and stay for a week after the race. These engineers do not come out of mere idle curiosity; they come because they realize that racing is, in truth, the crucible of the automobile industry.

The Indianapolis Motor Speedway Corporation does not take all the credit for the development of the modern automobile. But in all the years that there has been an annual 500-mile race on the great brick course, the rules have pointed toward the one end—the greatest good to the development and experimental work of the automotive industry as a whole.

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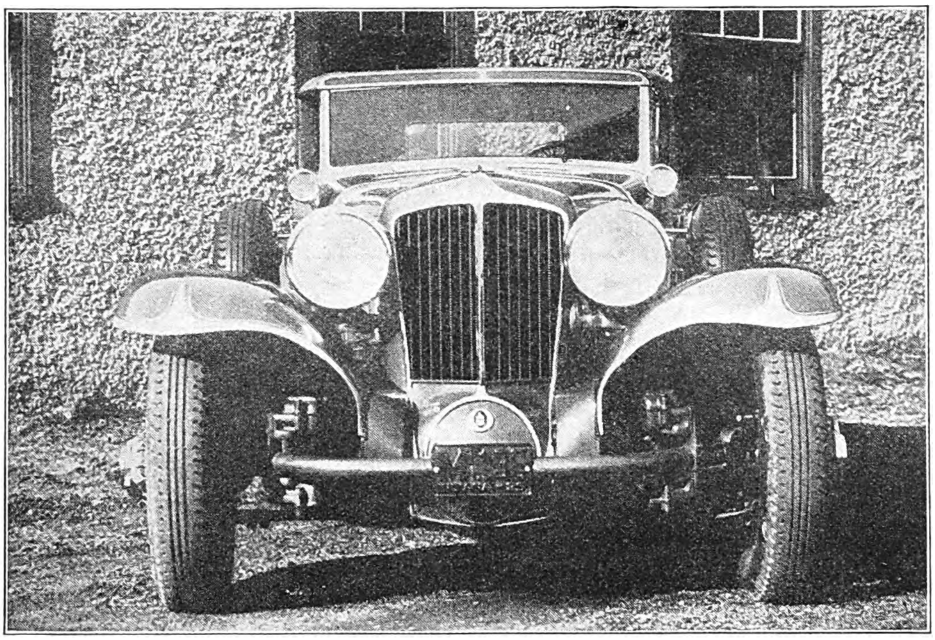
*Walter Christie built front-drive cars a score of years ago, but they were not made in any quantity, and soon faded from the automobile picture.

In 1911, when the first 500-mile race was run on the speedway, nine tenths of the production cars were of four-cylinder design, with huge engines—power plants whose pistons had a diameter of from five to seven inches and whose stroke was represented by the same figures. The power was derived from the great capacity of the cylinders and the combustion chamber, and this all made for a slow-moving, ponderous motor, which was considered "revving" at terrific speed if it reached 1800 revolutions a minute. The car was not "flexible," and this made for a lot of gear changing, as the least resistance to the car's forward movement meant a laboring engine, which called for an immediate shift into a lower gear. The oiling was of the splash type, that is, the cylinder walls and connecting rod bearings were lubricated by a spoon on the lower connecting rod bearing dipping into a shallow oil trough and literally splashing the oil to the parts needing lubrication.



NOW IN COMMERCIAL PRODUCTION

The front-drive principle, as applied to stock passenger automobiles, gives a rugged, clean-cut appearance. The illustration here is of the Cord car, described in detail on page 28

THE automobile as a whole and its individual parts were rather massive, for the industry had not yet learned that steering knuckles, axles, and other vital parts could be small and light as to weight, yet strong. The car was just a good big brute, with all the crudeness that one associates with a good big brute. And with it all, it sat well up in the air, and this height tended to make the center of gravity high and tended to make the car difficult to handle at speed.

Consider the car of today: The pistons are little more than half the size of the 1911 product. The combustion chamber is smaller and designed to handle higher compression than prevailed in the ancient cars. An engine that will respond on demand to a speed of 3600 revolutions per minute is not unusual. The oiling systems in a large degree are of the pressure type, designed to lubricate perfectly the bearings and the cylinder walls as the car floats along at from 50 to 90 miles an hour, in a way that never could have been done with the splash system, which considered itself overworked if it had to provide for a speed of 60 miles an hour for short distances, and whose operation depended a great deal on the car being fairly level for best results.

A great deal of attention has been paid to a low center of gravity in the present-day car. One has only to note the cars that go flashing by. Some of them seem actually to be rubbing the ground.

The car of the present moment is eight-cylindered, with experimental work going on in one or two factories for double that number. Multiple cylinders make for extreme flexibility. Gear changing is reduced to a minimum and one of the bugbears of women drivers is thus eliminated. The eight-cylindered car came to the Indianapolis track because the racing drivers recognized in its multiple cylinders something they needed in their business. It came into production because the manufacturers recognized in it something to fill a vital need.

After the 1911 and 1912 Indianapolis races had been run with cars of a piston displacement limit of 600 cubic inches, the speedway owners, with that rare vision that has made their race the wonder of the world, saw that the gravel and dirt roads would in time be giving way to those of the hard surface type. They foresaw the speed curve of the automobile rising higher and higher. They must have realized that in the nature of things the automobile would have to change to accommodate itself to the change in conditions under which it was to be used.

The then owners of the speedway, Carl G. Fisher, James A. Allison, Frank H. Wheeler, and A. C. Newby, had all prospered through the automobile industry and were due to prosper much in the future. They felt they owed the industry a debt of gratitude and the payment, they decided, was in the use of the speedway as a laboratory for the industry. In furtherance of this idea, they decided that the rules for all their races should be drafted so that they would anticipate by two or three years as nearly as possible the trend in the industry.

Accordingly, in 1913 and 1914 the piston displacement limit was set at 450 cubic inches, to anticipate the downward trend in the size of the automobile engine. At this time the race entries were all factory cars and in effect merely stripped-down stock cars.

IN 1915, 1916, and 1919 (there were no races in 1917 and 1918, the war years) the piston displacement limit was reduced to 300 cubic inches. Factories still participated in the race, although not so heavily as in the early years. Whereas even stock parts were used on the early cars, now began a gradual change from stock parts to specialized parts where the racing strain was greatest.

The year 1920 ushered in the rule that the cars must be of 183 cubic inches displacement. This year saw the real beginning of the highly specialized, specially-built racing cars.

In 1923 the displacement was re-

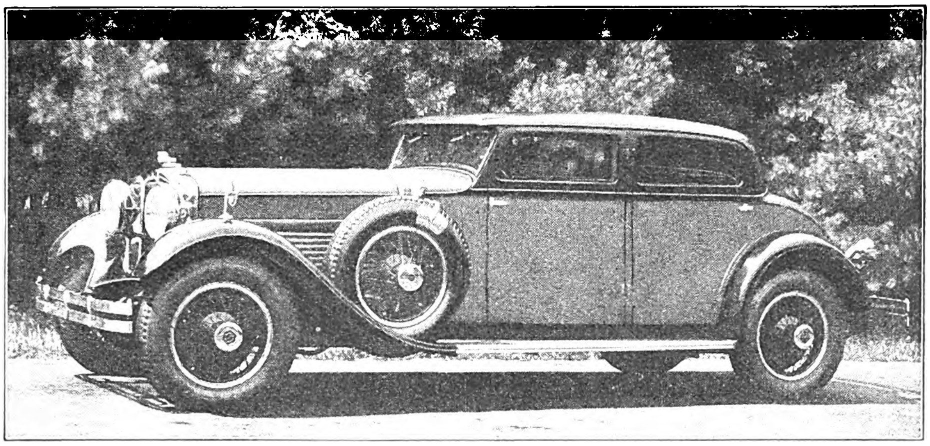
HIGH AND AWKWARD

One of the first: Elwood Haynes, the automobile inventor, in his 1893 buggy-like car, a sputterer which stood high on its wheels duced to 122 cubic inches and in 1926 this was changed still further downward to 91½ cubic inches, a quart and a pint, just half the size of the Ford motor of that day. That year, too, saw the inauguration of the one-man racing car.

There was a definite rise in the motor speed with the gradual decrease in the piston displacement. With 600 cubic inch cars the engine speed was approximately 1800 revolutions per minute, in rare cases 2000; the 450 cubic inch cars showed a rise to a top speed of 2300 revolutions; 300 cubic inches, 2800 to 3000 for four cylinder cars and 3500 for eights; 183 cubic inches, to as high as 4000; 122 cubic inches to a top of 5400; 91½ cubic inches to as high as 8400, with an average top of 7000.

IT is true that the present-day manufacturers are not using such high engine speeds, but they are able to get much valuable information from such speeds.

When the Indianapolis Motor Speedway Corporation reduced its engine maximum size to 91½ cubic inches it felt that it had reduced it to the minimum, so far as benefit to the industry was concerned. It had, through the ingenuity of the racing drivers and the engineers who did the work for them, shown the automotive industry (1) that engines with a top motor speed of 7000 revolutions per minute were possible; (2) that lubrication could be had at those speeds; (3) that great horsepower could be obtained from small engines, as these small supercharged power plants developed in excess of 200 horsepower; (4) that reciprocating parts could be so well designed and balanced that they would perform satisfactorily at such high speeds; (5) that parts of the automobile that had to withstand great stresses could be built strongly, even though of light construction.



LOW-HUNG, RACY, WELL BALANCED

In this modern car many things learned on the race track have been incorporated. The Stutz here shown, and its companion, the Blackhawk, were almost literally born of the track

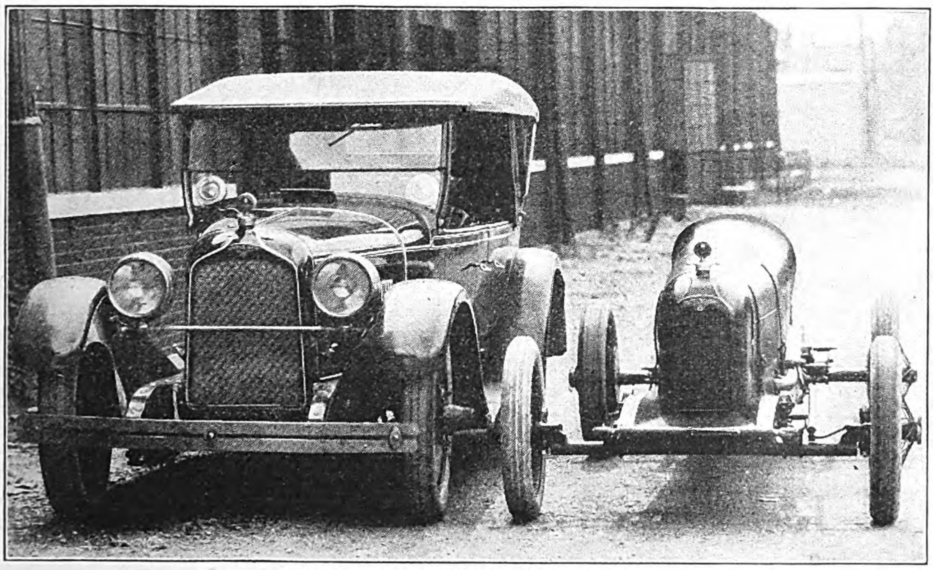
So long as a small high-speed engine would benefit the industry, the speedway clung to it. When the centrifugal type of supercharger was introduced and it was thought it would eventually be of use to the automobile manufacturer, the speedway aided in its development. Today it is known that the centrifugal type is not the supercharger to be put into the car that goes to the person in the street, because of its high speed—upward of 40,000 revolutions per minute on racing cars—and its delicate adjustment.

With hard paved, wide highways, and the demand for high speed in production cars, along with comfort, the demand has swung back along the trail. There will always be small cars and small power plants, it is true, just as there probably will always be four-cylinder cars in this class. But the medium-priced and the high-priced demand in America is for a car that approximates in size those of earlier days. The engines have not traveled so far along the backward road as have the cars themselves. High car speed and power may be had with a medium-sized motor, with high engine speed. These cars, with their multiple cylinders and other improvements, have all the flexibility to be attained with any engine, regardless of size.

With the demand, then, so well pronounced for a medium-size engine, the Indianapolis Motor Speedway Corporation, true to its tradition, feels that it must fall in line and aid in its development. It bans the small car, bans the supercharger, and asks the driver to get his carburetion from two carbureters instead of the eight that were used before the advent of the supercharger. Two carbureters are specified because that is the trend in the industry where eight-cylinder cars are concerned. The two-man body is added, because it more nearly approximates stock car design and the mechanician alongside the driver is expected to make racing safer, although this particular point may be open to question.

Now that the slow-speed, blower-type of supercharger, which runs at engine speed, instead of five times faster, is becoming a factor in cars that demand excess speed and excess power for heavy going, there is little doubt that the speedway may, in time, permit its use to aid the industry.

IT may all be explained in one sentence: The Indianapolis Motor Speedway Corporation feels that its track can be of more use in developing the features that are part of the cars of today, than in continuing to race with the highly-specialized small-engined cars of the past that have given all they have to offer to the industry.



BROTHERS UNDER THE HOOD

A Duesenberg touring car of 1926 and, beside it, the Duesenberg racing car of that year. Duesenberg, a veteran racer, was the first American engineer to use four wheel brakes

¶ *An ocean covered the land; millions of minute sea animals died, sank to the bottom, and the embedded mass became marble when the water receded. Marble, the memorial stone, will be discussed in an article soon.*

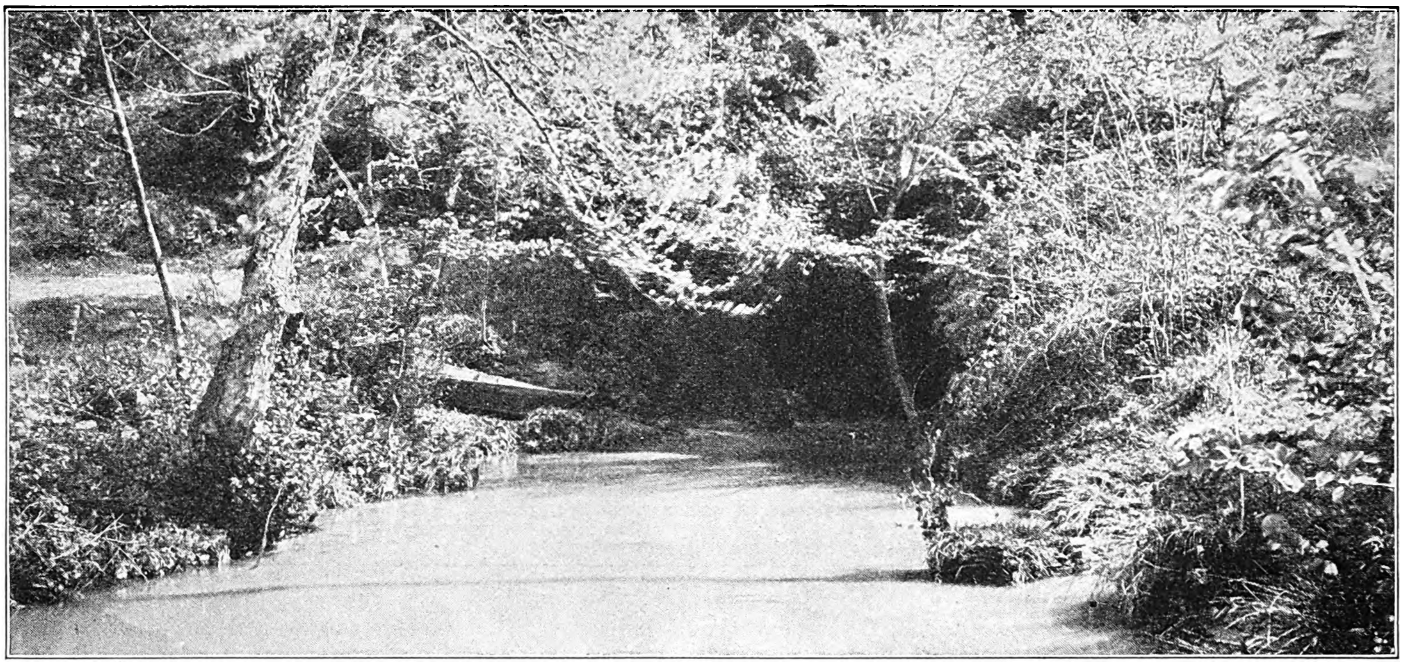


Photo by Max Bégouen

ENTRANCE TO THE CAVE OF TUC D'AUDOUBERT IN SOUTHERN FRANCE

Access may be had only by means of a row boat in which one ascends the stream a short distance, then clambers up through a small opening. The cave was discovered on his own estates by Count Bégouen in 1912. It contains many treasured evidences of prehistoric man

When Reindeer Roamed the Pyrenees—II

How the Anthropologist Explores the Buried Evidence of the Ancient Past and Reconstructs an Outline of Prehistory

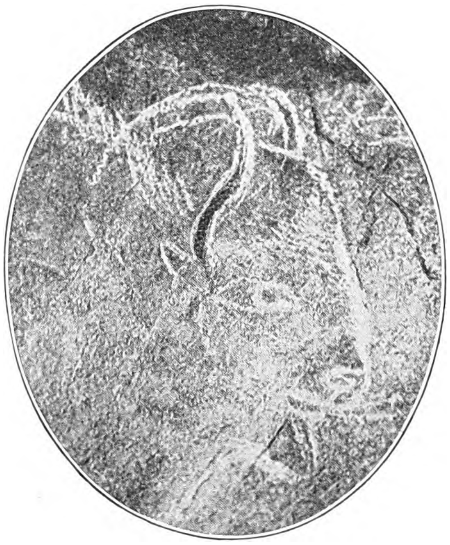
By IDA TREAT, Ph.D. (SORBONNE)
Co-author of "Primitive Hearths in the Pyrenees"

(Concluded from December 1929)

WHILE the sites of buried civilizations in Dordogne have for the most part been accurately mapped, there exists as yet no complete guide to the prehistoric underworld of the Little Pyrenees. Many "painted" caves have been discovered and explored and many Stone Age shelters excavated. But no one knows the exact limits of this portion of the cave man's country, for the whole district is honeycombed with caves.

THERE are caves with galleries vast as a cathedral nave and caves like rabbit-holes; caves that open gaping mouths in the hillside and caves completely choked at the entrance with earth and fallen rock; caves that consist of a single short tunnel, and labyrinth caves with dozens of branching passages. Some have long been known and explored; others no man has penetrated since the cave men left them; and still others for countless centuries have served as shelter only for wild animals—dens of the ancient cave bear and cave lion, and today the haunt of foxes.

Three of these caverns count among the great prehistoric art sanctuaries of France. First, the giant cave of Niaux that bores into the mountainside above the modern steel-town of Tarascon. There the visitor walks for over a mile through vast subterranean galleries of red and black-veined marble, coming at last to a chamber so lofty that the light of his acetylene lamp fails to reach the roof. At the top of a steep incline of sand he stands before one of the marvels of prehistoric art, a row of animal figures painted in black on the rock wall, startlingly life-like, a bison, horses, and a wild goat. In appearance, the paintings seem as fresh as if they had been traced there yesterday, but over them all lies a thin transparent "varnish"—a stalagmitic coating deposited there by the slow oozing of lime-charged water through the rock, a stony guarantee of their authenticity.



ENGRAVED BISON'S HEAD

From the cavern of Tuc d'Audoubert. Photographed by Max Bégouen

A FEW miles distant lie the twin caves of Tuc d'Audoubert and the Trois Frères, less spacious than the great cavern of Niaux, although the longer of the two is nearly a mile in length. Both are difficult of access. A subterranean river flows from the opening of the Tuc. To enter the Trois Frères, one must climb down a pit for over 100 feet at the end of a rope. Each cave consists of fairy-like chambers hung with snowy stalactites, low passages with barely space enough to crawl, and upper galleries which can be reached only by scaling vertical walls of rock.

The Trois Frères owes its renown to a series of 300 animal engravings and a strange figure that looks down from a high niche in one of the rock chambers—half man, half beast, perhaps the sorcerer or shaman of the cave man's tribe, or perhaps a strange god of this buried heathen world. The cave of Tuc d'Audoubert contains, together with many engraved drawings of animals, a unique example of prehistoric sculpture: two bison modeled in clay that today is as plastic as when the cave-artist laid aside his tools 300 centuries ago!

In these two caves as in no other, you realize that these underground art galleries were in no sense prehistoric habitations, but sanctuaries, hidden temples for the celebration of mysterious ceremonies and strange sacred rites. In one low chamber close by the modeled bison, you see hundreds of human footprints beneath a thin stalagmitic layer, footprints that go 'round and 'round as if in a primitive dance; while on the clay floor lie strange clay objects, modeled symbols of an ancient phallic cult.

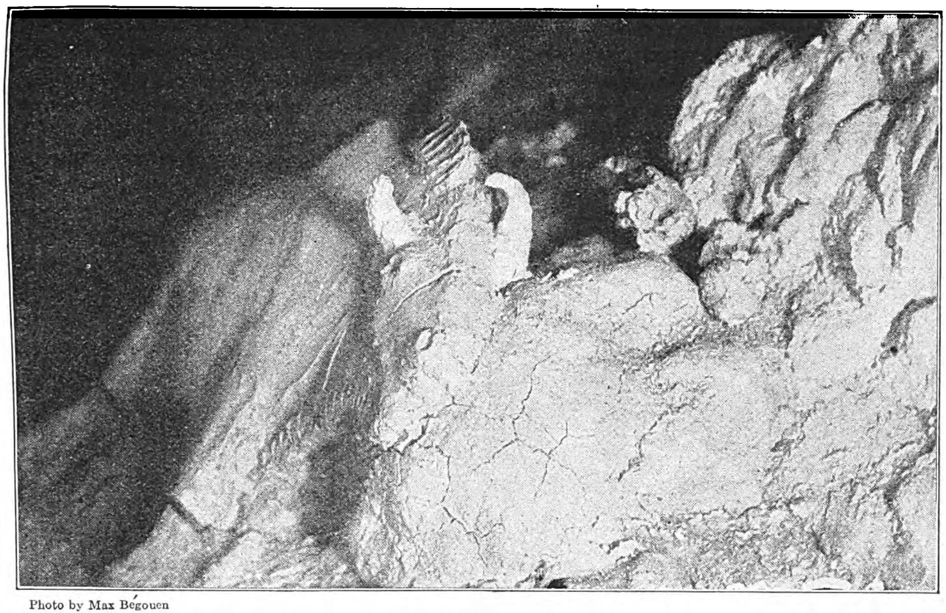


Photo by Max Bégouen

ONE OF THE MODELED BISON OF TUC D' AUDOUBERT

It and a male bison figure, which does not show, no doubt had something to do with magic rites supposed to control the reproduction of the animals used for the ancient hunters' food

YOU can imagine the scene: the weird glare of smoking torches, the crouched, dancing figures—faces barred with paint, and bulky garments of skins; and perhaps standing by the modeled figures of the bison the sorcerer himself, masked and terrible, the artist and master of ceremonies.

Here too you can understand why the cave man did not dare venture often into the dark inner recesses of the cave. Driven from the entrance by the presence of man and his camp-fires, the cave bear no doubt continued to haunt the labyrinth of inner galleries. Today you see his traces everywhere—his clawmarks on rock and floor, the hollows in the soft clay where he slept, and the imprint of the furry haunches and paws of the great beast, a formidable adversary at close range for men armed only with weapons of flint and bone.

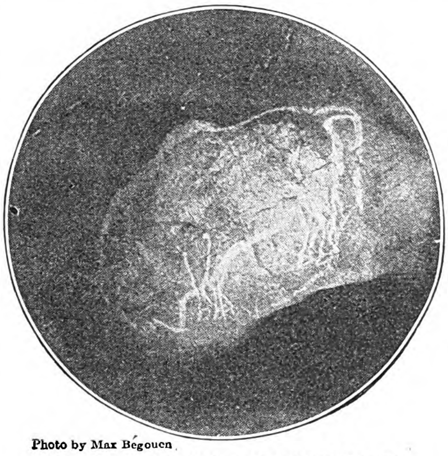


Photo by Max Bégouen

LITTLE BISON ENGRAVING

Also from Tuc. The prehistoric artist had a knowledge of form and posture that would do credit to modern art!

You may even conclude that the modern child's fear of the dark might well be a legacy from the cave ancestor to whom daylight or the glow of the camp-fire spelled safety, while darkness meant hostile, hungry beasts. The bold child or man who wandered away from the protecting flame risked a sudden and untimely end.

Aside from the three main sanctuaries there are other art caverns in the Plantaurel: Le Portel with its red horses and black bison; Montespan with its magic signs and crudely modeled clay figures; Gargas and its arabesque designs, its walls spattered with dozens of human handprints on a white or colored ground; and still other caves that contain isolated drawings, splotches of color or an occasional red arrow painted on the rock wall pointing to an upper passage or an inaccessible "chimney."

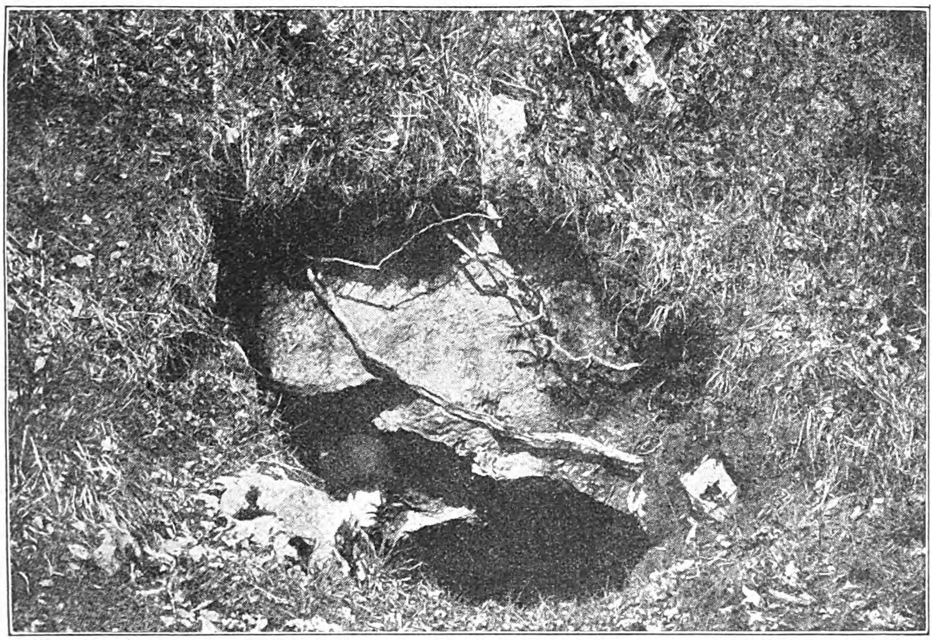


Photo by Max Bégouen

ENTRANCE TO THE CAVE OF TROIS FRERES

This cave, which is closely adjacent to the cave of Tuc d' Audoubert, was discovered in 1914 by Count Bégouen and named "Three Brothers" for his three young archeologist sons

BUT the caves that sheltered the cave man are far more numerous than the painted sanctuaries. Like modern towns that cluster about their churches, so the settlements of the Cro-Magnons seem to have comprised a multitude of rock dwellings in proximity to a cave temple for the celebration of his magic cult. Not that dwellings nor sanctuary were necessarily permanent, since the nomad hunters must have shifted their settlements as the herds of game wandered from one part of the region to another. But wherever they camped, the temple of their primitive religion seems to have formed a part of the cave man's life, fully as essential as the cavern that sheltered the tribe and its camp-fires.

For at least 50 years scientists have turned their attention to the prehistoric caves and shelters of the Plantaurel. They have discovered and explored painted caves and excavated the cave man's refuse heaps, removing the successive layers of ash, bone, and flint deposited there by Neandertal and Cro-Magnon man. But anyone who goes climbing today among the limestone ridges of the Plantaurel, pushing his way through the tangle of scrub oak and briar that masks the rocky slope, comes speedily to the conclusion that much of the prehistoric underworld still remains to be discovered.

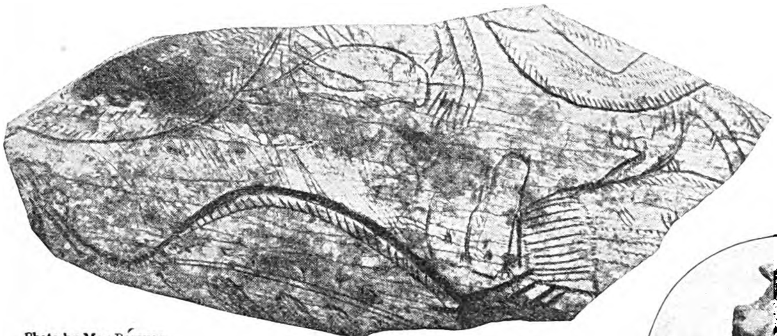
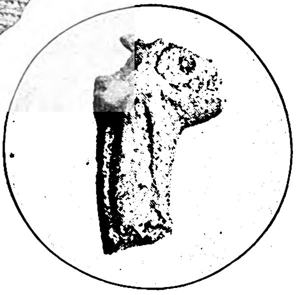


Photo by Max Bégouen



OBJECTS FROM TROIS FRERES CAVERN

Above: The only engraving of a prehistoric grasshopper (near top, in center). *At right*: Head of an ibex with eyes of flint. Probably both animals served as food

Since 1924, I have explored and dug in a part of the Plantaurel that lies about five miles distant from the great art caverns of Tuc d'Audoubert and the Trois Frères. In a district not more than 10 miles square, I have visited dozens of unexplored caves, their entrances for the most part hidden by underbrush or blocked with fallen rock.

ONLY a fraction of these had ever afforded shelter to Stone Age man who, I discovered, showed considerable similarity with the modern apartment hunter when he set about choosing his lodgings. He preferred commodious quarters, although not so vast as to be drafty, with wide openings to admit light and air, and wherever possible a sunny southern exposure. He liked caves that open on a broad terrace where in pleasant weather he could work and eat in the open; and he wished his water-supply close at hand. Such caves, I found, almost invariably contain traces of the cave man's presence and were occupied practically without interruption by the successive Stone Age populations. Caverns less favorably located sheltered intermittent guests; and some dark and drafty holes had served merely as an occasional night's lodging for groups of hunters. Of all the caves I visited, seven yielded prehistoric hearths. Three of these I have already excavated; the fourth cave is being dug.

Each time you enter an unexplored cavern, you look for two evidences of the cave man's presence—mural art and hearths. You advance slowly through the dark passages, holding your miner's lamp at arm's length and scrutinizing walls and roof for traces of color or the lines of an engraving. It takes no particular skill to detect a prehistoric painting on the rock wall, but you need a practiced eye to distinguish an engraved line from the natural cracks and fissures of the stone. Even when you succeed in making out a detail of the drawing it requires considerable focusing of the imperfect light before the whole design is visible in a complete and distinct outline. Often, too, the cave wall may be covered by a tangle of engraved figures, some standing on end, others lying on their backs—a confused interweaving of lines like a complicated puzzle.

No niche is too small to be examined. I remember one little horse no larger than the palm of a hand, exquisitely cut like an etched gem in a dark hollow of rock only a few inches above the cave floor. In an oven-like chamber so low that the artist must have worked lying on his back, the outline of a deer had been carefully engraved in the smooth limestone of the vault. As a general thing, spots which prove almost inaccessible to the modern explorer seem to have offered little difficulty to the prehistoric artist. It requires breakneck gymnastics to approach within reaching distance of the "sorcerer" in the cave of the Trois Frères; its creator must have clung like a fly to the vertical wall while he cut and painted the masked figure.

WHILE cave exploring in the Plantaurel does require a certain amount of acrobatics on the part of the visitor, it offers little actual risk. No more, in fact, than confronts the small boy who goes clambering among the rocks at the sea shore. The low passages through which you must crawl are generally smooth semicircular tunnels; in the larger galleries it is comparatively easy to avoid dangerous proximity to holes or rocks which look as if they might crash down at any moment.

The only really unpleasant caves are those that earthquakes have fissured and shaken into a chaotic disorder of rock and clay, but in these you risk little chance of discovering the cave man's trail. Disagreeable, too, are the "carrion" caves, pits into which the Pyrenees peasants have flung dead farm animals for many generations. Such caves you generally avoid, however keen your scientific curiosity, although it may happen—as it did once to myself—that while exploring a passage you may come upon such a pit. On that particular occasion, even before we realized the meaning of a heap of animal bones at the end of a long gallery, the flame of our lamps dwindled to a red spark from the lack of oxygen and we beat a hasty and undignified retreat.

Underground streams represent an

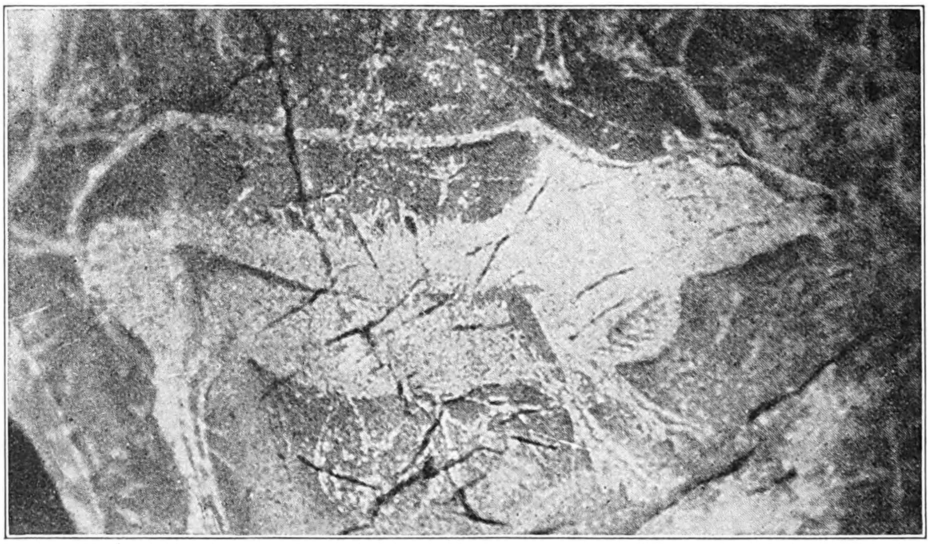


Photo by Max Bégouen

AN ENGRAVED REINDEER FROM THE CAVE OF TUC D'AUDOUBERT

The cave artist's tasks were not lightened by modern conveniences. His illumination was a flickering lamp (such as have been found); his tools were flint; smooth surfaces were rare inconvenience rather than a danger. Their volume in the Plantaurel district is rarely important, but the water is icy cold and to cross them means that you continue the exploration in clammy, sodden garments. If the water proves too deep to ford on foot, it is not over prudent to trust entirely to your ability as a swimmer. A couple of square gasoline cans make safe and convenient floats.

ASIDE from the prehistoric mural art which may, or even more frequently may not, be present on the cave walls, the explorer keeps an eye constantly on the cavern floor for traces of the cave man's hearths. For while Stone Age man did not inhabit the dark inner galleries, he occasionally built a fire there, perhaps to prepare a sacrificial meal. Frequently such hearths lie on the present surface, partially welded to the floor by a layer of stalagmitic deposit. Your light falls on a blackened stone or two, a few fragments of charred bone, a forgotten flint tool. It may be an engraving tool, the very *burin* that the cave artist used to cut the outline of an animal on the wall above!

Often, too, the primitive hearth stones may have been covered by a layer of clay brought there by water long after the days of Stone Age man. If so, the explorer's only resource is to dig. That is to say, you select a likely spot and make a "sounding." If lucky, you may happen on a hearth; more frequently however you encounter merely a layer of sand, stalagmitic material, or of flaked clay—the original "bear clay" of the cave bottom—that contains only the bones of the cave bear and his animal contemporaries, the cavern's earliest inhabitants. After a few fruitless attempts you generally give up the search for scattered hearths; their presence is always problematical and to find them would necessitate digging up the entire floor of the cave, an immense task.

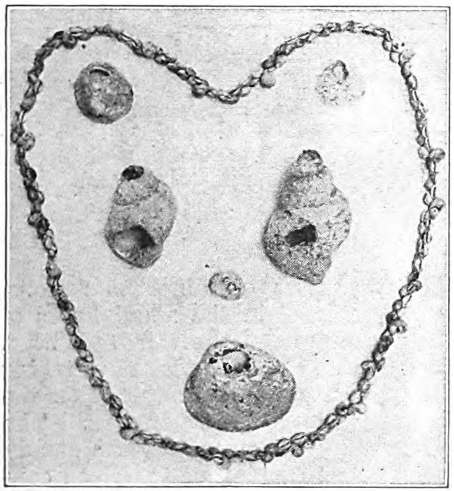
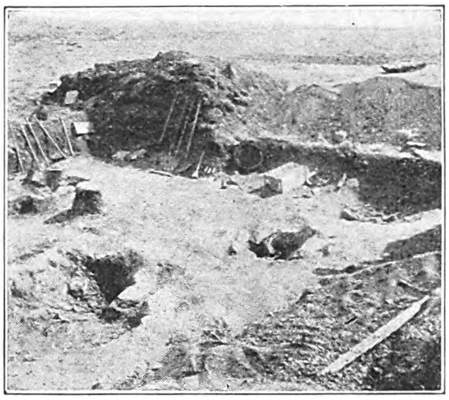


Photo by St. Just-Péquart

OBJECTS FROM THIVIEC

A necklace and ornaments. These objects date very roughly about 10,000 B.C.

Back in the entrance chamber of the cavern there is always a much better chance of finding prehistoric hearths and refuse heaps. A systematic search shows that fires were sometimes built in the center of the chamber, sometimes against the walls; or if the cave had many occupants, hearths may be distributed over the entire floor. You do not find them on the surface. They lie beneath a layer of stone fragments weathered and fallen from the roof, and earth brought in from out-of-doors by water or the paws of animals. Or they may be sealed beneath a stalagmitic layer. In one cave of the Plantaurel—the cave of Gargas—the stalagmitic layer is in places 20 inches thick. The excavator cuts through it with quarrier's tools, lifts off the limestone blocks and underneath, welded together in a compact stony mass, lies the kitchen refuse left there by Cro-Magnon man 30,000 years ago.



FINDS AT THIVIEC

At right: The prehistoric cemetery. Two skeletons and three hearths were found

In some of the more habitable caves, the digger finds heaped in successive layers the kitchen refuse of a complete series of Stone Age civilizations from Neandertal man to the Azilian fisherfolk. In others he may uncover traces of a single civilization. But in each layer, even though he may find no human bones, the animal remains and the type of flint and bone instruments tell in what civilization he is digging. A single flat harpoon says: "Azilian"; a fragment of reindeer antler means Cro-Magnon men; a triangular flint point and a rhinoceros tooth reveal the presence of the Neandertals. From the material taken from the ground and the carved and painted signs on the cave walls it is possible to reconstruct the history of the cavern through the long period when men of the Old Stone Age lived and hunted on the frozen steppe that today is southern France.

An occasional stroke of luck may bring to light an important discovery, but on the whole it is the painstaking every-day business of excavating that contributes the most valuable documents to the still incomplete record of the cave man's existence. The excavator's goal is not to find "museum pieces," although to dig up a fine bit of sculpture, a beautiful piece of chipped flint, or the bone of a hitherto unknown animal does represent the high-spots of his work. His task is to build up a careful cross-section of the far-away period from fragments which taken individually may appear quite unimportant.

"Stick to a site you know and dig it to the end," might be his motto. Indeed, the most important discoveries made in France within the past few years have come not from "wild-cat" prospectors for prehistoric treasure nor enthusiastic glory-hunters, but from men who for years have excavated—stone by stone and bit by bit of earth and clay—shelters and caves which, judged by their daily, weekly, or even monthly output, scarcely seemed to justify the effort.

Ten years of constant digging enabled Dr. Henri Martin to uncover a series of prehistoric burials and brought about the discovery of a sculptured stone frieze—bison, cattle, horses, and human figures—the most interesting example of the cave man's stone carving yet known. Careful excavations in an insignificant little cave of the Plantaurel led M. de St. Périer to find the little "Venus" of Lespugue, a tiny goddess of fecundity, the most beautiful of Stone Age images. Each year the patient work of Count Bégouen and his sons in the caves of Tuc d'Audoubert and the Trois Frères, and of M. Peyrony in the Dordogne region, bring to light new art objects carved in stone and bone by the primitive Cro-Magnon artist.

THE most recent discovery of the bones of prehistoric man was made not in the cave country of the Pyrenees, but on an island off the Brittany coast. On the barren little isle of Thiviec, in a thin layer of soil never yet disturbed by a plow, Monsieur and Madame St. Just-Péquart uncovered almost on the surface a veritable prehistoric cemetery. Among heaps of ashes and kitchen refuse they found primitive "tombs" containing marvellously preserved human skeletons. A peculiar feature of these burials was that each skeleton lay crouched beneath a tent-like structure of deer antlers. An examination of the animal bones and flint tools that accompanied the burials showed that this prehistoric cemetery is older than the curious stone monuments, the menhirs and dolmens of Brittany, that it dates in fact from the last period of the Old Stone Age. The men who lay buried on the island of Thiviec belonged to a race similar if not identical to that of the Azilian cave men of the Pyrenees.

Hunting Pocket Planets

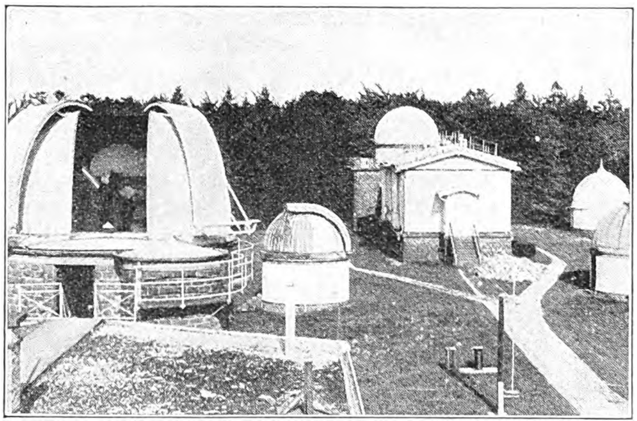
How the Astronomical Specialist Applies Scientific Management to the Systematic Search for New Asteroids or Minor Planets

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

IT is doubtful whether any man living could give from memory the names of all the known planets in our solar system. Many a reader may gasp at this statement and say to himself "Mercury, Venus . . ."; yes, every high school graduate knows or should know the eight large planets. But how about the thousand and more of small ones, the asteroids? The lore of classical, Teutonic, and Norse mythology has been well nigh exhausted in naming them; countries, cities, and universities have been commemorated, and to memorize the names which follow one another on a page or two of the list would be like recalling the names of the Pullman cars that leave a terminal station.

But before the tiniest planet can be named it must be discovered and its orbit worked out. In the old days of visual observation the search was most laborious. After making, through weary hours, a chart of all the faint stars in some region of the sky near the ecliptic where planets are likely to pass, the observer went over the region night after night hunting for stars not on the chart. In time he might find a moving body—a new planet. One enthusiastic amateur was so rewarded after 15 years of unsuccessful labor.



Photograph by David B. Pickering, courtesy of *Popular Astronomy*

SECTION OF KONIGSTUHL OBSERVATORY

Here Professor Max Wolf has discovered his long list of asteroids. The observatory is 1500 feet above Alt Heidelberg

BUT in modern times the discovery of planets has become a matter of "scientific management" and is done almost by machinery, thanks to the aid of photography. The pioneer in this work, Dr. Max Wolf, of Heidelberg, is still actively engaged in it after nearly 40 years of successful searching, and a recent visit to him at the Königstuhl Observatory suggested to the writer this present subject.

The asteroids are so small that they look exactly like stars, even with the greatest telescope. They may be distinguished from the thousands of faint stars which fill the field of the plate only by their motion. Fortunately this motion is fairly rapid, averaging about a quarter of a degree a day or half a minute of arc in an hour. If then an astronomical camera is directed toward the proper region and an exposure of two or three hours is made, following the stars carefully with the aid of a guiding telescope attached to the instrument the stars will appear on the negative as black dots, but the asteroid as a streak or trail which may immediately be picked out on inspection of the plate. All that is necessary is to pick out a likely region, preferably on the ecliptic and nearly opposite the sun, take the photograph and keep on again and again till the wished for trails appear.

A powerful instrument with a wide field of good definition is required and it is very desirable to have two such cameras mounted side by side on the same axis, as Dr. Wolf has. Then the reality of the faint trail may be confirmed "out of the mouths of two witnesses" and there will no longer be trouble from defects on the plate which occasionally look so much like planet trails as to deceive even the experienced observer.

All the known planets which fall within the field of the plates are of course automatically rediscovered, along with any new ones which are bright enough to appear. It is possible theoretically to calculate in advance where the known planets ought to be, but this is so much work that it is easier and cheaper to rediscover everything and then pick out the planets which are already known. This demands less calculation.

How things go at present is illustrated by the report of last year's work at Heidelberg. Sixty pairs of plates were taken by Dr. Reinmuth with a 16-inch double camera, and 139 single plates by Dr. Wolf with a 28-inch reflector. Upon these plates 99 new planets were discovered and 148 known ones re-observed. A comet was also discovered by Dr. Reinmuth.

It is evident that the asteroid seeker has still pretty good hunting. On the average 1¼ new planets were discovered for every pair of plates taken with the double camera. With the reflector, which has a much smaller field of good definition, one discovery was made for every five and a half plates taken, but these plates are of great value in recording the position and brightness of the very faint stars and so have additional scientific usefulness.

So far as the mere exposure time goes a planet was discovered for every two hours work with the camera and every four hours with the reflector. But this statement, while it shows to what an admirable degree of efficiency the asteroid work has been brought by years of experience, gives no idea at all of the amount of work which is involved.

SOMETIMES clouds come up and spoil promising beginnings. Moonlight fogs the plates so that no work can be done near the time of full moon. Clear moonless nights must be utilized to the full, although the flesh threatens rebellion.

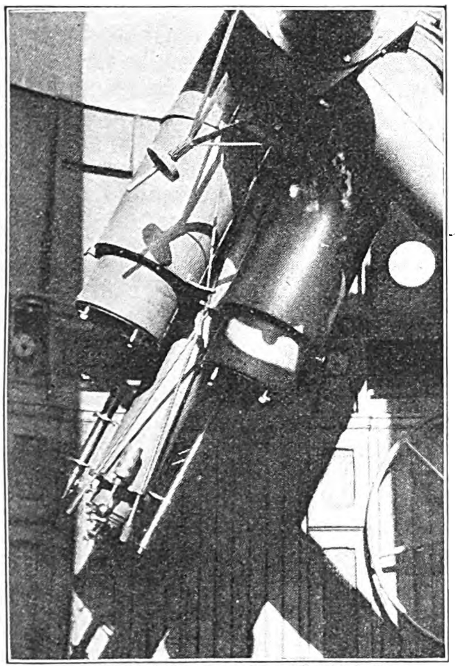
There is a tale of a young assistant who, having completed two three-hour exposures on different regions, started in the small hours of the morning upon the third. With a good driving clock the task of watching the guide star and keeping it on the cross wires was not strenuous. The surrounding darkness and the steady monotonous clicking of the clock control did not encourage insomnia, and the observer knew no more till he was awakened by the rays of the morning sun shining faintly into the dome.

When the plates are taken and developed the heavy work is only begun. They must be most carefully examined under the microscope, going over every square millimeter of the image in order that nothing be missed. The new planets are all faint—if they were bright they would have been picked up in past years—and only an experienced observer can be sure that the faint trails are real. But suppose that a trail has been found, confirmed on the duplicate exposure and marked on the plate. Before the discovery can be of use to anyone else, the planet's exact position must be measured. This demands more work with a micrometer microscope, measuring not only the planet but neighboring stars whose places in the heavens are accurately known, and following up the measures by the necessary calculations.

Then the planet must be found again and observed on at least three nights if a rough orbit is to be calculated. With set fair weather this is not difficult, but only too often unfriendly clouds intervene or the full moon puts a stop to observation and when the next good chance comes the planet can not be found.

IT may have been receding from the earth and have grown fainter, or the rough idea of its motion gained from the original trace may not suffice to locate it after a fortnight. Anyway a considerable fraction of the newly discovered planets get lost again before the three requisite observations have been obtained, despite the best efforts of the observer. Sooner or later these lost planets are likely to be rediscovered and it is a commonplace to hear that a calculation reckoning back with the aid of the orbit finally computed from an adequate set of observations, has found that observations of "lost" planets in earlier years belong to the same body.

Planets get lost in another way, too. The observations of the first season are often insufficient to give anything better than a rough orbit, and if the planet is missed for a year or two thereafter the calculated position will no longer be good enough to tell where to point the camera. Some planets are thus lost for decades and then rediscovered. For example, an asteroid discovered in 1873 and named Aethra was lost in this fasion and only rediscovered in 1922, nearly half a century afterward.



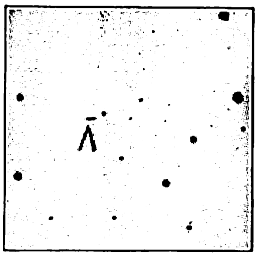
Photograph by David B. Pickering, courtesy of *Popular Astronomy*

DOUBLE 16-INCH CAMERA

Between the duplicate photographic refractors is a ten-inch finder for visual use

The number of "known" asteroids for which we have good, or at least fairly good, orbits now amounts to more than 1100. Yet two new ones are still discovered for every three old ones that the plates pick up. It is reasonable therefore to conclude that there are at least 700 more which await discovery. Making allowances for improvement in the methods of search it appears probable that the number of small planets in our lists will reach 2000 before the hunting becomes poor enough to discourage further searching.

Even then, the observers will still have plenty to do and the theoretical astronomers much more. The orbits of the asteroids come much nearer to Jupiter than do those of any of the larger planets, and the changes in the orbits produced by Jupiter's attraction are correspondingly great. An accurate calculation of the perturbations of one of these "little rocks" would in most cases be an enormous job. If it should be desired to predict the position as accurately as it can be observed, each of the 2000 asteroids would demand an amount of mathematical work which would average at least as great as that involved in the famous Lunar Theory. Roughly speaking one may guess that from 30 to 50 years work by a skilled mathematician with assistant computers would be required in a typical case. There is no fear, then, that the lovers of celestial mechanics will be in danger of idleness for centuries to come.



From Russell, Dugan and Stewart's "Astronomy." Courtesy of Ginn and Company

DISCOVERING AN ASTEROID

The technique is described in the text. Arrow points to asteroid's trail (retouched)

Photograph by David B. Pickering, courtesy of *Popular Astronomy*

PROFESSOR MAX WOLF

"... with iron-gray hair and beard, twinkling eyes beneath bushy brows .."—D.B.P.

There might seem to be some fear that the asteroids would get quite out of hand and utterly outrun the powers of the calculators. But fortunately it is relatively easy (for a few experts!) to calculate the influence of Jupiter on an asteroid's motion, closely enough to predict its position in the sky within a few minutes of arc. With the aid of such tables we can be confident of finding the little planet again, even after letting it out of sight for 20 or 30 years. If we point our camera at the tabular position the asteroid may not turn up exactly at the center of the plate, but it will be safely *on* the plate and that is all we need to keep track of it.

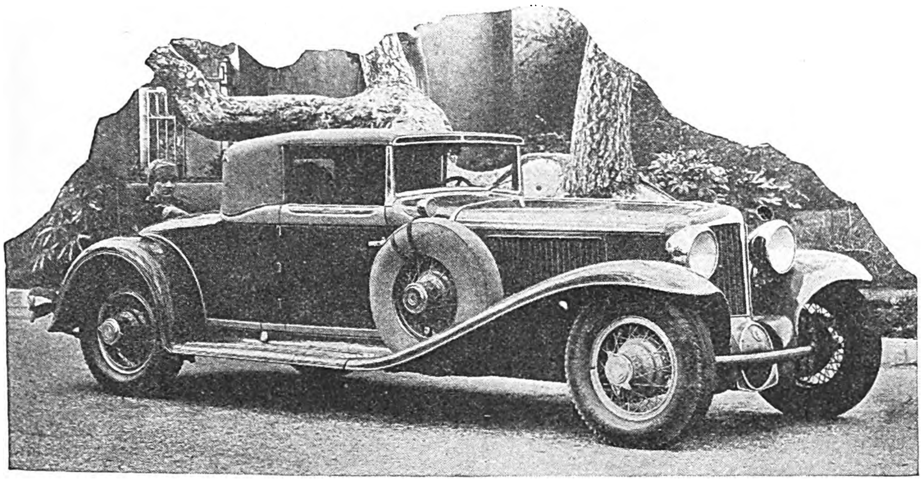
Observation of the small planets in this fashion should, so far as can be seen, keep a few observers busy indefinitely. The course of their work is likely still to be enlivened by occasional discoveries. A number of asteroids are known which move in very eccentric orbits and approach the earth's orbit closely on one side of the sun but are far away on the other. When such a body comes to opposition at or near its point of closest approach, it may be tolerably bright. When in the opposite part of its orbit, even at opposition it may appear 100 or even 1000 times fainter.

TWO or three such planets are known which are so small that they can be observed only in the favorable years of close approach. There must be many more that are undiscovered, and picking them up at one of the rare occasions when conditions are favorable may interest the observer of the future, after the general run of the less interesting planets have been accounted for.

It is impossible to conclude without a word of enthusiastic admiration for the courage, skill, and devotion to science which enable Prof. Wolf and his associates, in spite of severe limitations in the finances of their observatory, to discover planets at the rate of a hundred a year, and moreover to make other important contributions to the advancement of astronomy which there is not space to relate.—*Pontresina, Switzerland.*

An American Front-End-Drive Car

Many Advantages Seen for the Front-End Drive Which Has Recently Been Applied to an American Pleasure Car



THE CAR THAT "PULLS" ITSELF INSTEAD OF "PUSHING"

One model of the Cord automobile, the first stock American car to have front-end drive. Standing only 61 inches high, it is said to introduce greater safety and driving ease

INTRODUCTION by Auburn of the Cord front-drive automobile marks a new era in the automotive industry, in which America leads the world. While Europe took the first lead in the front-drive principle of automotive propulsion, limited production facilities and the smaller markets kept these cars from making great headway.

The history of the front-drive car in America is mostly a racing history, but it is replete with progress and accomplishment. Barney Oldfield as early as 1912 introduced the front-drive car to the American speedway, piling up many records with his car known as the "Christie," but it was left to Jimmy Murphy and Harry Miller to introduce the all-American front-drive car in 1924. Murphy died in that year, and the car was finished by Miller who entered it in the Indianapolis Speedway races Decoration Day, 1925. The car was driven by Dave Lewis and won second place (100.82 m.p.h.), in the fastest race ever held on the speedway.

Since that time the front-drive car has been a formidable contender in every major race in the country with such drivers at the wheels as Pete DePaola, Harry Hartz, Leon Duray, Cliff Woodbury, Pete Kreis, and Hepburn.

It is interesting to note the comment of Harry S. Miller on the reasons for his going over to the front-drive type racing car. He says:

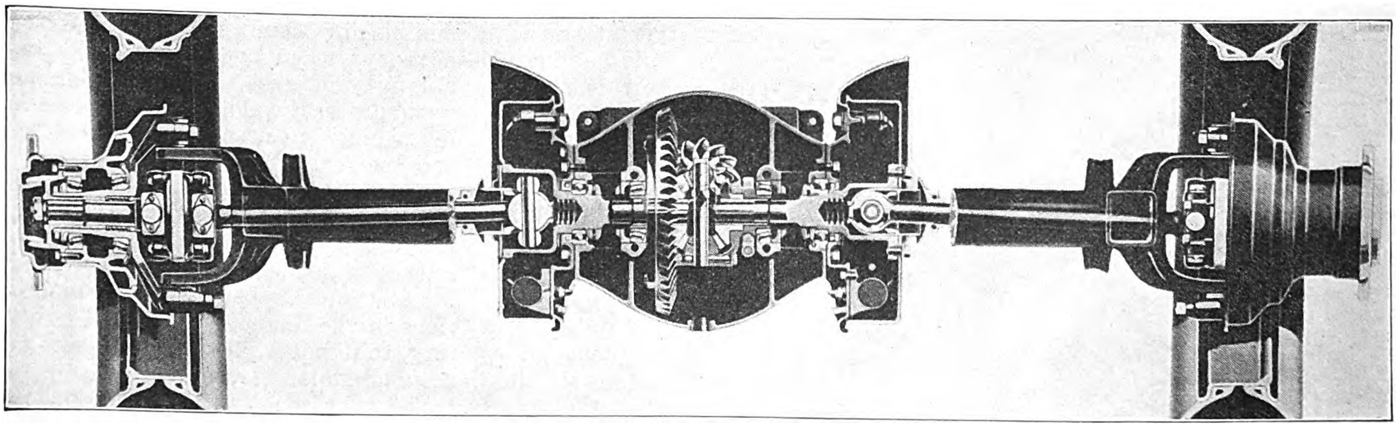
"I do not believe that the front-drive car is any faster than the rear-drive type. The reason why it can make better time on the speedways is that it is unnecessary for the drivers to slow down around corners, the skidding of the front-drive type being reduced to a minimum. The success of the front-drive car has been in the safety factors which it provides. It is a monumental record that in the five years front-drive cars have been used on the speedways there has never been a death due to one of these cars getting out of control."

While racing has its interest to the public, most car owners want to know what the front-drive has to offer them. The consensus of automotive engineers is that the chief contribution of the front-drive type automobile is, like that of the racing car, safety, with a second consideration of comfort, and possibly a third in economy. Three factors make possible the added safety of the front-drive car: its unusual lowness of design (it fairly hugs the ground), its lack of unsprung weight, and its "pulling" traction.

Some two years ago Harry Miller became associated with E. L. Cord, President of Auburn, in the production of a front-drive car. After eighteen months of experiments, with experimental cars on the roads day and night, the Cord front-drive car, built around the Miller patents, was announced.

PROBABLY the most noticeable feature of the new car is the closeness with which it hugs the ground, and yet it has a road clearance equal to most rear-drive cars. An ordinary size man standing beside it can look over the top. The phaeton-sedan, for instance, is only 61 inches high at the peak point, but even with this low construction head room is a full 38 inches. The average rear-drive sedan stands 70 to 73 inches with the same amount of head room.

Striking in appearance also is the long hood which is 46 inches in length, giving the car an unusually fleet and powerful appearance. The front fenders have an over-all length of 80 inches, and are the longest used on any production car. They are of the one-piece type and their long, sweeping lines add again to the fleet appearance. The

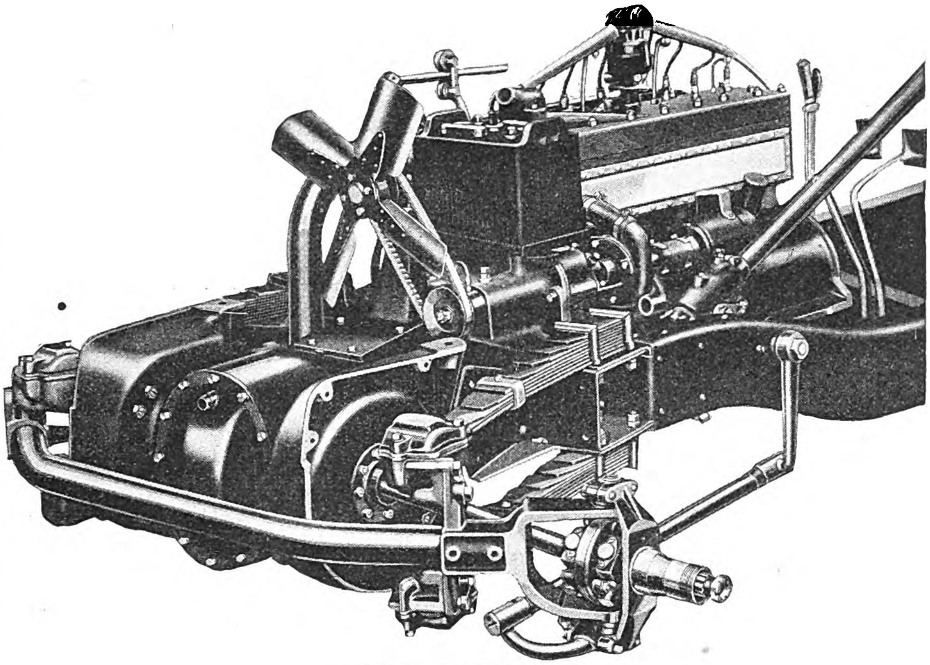


THE FRONT AXLE IS THREE QUARTER FLOATING

To transmit power to the front wheels and at the same time permit turning at a sharp angle presented a problem which the engineers finally worked out successfully by designing a special universal joint. Transmission, differential, and short drive-shaft are back of front axle radiator is of the "V" type similar to the design used on Miller racing cars, although much larger, with the top line of the hood practically parallel with the ground. The body itself is streamlined throughout, with the rear seat on the same level as the front.

From a mechanical and engineering standpoint the front axle and method of drive are of chief interest. With the new Cord front-drive the engine, the transmission, the drive shaft, the differential, and the driving axle become a single power unit, thus adding to the efficiency.

The front axle is three quarter floating, and consists of a latitudinally bowed tubular member joining the steering knuckles. The propeller shafts are entirely separate from this, entering only at the ends where the steering knuckles are attached. The transmission and differential are all located directly back of the front axle and are mounted on the frame of the car, becoming sprung weight.



THE POWER PLANT

Engine of the new front-drive car. Here will be seen manner in which all except front tubular axle has been made sprung weight. Note special universal and method of steering

UNIVERSAL joints are provided in the propeller shafts, the two inner ones being of the Universal Products type, and the two outer ones of a special constant velocity type patented and used for the first time by Auburn in the front-drive car. It is this special universal joint that has made the Cord car possible. Heretofore, designers of front-drive cars have been hampered by their inability to obtain a universal joint which would give constant velocity to the front wheels when making a turn. Race drivers who have used the front-drive cars were under the handicap of having to make wide turns. Through the use of this new type universal joint the turning radius of the car has been reduced to 21 feet, or less than that of any rear-drive car of the same wheelbase.

Another outstanding feature of this front axle is that the king pin is perpendicular and that no transverse inclination has been necessary. This permits the use of a longer king pin and greater bearing surface, resulting in easier steering.

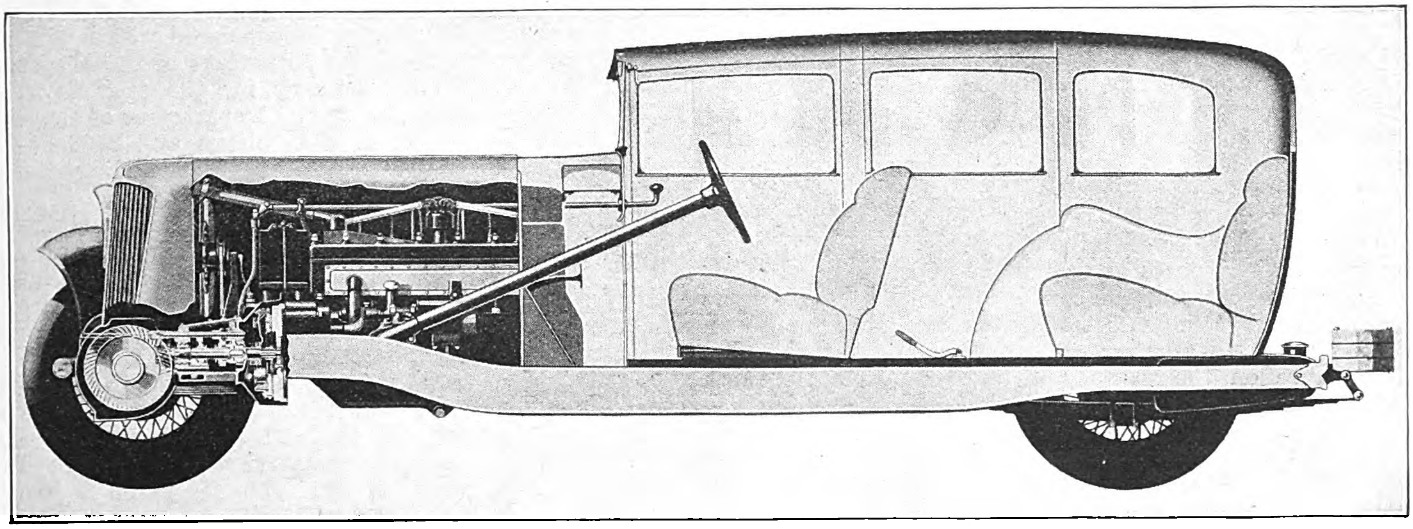
In detail, the car is powered by a straight-eight, 125 horsepower, Lycoming motor, which has been developed especially for this model. This engine is reversed from the usual type, the flywheel being in front, next to the transmission. The rear axle is of the I-beam type, and is approximately of the same weight as the front axle of the ordinary rear-drive car.

Brakes are Lockheed, 4-wheel internal expanding hydraulic, with a division of braking 60 in front and 40 in the rear. The emergency brake is operated by a hand lever well forward in the front compartment, and brakes on the rear wheels. The gear-shift lever extends through the instrument board and operates by a thrust turn.

The chassis frame has been made unusually strong, the channel stock being 7 by 3 by 7/32, and is unusually heavily reinforced by an X-cross bracing. Front springs are of the double quarter elliptic type, with the spring ends set in rubber. The rear spring is of the semi-elliptic type, and is built unusually rugged.

Through the elimination, at the rear, of the differential, transmission, and long drive shaft, it has been possible to design straight body sills, the elbow type of the rear-drive being unnecessary for the clearance of rear axle housings, which enables the rear of the body to be set much lower, the rear seat being on the same level as that of the front seat. The body of the car rides unusually low, and while the over-all height is considerably less than that of the rear-drive car, the head and leg room are greater. Average front head room is 38 inches and the rear 38 inches. The front seat is adjustable.

Four models are available, a Sedan, Phaeton-Sedan, Cabriolet, and a Brougham, all on a chassis of 137⅝-inch wheelbase.



PHANTOM VIEW OF FRONT-END-DRIVE CAR TO SHOW LACK OF BENDS IN CHASSIS FRAME

The Truth About Aviation Stocks

Basically Sound, the Aircraft Industry Has Suffered Severely From "Growing Pains," But Is Now Becoming Stable

By REGINALD M. CLEVELAND

AVIATION, that precocious infant among industries, which has leaped from the cradle to its majority—in performance at least—in less than half the time the human being requires to come of age, presents the anomaly of still suffering rather severely from growing pains.

In fact, in the last few months, these troublesome attendants upon growth have become severe. The industry, although fundamentally sound, and destined, in the belief of the writer, to have an even more important future than some of its rosiest protagonists have painted, is in a condition of confusion, of uncoordinated effort and, in many of its branches, of a very definite and disturbing over-production.

When, upon the impetus of the Lindbergh flight, and with the stimulation supplied by the gradual turning over of airmail operation by the Government into private hands, the industry quickly gained the immense momentum which has been manifested for the last year and a half, it was perhaps inevitable that it would build its house to some extent upon the shifting sands of dreams rather than upon the enduring rock of public service and patronage.

AVIATION securities, eagerly snapped up by an air-enthusiastic, if not truly air-minded, public, have come tumbling down in value. This does not refer to the spectacular events, the orgy of hysterical and distressed selling, which affected Wall Street in the closing week of October and saw aviation stocks tobogganing along with those of far longer established and more fundamental industries. I refer to a decline, less immediately impressive but more fundamentally disturbing, which took place, broadly speaking, all through the summer.

The performance of ten representative air stocks is reflected in the following table. The figures given are the high for the year and the low as of October 14, before the general avalanche of selling affected all stocks of whatever nature on the markets of the United States.

NEW YORK STOCK EXCHANGE

High		Oct. 14
20	Aviation Corp (Del.)	11½
104⅜	Bendix Aviation	65
37⅛	Curtiss-Wright A.	27
48¼	National Air Trans.	20
162	United Aircraft	106

NEW YORK CURB EXCHANGE

48½	Aero Underwriters.	29½
89⅞	Aviation Corp (the Americas)	40⅛
67½	Fokker Aircraft	35½
18	Roosevelt Field, Inc.	6½
78¼	Western Air Express	44½

A study of other aviation securities would reflect a like general tendency.

IT is not contended that all of the losses in values shown were justified. The worthy declined with the unworthy, due as much as anything, it may be, to an awakening on the part of the public to the fact that *gross* earnings from manufactures, plus those derived from the transportation of airmail and the irregularly profitable transportation of passengers, could hardly exceed, for the year 1929, the sum of 100,000,000 dollars out of which only *net* earnings would be applicable to an investment of close to 1,000,000,000 dollars.

It must not be supposed that, because the ratio of income to investment is so unalluring as yet for the industry as a whole, certain soundly organized and ably managed companies in the fields of both manufacture and transportation are not upon a healthy and profitable basis. The trouble has been that the sudden loosening of the purse strings of both the banks and the public, and their readiness to leap to the support of almost any or every enterprise which could be linked with aviation, has been far from an unmixed blessing. Altogether too many inexperienced persons and ill-conceived manufacturing and transportation programs have entered into the picture.

These must necessarily fall by the wayside. They are already doing so. Certain types of aircraft, notably the smaller planes unbacked by substantial performance records, remain unsold in hangars and stockrooms in many parts of the land. The state of overproduction is very definite.

Again, on the transport side of the picture, too many inexperienced operators, lured by the undoubted substantial profits which have been made in many instances in the transportation of airmail, have been led into the inauguration of passenger-carrying services. Some such services are already distinctly profitable. Many—one might almost say most—are not yet profitable, chiefly because the American public, while reading, talking, and thinking avidly of aviation, does not as yet take sufficiently to the air.

There can be but one result in a situation of this kind. The intelligently conceived, soundly managed, and well financed "strong" companies will survive. Those that do not have these characteristics, both in the manufacturing and in the transportation ends of the business, will cease to be. From the point of view of the investor it is a time for careful analysis and rigid selection in the purchase of aviation securities.

How far short the year 1929—in spite of overproduction in certain types—will fall, in comparison with the optimistic estimates which marked the beginning of the year, may be gathered from an examination of the comparative figures. The early estimates set the probable plane figure for the year at 12,000 to 15,000. There were actually manufactured in the first six months of 1929, according to the figures of the Aeronautical Chamber of Commerce, a total of 3381 airplanes (including 527 for military use) and 3826 engines (including 551 for military use).

THESE figures, which represent 93 percent of the industry, do not indicate a total production of planes exceeding 6500 to 7000 for the year, or of engines in greater number. The figures may be compared with a total representing 95 percent of the output of the industry for the year 1928, according to the Department of Commerce, of 4345 planes and 3496 engines—in both cases including the military.

It is estimated, according to statistical studies made by Air Investors, Inc., that 75 percent of all the industry's activities are carried on by less than ten companies. On the other hand, the Chamber of Commerce lists 278 companies claiming to be aircraft manufacturers. Of these it is possible that 200 will have manufactured some aircraft during the year. If 7000 units be taken as the total, this will bring an average production of 35 planes per manufacturer, obviously not a basis upon which profitable manufacturing could be carried on. The fact is that a handful of companies will of course have very much larger production than this average and that most of the rest will no longer be in the aircraft manufacturing business.

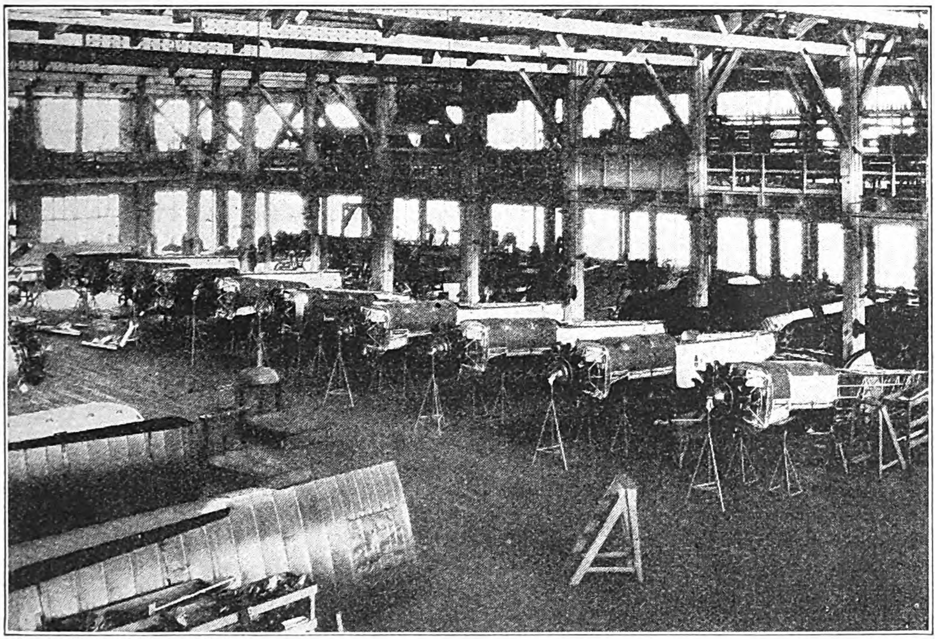
Looking to the sound future of aviation, it is probably very well indeed that the manufacturing estimates for 1929 will not be reached, for there are not pilots enough to man any such fleet of planes. On June 30, 1929, the number of licensed pilots was only 90 percent of the number of planes which had been licensed and identified by the Department of Commerce. In the 12 months ending on September 1, 17,350 applications for student pilot licenses were received by the Department. Of these applicants only 45 percent passed the physical test, completed their flying courses, and applied for pilot licenses, and only 26 percent, or 4570, received pilots' licenses. On September 1 there were 6891 licensed pilots as against a total of not less than 8000 planes.

No one with the interest of aviation at heart could wish that licensed planes or unlicensed planes, for that matter, should be flown by unlicensed pilots. The very real and menacing bugaboo of aviation is the unlicensed pilot and the unlicensed plane. The leaders of the aviation industry quite rightly urge that the public, in reading the daily toll of airplane fatalities, should draw the sharpest kind of a line of demarkation between the crashes in which untrained personnel and unfit equipment are involved and the very small and constantly diminishing number of accidents involving trained personnel and proper equipment. It would indeed be hard to put too much stress upon this contrast, and one need only learn of such records as that, for example, of Western Air Express which has operated its passenger-carrying planes 3,200,000 miles without an accident, to realize how safe properly organized air transport can be.

IT goes without saying, then, that aviation could hardly be benefited by a great surplus of planes without an adequate number of trained pilots to operate them. It will be of vital importance to the industry to emphasize to a much larger body of men and women during the coming year the training points required by the wise provisions of the Department of Commerce.

In addition to overproduction, and to the deflation of security values, aviation has been forced, during recent months, to face the swallowing of two rather bitter pills: First, the probable reduction of the army and navy appropriations for aircraft by three million or four million dollars each; and second, a reduction in the rates paid to operators for the carrying of the airmail, or, at least, a very considerable readjustment of those rates.

The outlook for the industry, however, in the view of the writer, is a most favorable one. The recent period of readjustment, of that settling of the yeasty brew which inevitably follows such unusual expansions, was only to be expected. Painful as the process may have been, for individual concerns and for those persons who sought to capture a pot of easy gold at the end of the aviation rainbow without due analysis of its spectrum, it can only lead to a more substantial and a better founded structure.


Courtesy Boeing Air Transport System

ONLY THE STRONG CAN SURVIVE

Intelligently conceived, soundly managed, and well financed aircraft manufacturers will remain in the industry and will eventually show profits. All others will fall by the wayside

There is no justification for pessimism in regard to aviation. From the point of view of manufacture, the strong companies are carrying out programs carefully and efficiently planned and buttressed by back-logs of orders which will keep their plants busy 80 to 90 percent of capacity for many months to come.

The most farseeing of the strong companies are reaching out well articulated tentacles into the export field. It is a field of immense promise, and no less an authority than Daniel Guggenheim, donor of 5,000,000 dollars to the advancement of aeronautics and of many times the value of that amount in the stimulation wrought by the Fund which he founded, predicted in a comprehensive article in *The New York Times* recently that aircraft and their accessories would come to be major factors in the export trade of the United States.

POWERFUL interests, heretofore outside or only remotedly connected with the aviation industry, have manifested their more active interest by investment in aviation projects. Notable among the recent moves of this sort has been the formation by the General Motors Corporation, acting with the Fokker Aircraft Corporation—of which it owns practical control—of the American Dornier Corporation, to bring the manufacture of Dr. Claude Dornier's giant flying-boat types to the United States.

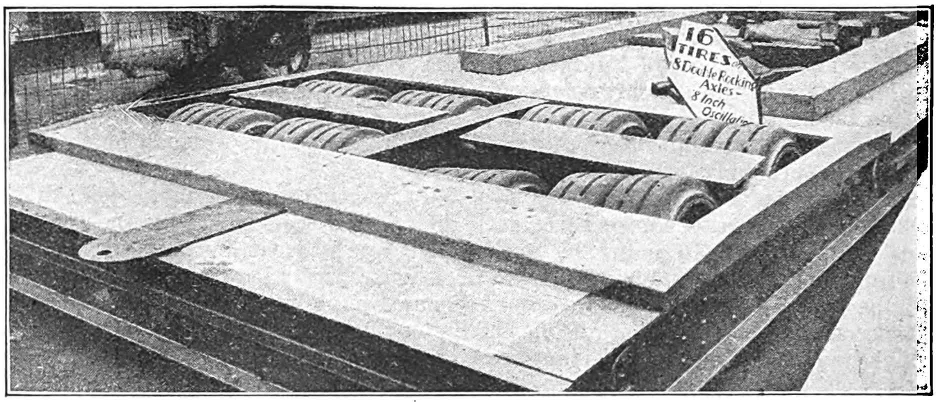
Pan-American Airways, after Colonel Lindbergh's latest line-charting trip, may be expected rapidly to bring the circle of the Caribbean into the scope of its expanding passenger transport. Meanwhile it has arranged a 30-hour service with air-rail hook-up between New York and Havana, and looks for such an influx of business on the Miami-Havana route that it is contemplating the use of the new giant Fokker *F-32* landplane for this popular flight.

Universal Air Lines and Western Air Express, acting together, will fly passengers from Atlantic to Pacific in about 30 hours.

Meantime, the dirigible *R-101* performs even better than had been expected in her early flights in Great Britain, and the "ring" has been laid for the first of the two super-dirigibles for the navy in the world's largest building, the new hangar of the Goodyear Zeppelin Company at Dayton.

Aviation, then, is very far from moribund. It is a strong young tree which has made too much wood for its own health. Some of that wood has been rotten, some of it has been merely superfluous. A drastic pruning has been in operation. The result will be a healthier growth.

Giant Trailers Protect Pavements



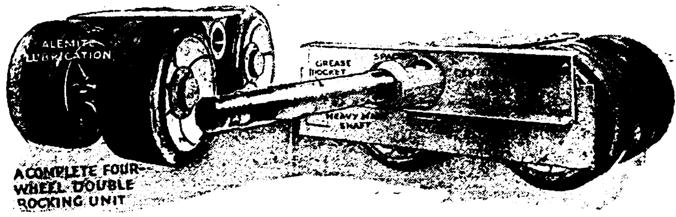
TRAILER FOR TRANSPORTING HEAVY CONSTRUCTION EQUIPMENT

In order to move heavy machinery without crushing paved or surfaced roads, the equipment is placed on a trailer equipped with 16 solid rubber tires on wheels mounted on rocking axles

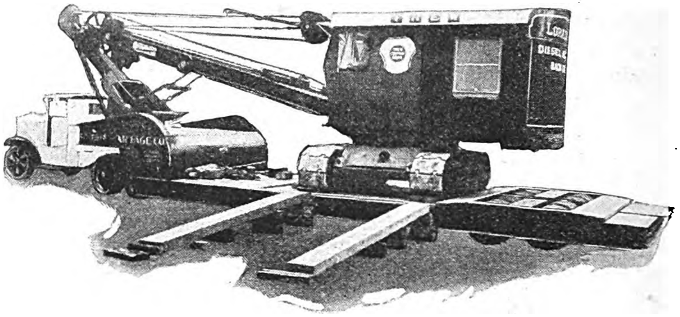
TO keep pace with the trend toward larger and heavier construction equipment, such as steam and electric shovels and draglines, trailers of a new type are now being used to transport such equipment. Laws to prohibit the movement of heavy equipment under its own power have been passed by a majority of municipalities, states, and counties. In order to prevent unnecessary damage to paved and surfaced roads, many highway authorities insist that large and heavy equipment must be moved on rubber-tired wheels. Even when using rubber tires, the street or road is likely to be damaged if the load is not equalized properly by the use of auxiliary wheels.

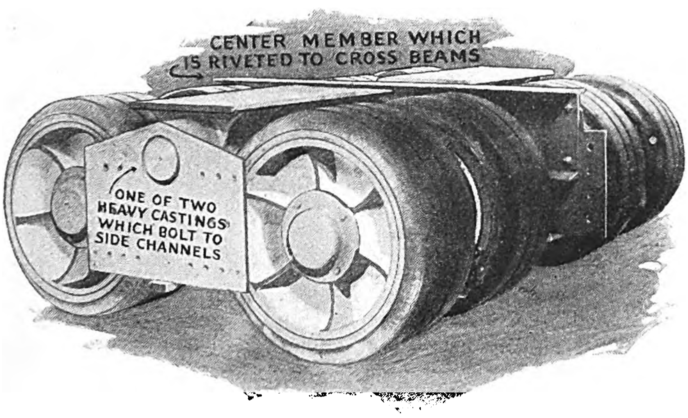
The trailer illustrated here has a capacity of 100 tons, and by means of eight double-rocking wheels, the load is equalized sufficiently to transport the heaviest equipment now in use without damaging the pavement or highway surface. Sixteen solid rubber tires are provided on eight wheels mounted on double rocking axles which automatically distribute the load over all of the tires in such a way that the wheels can conform to the variations in the surface of the road. This eight-wheel assembly is used on the rear of the truck where most of the weight is centered. The front part of the trailer is supported by a heavy duty "goose-neck" attachment, which facilitates hauling.

Each four-wheel rocking assembly functions as a complete unit, although pivoted on the heavy main shaft or axle. Between each pair of wheels is a rocking member composed of an electric-steel casting with bronze bushings, attached to a heavy steel shaft, which provides the flexibility needed when a wheel encounters a minor obstruction or depression in the road. Each wheel is mounted on a non-tapering spindle, equipped with tapered roller bearings. Extra large brake shoes are provided. The mechanical parts are all lubricated by grease gun, and every axle is so shaped as to provide a grease pocket or reservoir.

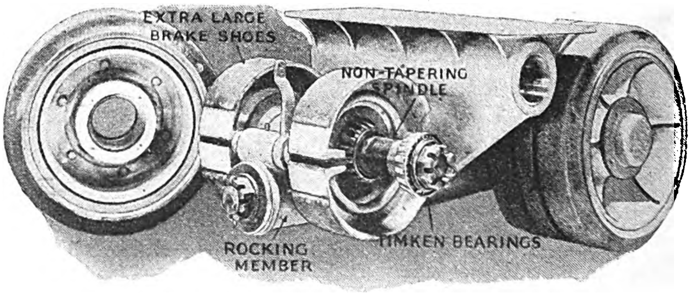


In the illustration at the top of the page, showing the rear section of a large-capacity trailer, the flexibility of the wheels is shown clearly, as one wheel passes over a depression in the road. The method of loading a large Diesel-electric shovel is shown in the picture immediately below that of the trailer. By means of heavy planks placed to form ramps, the shovel moves under its own power to take its place on the trailer. The powerful truck which provides the means of locomotion is dwarfed by its massive cargo.

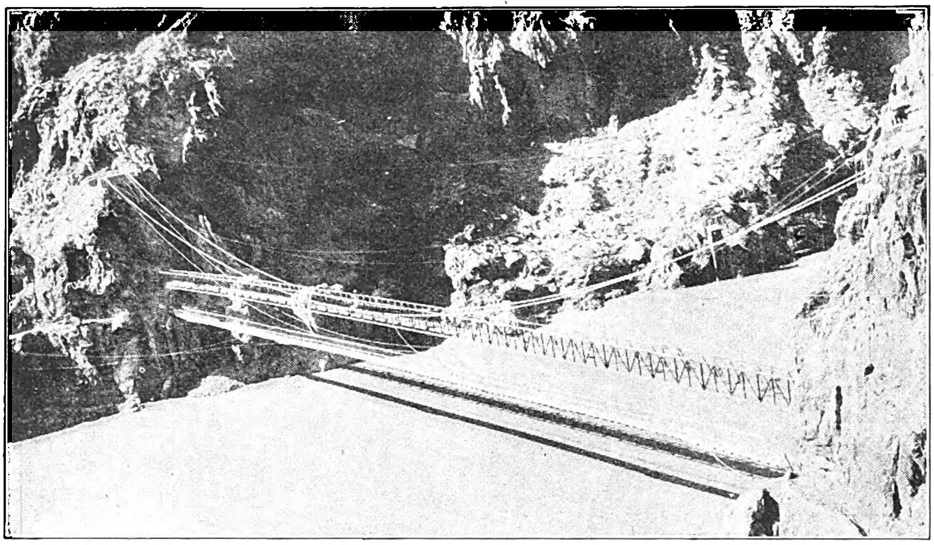



CENTER MEMBER WHICH IS RIVETED TO CROSS BEAMS
ONE OF TWO HEAVY CASTINGS WHICH BOLT TO SIDE CHANNELS

At the left is shown a four wheel double rocking unit detached from the axle. Note the grease pocket on the main shaft. At the lower right, a wheel assembly is shown with two of the wheels removed. The outer bearing and nut have been replaced to illustrate their position when assembled. Control of the trailer is facilitated by the extra large brake bands. At the bottom of the page the detail of the eight wheel assembly is illustrated. Two heavy castings bolted to the side channel beams provide housings for the ends of the main shaft or axle. The trailer is suited to a wide variety of applications, depending upon the shape and nature of the equipment to be transported, the length of the haul and local factors.



¶ *When a graceful bridge serves as a new tie to aid in cementing existing bonds of friendship between two great countries, it takes on an economic significance aside from its engineering features. Such a bridge is the Ambassador Bridge from Detroit to Windsor, Canada, an article on which is coming soon.*



SUSPENDED ON SLENDER THREADS

The tourist to the Grand Canyon may now take a train to the region, cross the new canyon bridge safely afoot or on horseback, and then proceed on his journey via another railroad

Bridging the Grand Canyon*

Intrepid Engineers Anchor Cobweb of Steel to Gorge's Precipitous Walls

By KIT McKENZIE

ACROSS the Grand Canyon of the Colorado, at the foot of the Bright Angel Trail, engineers of the National Park Service and Forest Service have spun a bright new cobweb of steel upon which the tourist may cross safely from the south rim to the north and the great Kaibab Plateau. Adventure and danger were the warp and the woof of its building; its opening last year represented a triumph of man over nature in the face of appalling obstacles.

Years ago, when men first crossed the canyon, they swung dizzily through the air on a single cable, high above jagged granite rocks and the swift and dangerous river. Later, the first straggling tourists crossed on a swaying suspension bridge, built by the National Park Service in 1920, the first span to be thrown across the chasm and the only safe means of transport in a stretch of 300 miles.

The need of a new bridge became apparent in 1927, when the Kaibab Trail was under construction, and funds from the Roads and Trails Fund of the Service were made available for its building. The old bridge had served its purpose well, but it was considered too light and too elastic to accommodate safely the increasing number of visitors to the Park. It swayed to the rhythm of the pack train, and winds driving up and down the canyon at a terrific rate tossed it about so violently at times that crossings were impossible. More than once during a violent storm it was turned completely over.

In designing the new bridge, unusual factors had to be considered. Not the least of these was the difficulty and expense entailed in transporting materials from the rim of the canyon to its floor, an airline distance of about four miles and a drop in elevation of nearly 5000 feet. The construction of a cableway was considered, but after careful study it was decided that a pack train would be more economical and satisfactory.

THUS down a narrow, zigzagging defile, seven and a half miles in length, sturdy little donkeys packed the bulk of the materials and supplies used in the construction of the bridge. Three months were required to carry the main part of the load from Yaki Point to the construction camp, pitched at the junction of the roaring Colorado River and Bright Angel Creek.

Use of the pack train placed a limit upon the size of the pieces used in the bridge and affected its design. Only pieces ten feet or less in length could be transported by the animals and the weight each could sustain was limited to 200 pounds. Each of the main cables, of which there were eight, was 550 feet long and weighed over a ton. These were carried down on the shoulders of 42 men, mostly Indians, each man supporting a weight of about 50 pounds. The wind cable came in one piece, 900 feet long, and was transported by means of "go-devil," or heavy sled of original design.

Drawing up the actual plans and specifications of the bridge presented peculiar difficulties. The distance to be spanned measured 500 feet between supports with an allowance of five feet for width, since a narrower bridge would be likely to interfere with the passage of a loaded animal and, if the bridge were wider, there would be more opportunity for the animals to turn around and cause confusion in the line of a pack train. In spite of these limitations, it had to be strong enough to carry a train of any length; that is, a string of animals completely covering it from end to end.

POSSIBLE congestion due to inexperienced riders had to be taken into account so that the structure would hold even in a stampede. It had to be rigid so that there would be no possibility of a swinging or jarring motion that would cause fear on the part of tourists. The rushing winds of the canyon had to be provided for; the bridge must remain staunch against transverse wind stresses that might cause it to turn over as the old one had done.

The new bridge is the longest ever built by the Park Service, the usual run being from 100 to 300 feet. Therefore the engineers, Chief Engineer F. A. Kittredge, Ward P. Webber, designing engineer of the Park Service, and John H. Lawrence, a Forest Service construction engineer, were called upon to exercise their inventive genius in meeting and solving the unusual problems encountered without incurring too great a cost.

The first items of construction were the pits for the main cable anchorages

A TICKLISH JOB

In a saddle suspended from a transverse cable, engineer Lawrence anchors a wind cable to the precipitous canyon wall

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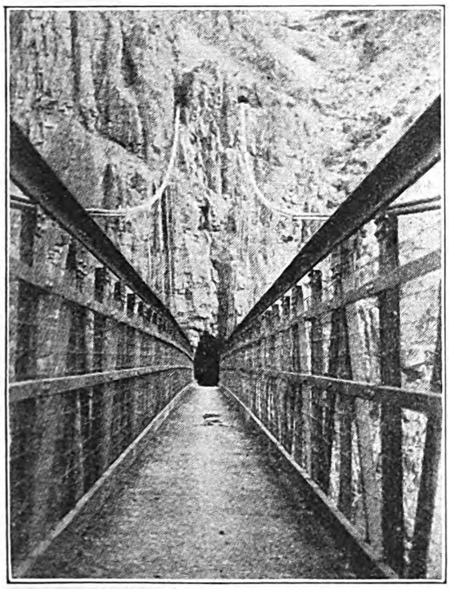
*Reprinted by permission from *American Forests and Forest Life.* Photographs courtesy Department of the Interior, National Park Service and cable supports. On the north end the upstream pit was sunk 14 feet into solid rose granite; the downstream pit was drilled four feet into the rock of the canyon wall.

Since the new bridge was to be located on the site of the old, but at a slightly higher elevation, and the old bridge was to be in uninterrupted use during construction of the new, all excavation work had to proceed cautiously for fear of dislodging the old supports. Only light blasts were possible and certain parts of the original bridge had to be braced to insure safety. The anchorage steels were deeply imbedded in solid concrete and farther down the canyon wall, concrete cable supports and the north abutment were constructed under conditions that were equally hazardous.

BECAUSE of the higher elevation of the new bridge, the trail approaches at both ends had to be altered. At the north end this was fairly simple. A spiral was constructed beginning at the grade of the old abutment, swinging upstream and to the east, then back to the new bridge. This permitted using part of the old trail and gave an easy, attractive approach to the new structure.

Excavation work was simultaneously under construction at the south end of the bridge and here more serious difficulties were encountered. First of all, the location of the new cable supports was so near the old that making open cuts in the rock for passage of the main cables would seriously endanger the security of the old bridge. To obviate this, small tunnels had to be drilled back to a safe mooring through the solid rock. The canyon wall in that place was of a mica schist formation—very blocky—and the concrete works of the old cable anchorage lay directly above each new cable tunnel. Consequently the tunnels had to be excavated by hand. They measured about two and a half feet in cross-section and were 17 and 11 feet long.



READY FOR TRAFFIC

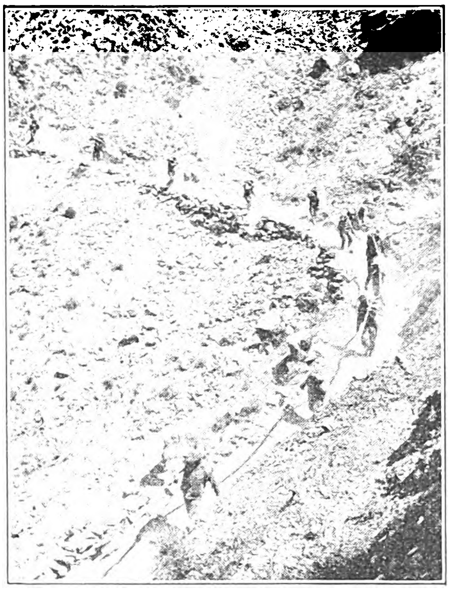
The completed bridge and the tunnel approach 5000 feet below the canyon rim

Because of the overhanging canyon wall, creating a danger from falling rocks, and other factors, a tunnel had been decided upon as the safest approach to the bridge from the south. Its construction was an achievement in itself. It is 105 feet long, 10 feet high and six feet wide. Workmen doing the excavation were inadequately equipped with tools, two old air compressors being all that were available for work on the entire structure. Half the time these operated so poorly that both had to be used to run one small jack-hammer. To speed up construction, two eight-hour shifts of workmen operated in the tunnel day and night with the work in progress at both ends. The arduous nature of the task can be imagined from the report of Engineer Webber, a part of which follows:

"An average of seven hours was required to drill a round of seven holes," he wrote, "the eighth hour being required for loading and blasting. One round would 'pull' from two to four feet, depending on the material encountered. All tunnel workers had to wear respirators and goggles as a protection against rock dust, and owing to the extreme danger of some of the rock over the portal caving in, it was necessary to resort to timbering and, later, to concrete the portal."

THE hoisting of the main cables and their adjustment signaled the beginning of the bridge proper. When these had been secured, an engineer and a rigger swung out over them in fragile-looking swing seats called "bos'n" chairs to measure and mark them for the hanger cables. The transoms, each consisting of a floor beam and two verticals, were then trundled out onto the old bridge and attached to the hanger cables at positions corresponding to those they were to occupy in the new structure. Then the entire group was hoisted by means of a tackle and adjusted in place by a rigger.

The framework of the bridge having been spun, there remained the adjustment of the heavy floor beams. These were riveted together and swung directly onto the bridge by means of a special cable, or high-line, strung across the canyon above the new structure. Large and unwieldy, these beams were perhaps the most difficult parts of the bridge to place. The riggers had to "ride the steel" and make a flying connection. As fast as the sections were brought up and placed, the floor plates and guard angles were brought onto the bridge and bolted into their places. Then stiffening trusses were laid and riveted together in a continuous piece to give the greatest possible rigidity.



A PYTHON-LIKE CABLE

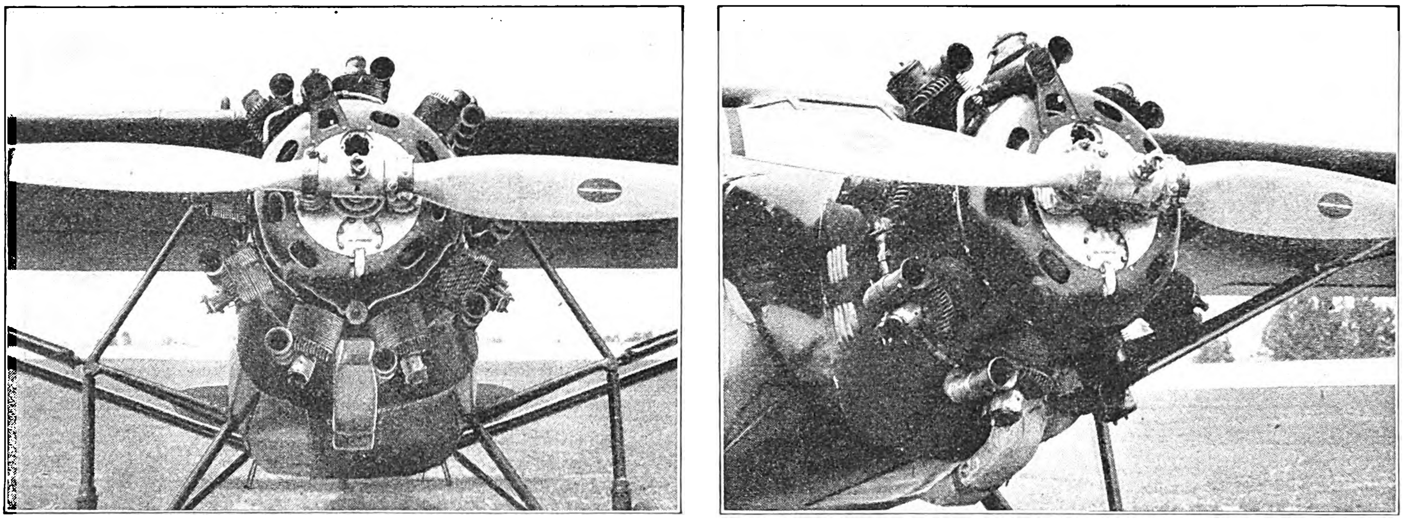
From the canyon rim down the Yaki Trail a cable is carried on men's shoulders

The next task was to adjust and anchor the cables designed to brace the bridge when swift storm winds ride the canyon. The anchorages of the wind cables, one on each side of the bridge, were placed at an angle of 26 degrees below the bridge so that the cables would brace it not only against transverse currents but also against winds tending to lift and toss the floor. Placing the anchorages in the sheer rock lining of the canyon was a task both dangerous and difficult. The jack-hammer operator who drilled for the guys was lowered by a rope over the precipitous wall and hung in a sling from two ropes, 125 feet below the rim of the canyon, with 70 feet of rock, in a sheer drop, below him to the river.

TO afford a more secure foothold on the bridge, a two-inch surfacing of screened gravel, sand, and cold asphalt emulsion was laid on the floor of the structure. Other finishing touches, such as the wire fence and guard rails on the sides of the bridge, were then added to complete the structure.

It is a tribute to the engineers that in building this great bridge across so awesome a chasm not a life was lost. Even the patient, plodding pack animals came through the ordeal safely. There are 122 tons of steel and other materials in the bridge; not one piece was dropped into the river far below.

¶ *"Will the business man fly?" is the subject of a coming article which points out many pertinent facts that tend to show the gradual but inevitable adoption of the airplane by business on a wide scale.*



TWO STRIKING VIEWS OF THE PACKARD DIESEL ENGINE FOR AIRPLANES

The Airplane Diesel in 1940

The Many Advantages of This Simple Power Plant Point Toward a Great Increase in Its Use

By ROSWELL H. WARD
Managing Editor, Motorship

IT is a far cry from the cumbersome stationary Diesel engines of past decades, deep-rooted in massive foundations and cumbrously wrought in cast iron, to the alloy-steel perfection of the present day airplane engine, eloquent of speed, power, and *light weight* in every line and contour!

However, it has been this technical gulf, this wilderness of abstruse metallurgy, combustion phenomena, and stress analysis which the Diesel engineer has had to bridge in essaying the development of a practical aviation Diesel engine.

HOW successful these explorations have been is evidenced by the remarkable evolution of light-weight, high-speed Diesels in recent years. In the 11 years since the World War, the weight of the lightest Diesel engine has been reduced from about 65 pounds per horsepower to less than three pounds per horsepower, and the speed, which in the past was supposed to be definitely limited in the Diesel engine, has been increased from about 750 revolutions per minute to well over 2500! And at least two types of Diesel engine—probably more—have actually flown in heavier-than-air machines, to say nothing of the Diesels installed in the British dirigible *R 101*, which, at the time of writing, has been successfully flown in various tests. (See photograph on page 38.)

Diesel aviation progress has reached a transitory stage, where its advocates, gratified at last to see a Diesel engine actually in flight, have inclined to over-enthusiasm in prophesying the scope of its immediate application.

The air transport executive, confronted with the necessity of making an impartial technical judgment, has reacted to this over-enthusiasm in a way well expressed in these columns heretofore, (See SCIENTIFIC AMERICAN for September, 1929), and has raised a series of very sound questions which deserve to be answered by careful analysis rather than by argumentative advocacy.

Foreside

THE question of Diesel engines for airplanes is one that is of absorbing interest to everyone following the progress of aeronautics. The accompanying article was prepared to supplement the one entitled "Is the Airplane Diesel Practical?" presented in our issue for September 1929, and in doing so, the author placed the time of his description ten years in the future. But this is no "futuristic" story based on a vivid imagination. It is a straight-forward presentation of facts that are apparent to all those with eyes to see, amplified by a thorough knowledge of the subject gained through close association with the men in the Diesel field who have been doing things.

—The Editor.

No one should be more cognizant of the scope and limitations of the aviation Diesel engine than the Diesel engineer. The basic problems in the construction of high-speed Diesels have been solved, but a tremendous amount of detailed development work must still be done to insure the future of the airplane Diesel.

There are metallurgical, production, and theoretical design problems to solve. In its present form the aviation Diesel can undoubtedly become in a few years an important *supplement* to the airplane gasoline engine, especially in large airplanes and seaplanes and in dirigible balloons.

Further to present a graphic picture of exactly how the aviation Diesel compares in actual flight with the gasoline engine, we will be over-conservative and estimate a lapse of 10 years, from which point of time we will visualize the attainment of the widespread use of airplane Diesels. Engines such as these will undoubtedly be in extensive use long before 1940, but we will jump ahead a decade in our prophetic study in order to depict the perfection of development which will probably be realized long before that time.

ANY airplane—whether large or small—is subjected to a daily inspection, a careful grooming and scrutiny which has in its routine attention to detail few parallels in any field of engineering or transportation. Skilled mechanics go over the engine, riggers examine the wings and control surfaces, keen-eyed inspectors check their reports and repair work with great care, and finally, the operations executive carefully scrutinizes the reports of both ground engineers and pilots. A race horse or a fine motor car gets no more attention on the eve of a great contest than does a transport airplane in the course of everyday service.

Let us follow the inspection of a 1940 Diesel "motorship of the air" such as we foresee, and determine wherein it differs from the present rites of those who serve the gasoline driven airliners. As the cowling is removed from one of the six-cylinder "in-line" air-cooled Diesels, (a cowling which leaves the upper part of the cylinders exposed and directs the air stream along the cooling fins), our attention is drawn to its extreme simplicity.

There is no carburetor or intake manifold; there is no electrical ignition, no magneto or spark plugs; there is only a small pipe to the head of each cylinder, and there is only one valve in each cylinder head, from which a small "exhaust deflector" projects.

THE ground engineer does not have to adjust the carburetor; he does not have to worry about the intricacies of electric ignition or fouled spark plugs; when there are valves to be ground, there is just one, which takes care of both the air intake and exhaust in each cylinder.

The engineer is dealing with the highest expression of man's battle to wrest heat energy from petroleum—the most efficient heat engine in existence—and mechanically by far the simplest. With a compression about twice that of the ordinary aviation gasoline engine, this Diesel draws in the outside air through the single valve in the head, compresses this air to a temperature sufficient to ignite the charge of fuel-oil sprayed in from a little nozzle in the top of the cylinder, and when the power stroke is complete, exhausts the spent charge through the same valve in the cylinder head.

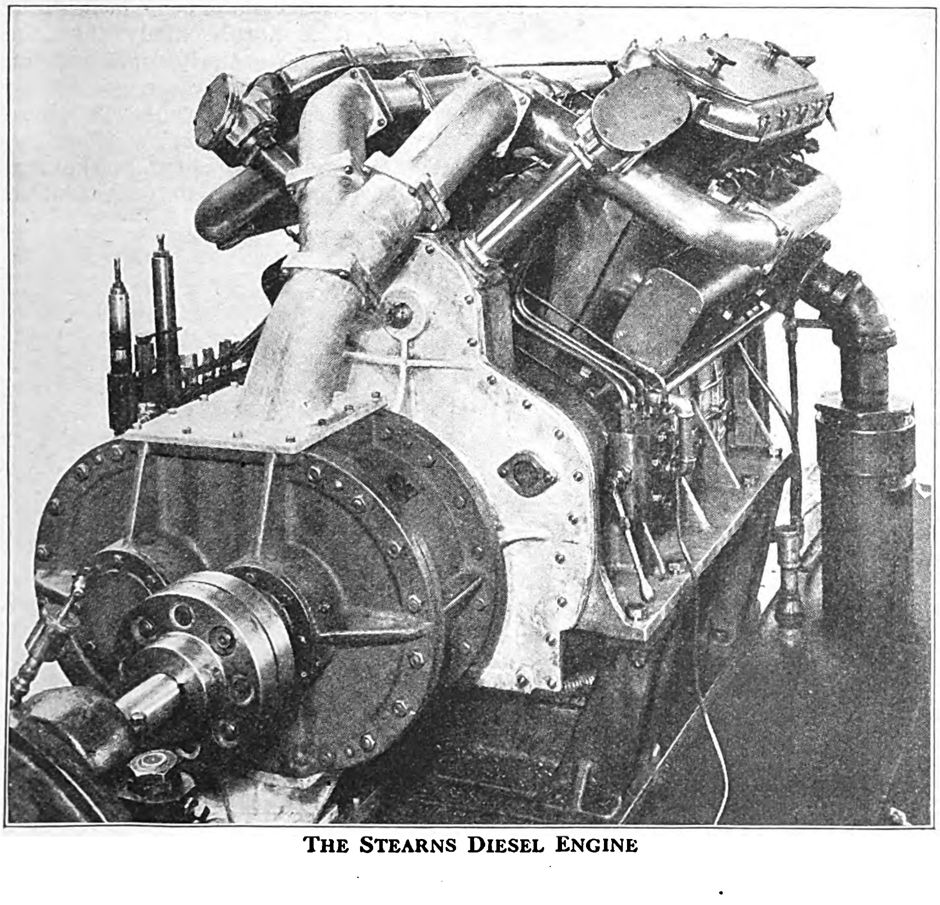
(This description is for a "four-stroke-cycle" engine; there will be numerous other types using the "two-stroke-cycle" and highly original valve and structural arrangements, but for descriptive purposes this type of engine has been selected as representative of American practice as now foreseen.)

Spared carburetor and magneto work, and with his valve inspection reduced to half, our mechanician, however, is up against some purely Diesel problems. He will have to remove and inspect the fuel nozzles in each cylinder head and, while the engine is running, will have to assure himself that the fuel pump which supplies a minute quantity of oil to each cylinder is functioning properly in its split-second work of metering and pumping.

THIS fuel pump is one of the points often criticized by those who question the reliability of the Diesel. It is the perfect embodiment of precision workmanship, is ground and honed so that its plungers fit to extremely close limits. This, in theory, is a knotty production problem. However, in actual practice, certain well-designed types of fuel pumps have shown themselves to be almost fool-proof. The precision of construction and the number of working parts in a well-designed Diesel fuel pump are much less a problem, comparatively speaking, than that of producing electric ignition magnetos and distributors, intricate operations which are taken for granted today.

DESIGNER AND PILOT

Left: Capt. L. M. Woolson, designer of the Packard Diesel, and Walter Lees, pilot

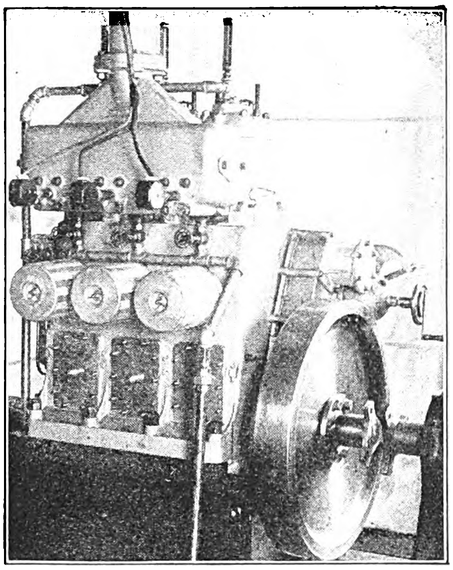


THE STEARNS DIESEL ENGINE

Most American difficulties with experimental fuel pumps have, to speak bluntly, been due to poor design, or to poor production engineering. As the demand for this type of equipment increases, this problem will be overcome, as many other more intricate ones have been solved.

WE mentioned above that our mechanic was working on an engine with *twice* the compression of a gasoline engine. This presents another difficulty—that of starting. At present an electrical starter capable of turning over a Diesel engine is much too big and heavy for airplane use. However, we may expect that this trouble will be mastered by releasing the compression in several cylinders and using an electric starter, or by some other expedient—it even having been whispered that a small gunpowder cartridge is used for starting on one American aviation Diesel!

Now that the inspection of our "air motorship's" power plant is completed, here comes a tank truck with fuel for it. To one reared in the atmosphere of high-test aviation gasoline, volatile benzol compounds, and so forth, the calm superiority of the "grease neck" who smokes a cigarette as he pushes the hose into the oil tank is somewhat uncanny; but he is dealing with fuel oil of about the consistency of ordinary furnace oil—non-volatile and unaffected in its condition in the fuel tank



Courtesy American Machine and Foundry Co.

MOREN-BRONANDER DIESEL

Estimated horsepower of this engine, at 1200 revolutions per minute, is about 30

by changes of altitude—it will not produce inflammable vapors in a rarefied atmosphere, or on the ground.

This new generation of "Diesel bred" airplane mechanics commit another heresy in the eyes of the old timer: they start the engine while the fueling operation is going on! But the exhaust from the cylinders is clear and carries no flame—and the ignition point of the fuel oil is so high that one could even spill some of it on the engine and it would not actually burn—something to be thought of in the event of a crash, and certainly a condition which makes for greater ease, safety, and time-saving in servicing the plane.

The scarcity and possibility of contamination of fuel oil at airports around the country is also one of the criticisms of the aviation Diesel. But what can one expect? Just as American industry will build reliable fuel pumps in quantity and develop workable methods of starting, so will the oil industry respond with more easily available supplies of Diesel fuel. Long flights have already been made on ordinary furnace oil and oil of that type is almost as easy to get as gasoline in this day of household and industrial oil burners!

IT was not necessary for the mechanic to start the engine to "warm it up," as is done now with all gasoline aircraft engines. All aircraft Diesels are "cold starting," the heat of the first compression is enough to ignite the fuel, and a Diesel airplane can take off immediately the engine begins to turn over, although if not necessary, it is just as well to let it "tick-over" on the ground for a short time. However, in cold weather operation, in an emergency, or in military service, this characteristic is something to be considered.

Now that we have entered the cabin and have waved farewell to those who watch our pilot "lift" us off the field with the calm mastery of these picked men who handle transport aircraft, we notice a smoothness of flight and an absence of that vibration which is sometimes felt in airplanes. This elimination of vibration is due to the fact that the engine does not run as fast as a gasoline engine. In order to get the weight of gasoline engines down to their present basis, it has been necessary to increase the power by increasing the speed, usually to 1800 or up to 2200 revolutions per minute. The Diesel will operate normally at about 1200 revolutions per minute, which is a much more efficient propeller speed then the higher figures mentioned.

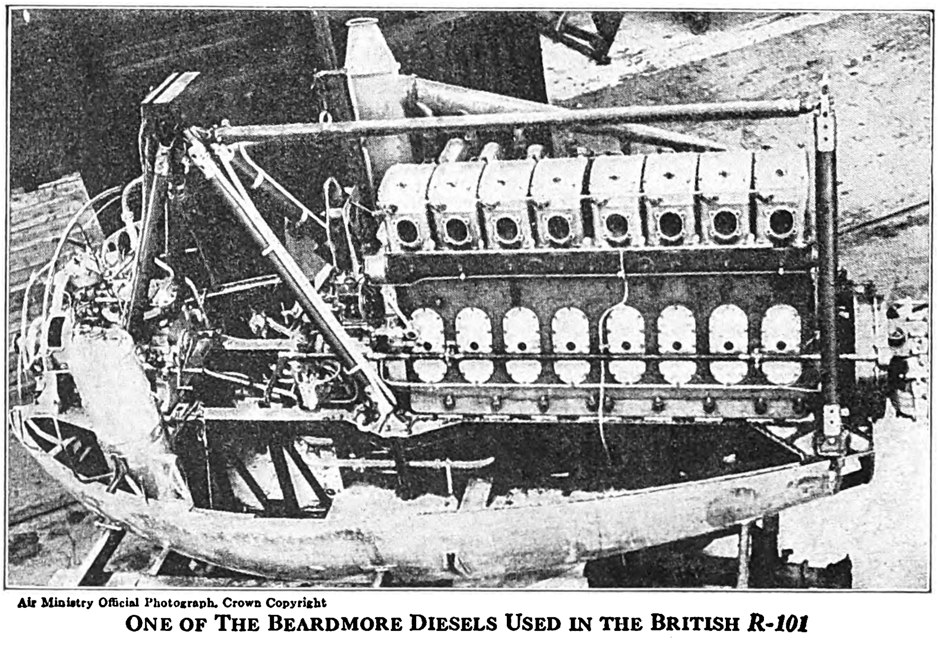
We may smoke in our cabin, just as the service man did and for the same reason, and our guide points out to us that spilling of the fuel, in event of a forced landing, would not set the plane on fire. A comforting thought for those with lively imaginations!

AND another characteristic is pointed out: Due to the fact that the fuel does not form a volatile mixture until it enters the cylinder, there is no chance of a backfire into the intake manifold as sometimes happens with gasoline engines. And the position of the airplane exerts no effect on the fuel supply; the fuel pump and the fuel nozzles will work as well upside down as they will in the upright position.

We look over a report on the cost of operating these Diesel-engined airplanes. The engine costs more than a gasoline engine, and will until quantity production is achieved. The fuel cost is considerably less than that of a gasoline engine. We are using Diesel fuel at about six cents a gallon instead of high-test gas at from 14 to 25 cents. But this is not the main argument for the economy of the Diesel. For a given combined weight of fuel supply and engine—provided that the weight of the Diesel engine is somewhere near that of the gasoline engine, (on this point more will be said)—the flying range or the carrying capacity of the Diesel-engined airplane is greater than that of the airplane with a gasoline engine. This is especially true for flights of 500 miles and over, when fuel economy becomes a large factor. Estimated conservatively, given the conditions outlined above in flights of this type, the cruising radius, or the weight-carrying capacity of the Diesel-engined airplane would be from 20 percent to 30 percent greater than that of an airplane powered with a conventional type of air-cooled gasoline engine, such as we know today.

THE condition made above in regard to weight is the prime reason we have conservatively set the date of the general use of aviation Diesels some years ahead. The aviation Diesel is now considerably heavier than gasoline engines—and this increased weight offsets most of its other advantages. However, as the weight is reduced, the fuel economy will help to make up for what weight handicap is left, and the Diesel will first become an important *supplementary* form of power to be used in large aircraft for long flights.

It is difficult to foresee what would happen if a Diesel were produced as light as the present types of air-cooled gasoline engines, but in view of the high degree of refinement of gasoline airplane engines, it is hardly likely that the Diesel will ever entirely replace them. However, it will assume a position of ever-increasing importance in those services where long range reliability, weight-carrying capacity, mechanical simplicity, and super-safety are desired.



Air Ministry Official Photograph. Crown Copyright

ONE OF THE BEARDMORE DIESELS USED IN THE BRITISH *R-101*

Sea-Safety Contest Winners

Our Competition Has Focused Attention on Devices That Make for Safe Navigation, and Are Reliable in Emergencies

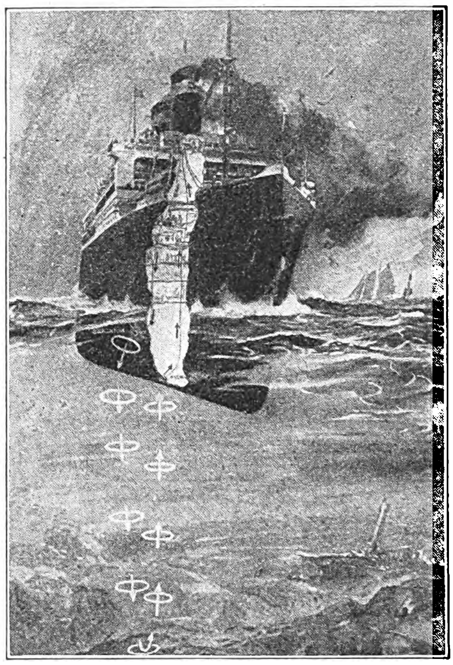
By ALBERT A. HOPKINS
Secretary of the Committee of Award

THE ninth SCIENTIFIC AMERICAN Gold Medal awarded by the American Museum of Safety was presented at a luncheon given by Mr. Arthur Williams, President of the Museum, at the Union League Club, New York, on November 7th. In the absence of Professor Fessenden in Bermuda, on account of severe illness, his son, Mr. R. K. Fessenden, received the medal and the citation signed by the members of the Committee, and responded for the winner. Mr. H. J. Fay, a business associate, read an admirable account of three inventions on which the citation was largely made. Those receiving the engrossed Certificates of Honorable Mention responded as each received the framed certificate.

THE task of the Committee of Award was to analyze the 80 designs or ideas: first to see if they conformed to the conditions; and second properly to evaluate their merit. The Committee was of highly technical structure, largely composed of men who are used to commanding vessels or fleets, and their decision may be regarded as of great technical value. Out of the 80 designs, 13 were selected for intensive examination; these were narrowed down to five, and then to one.

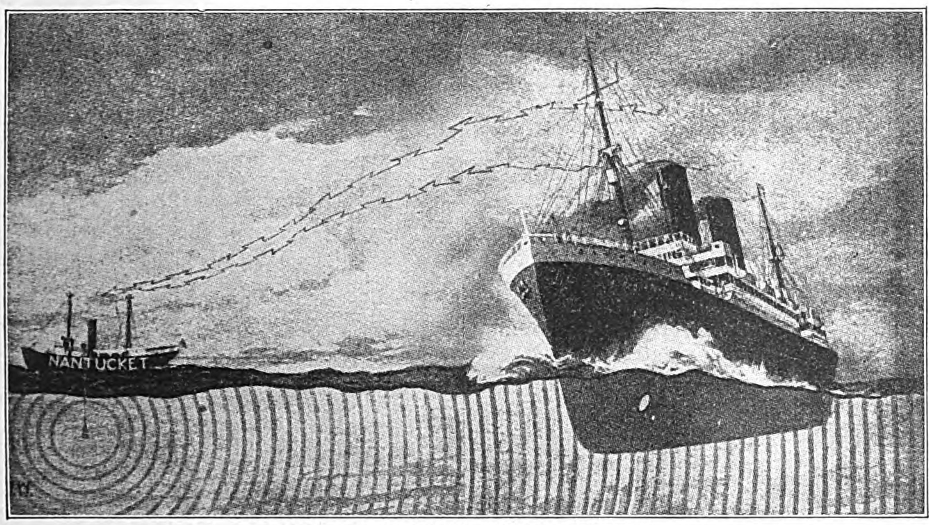
The Committee finally decided unanimously that the achievements of Professor Reginald A. Fessenden were sufficiently outstanding to warrant giving him the medal for his various devices for safety at sea. The award was made not for any one of his inventions but rather for a composite of them. Quite a formidable list of inventions was submitted and he then modestly narrowed it down to 12, as follows: The fathometer, acoustic-radio distance finder, phase compensator, iceberg detector, wireless direction finder (using the loop antenna), wireless compass (rotating and beam), gyrocompass and improvements, Fessenden prism, interference beam of radiation, submarine oscillator, wireless telephone, heterodyne.

Professor Fessenden joined the Submarine Signal Company in the year 1912, and at once his great inventive genius was directed toward the development of better means of transmitting sound signals for communication through the water, with results that have been of great benefit to humanity.



FESSENDEN FATHOMETER

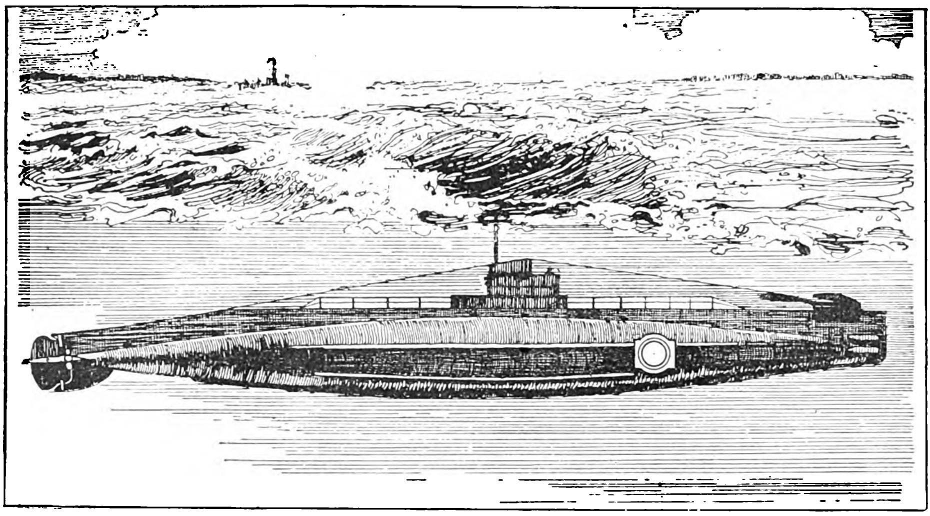
The fathometer is an electrical echo depth-sounding device which enables vessels to avoid stranding by ascertaining the depth between keel of the vessel and sea bottom without stopping the ship



FESSENDEN DISTANCE FINDER

Radio signals and submarine signals sent out simultaneously from lightship. Time interval between reception of radio signals and submarine signals on liner indicates the distance

The perfection of the oscillator the following year revolutionized the art of submarine signaling, doubling and trebling the range at which it had been possible to send sound signals through the water. The ease and speed at which sound signals in the form of dots and



FESSENDEN OSCILLATOR

The oscillator sends dots and dashes through the water with ease and speed, doubling and trebling the range. Nearly every submarine in the world is equipped with this instrument illustrated at right

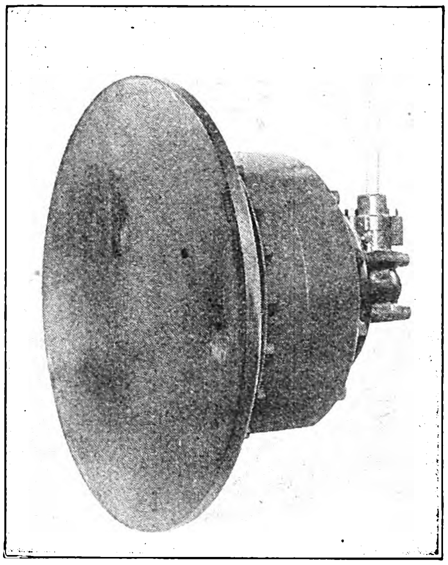
dashes could be sent through the water with the oscillator marked a tremendous advance over the older slow method of submarine signaling by a series of dots with a bell. The Navy, quick to recognize the value of the oscillator, adopted it for use on battleships and submarines. Today, practically every submarine in the world is equipped with one of these instruments.

Echo depth sounding, as embodied in the fathometer, marks the next and greatest work. This new method of depth sounding is linked in its history with the *Titanic* disaster. It was this appalling tragedy which led to experimenting with the submarine oscillator for the purpose of detecting the presence and proximity of icebergs, by means of an echo.

IN the winter of 1914, Professor Fessenden made tests on the Revenue Cutter *Miami*, while the latter was on its ice patrol off the Grand Banks. In these tests it was found that the oscillator could be used not only to detect the presence of and the nearness of icebergs but also to determine the depth of water beneath the revenue cutter by measuring the time between the emission of an oscillator signal and its return as an echo.

The submarine fathometer sends sound impulses periodically to the bottom of the sea, where they are reflected upward and then excite an electric sound receiver. The latter, by means of an electrical mechanism and a beam of light, indicates continuously on the calibrated dial the depth of water beneath the vessel.

Because of the World War, work on the fathometer was delayed on account of activities in the development of submarine detection devices for the protection of shipping from the ravages of submarine warfare. After the war, the echo depth-sounding work was



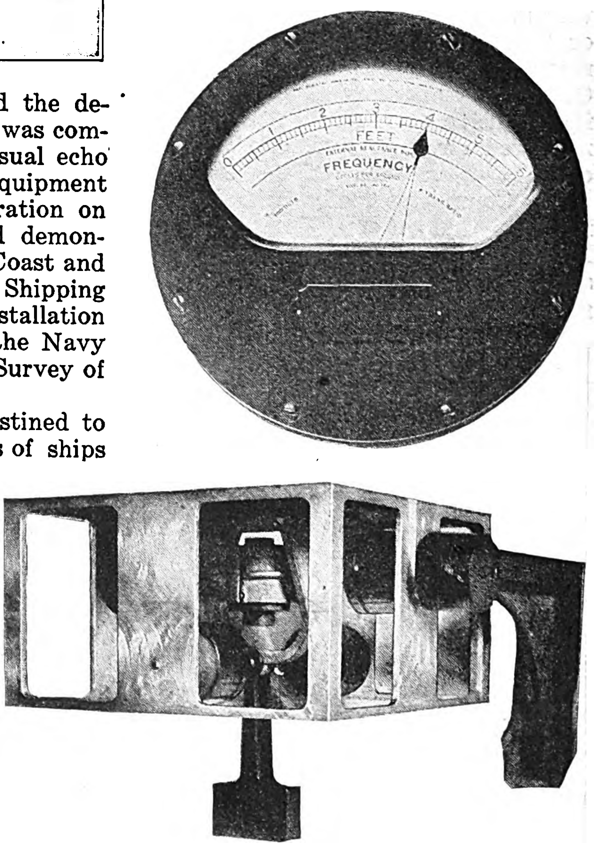
again taken up actively and the development of the fathometer was completed. In 1924 the first visual echo depth-sounding fathometer equipment was placed in practical operation on the steamship *Berkshire* and demonstrated to the Navy, to the Coast and Geodetic Survey, and to the Shipping Board. Following this installation came the approval of both the Navy and the Coast and Geodetic Survey of its accuracy and reliability.

That the fathometer is destined to save countless lives, hundreds of ships and millions of dollars seems unquestionable. The recent Safety of Life at Sea Conference at London has recognized this in recommending that the contracting governments should encourage the development and use of echo depth-sounding apparatus.

After the award of the SCIENTIFIC AMERICAN Medal the Committee considered that three devices were so outstanding in merit that a "Certificate of Honorable Mention" should be given. These honors are given to three individuals, two in New York and one in Utrecht, Holland, without designation of relative merit. Mr. J. Lyell Wilson of the American Bureau of Shipping, Member of the Society of Naval Architects and Marine Engineers, and the American Institute of Electrical Engineers, was given an "Honorable Mention" for his stability meter.

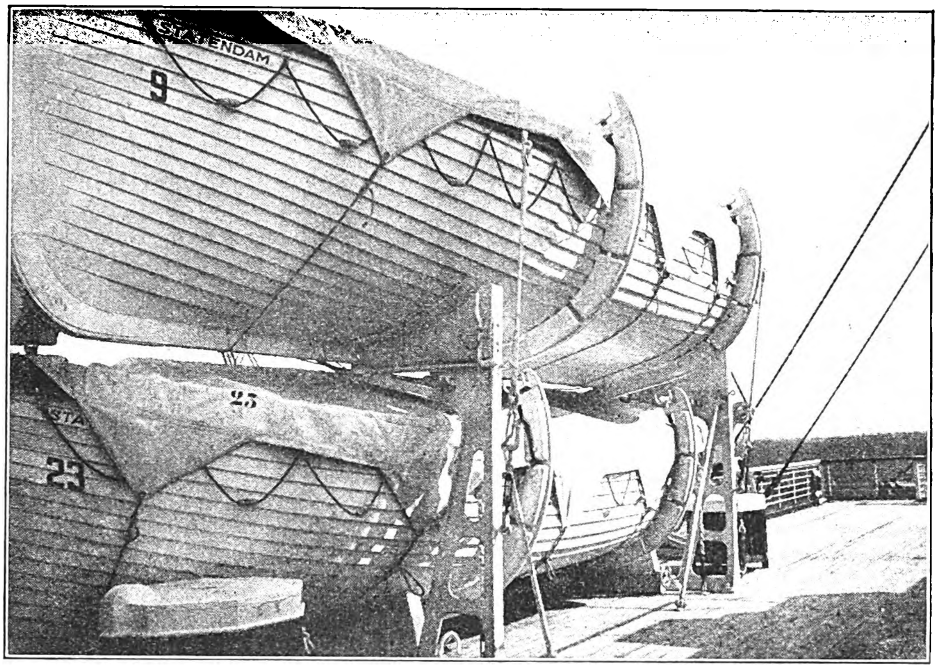
THE stability meter was designed to provide a ready means for determining the amount of stability or metacentric height that the vessel has while at sea on a voyage, so that water ballast may be used when needed to correct an insufficiently stable condition by lowering the ship's center of gravity. This use of water ballast has always been available but the means for determining when to use it has not, except by prior estimates of inaccurate and sometimes doubtful value, because of the infinite variety of possible service conditions.

In order to measure the stability of a floating vessel it is necessary to have some fixed axis for reference to which known forces and their effects on the ship may be referred. This part of the solution, which requires elaborate preparation, calm water, and the absence of wind and all other extraneous forces, is merely to locate the ship's center of gravity when she is empty. In principle it is exactly like finding the center of any irregular figure by suspending



WILSON STABILITY METER

An accurate means for determining the amount of stability a vessel has while at sea, so that she can be ballasted. It utilizes a gyroscope and a pendulum



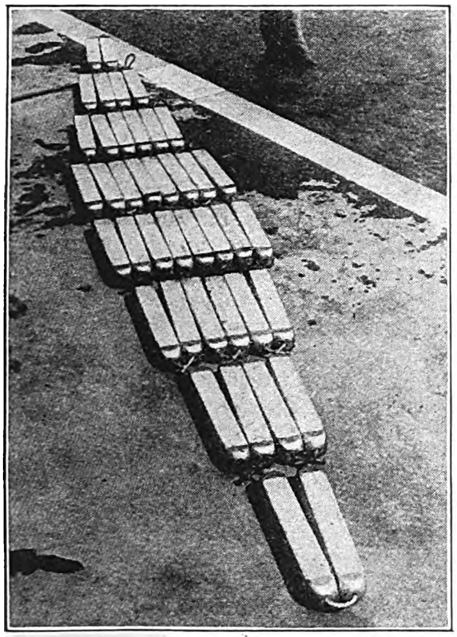
SCHAT SEA SKATE

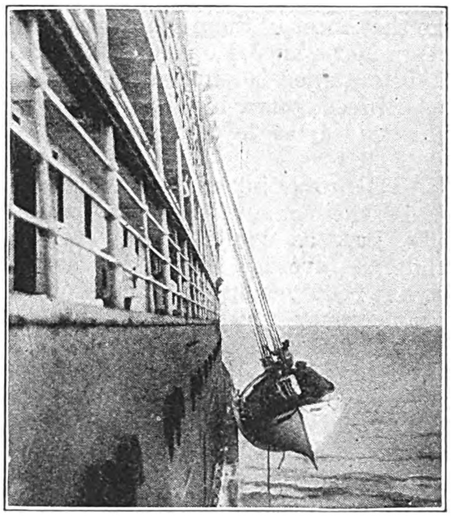
A demountable attachment for life boats which facilitates their launching even with a forty-six-degree list. In launching, it skids the life boat over obstructions

it from various points together with a plumb bob so that the intersection of all the traces of the plumb line will be the center of area or gravity. From such a procedure, called the inclining experiment, and with mathematical analyses based on the vessel's form and loading arrangements, her stability for various conditions may be analyzed.

A much more accurate and convenient method of determining stability is available, however, in the use of the stability meter which ignores the statical condition in calm water but measures the dynamics during rolling, the reference axis being that of a gyroscope which is independently referred to a fixed axis in space.

The stability meter therefore comprises a gyroscope and a pendulum, each properly suspended in a frame fixed in the ship and actuating variable inductances, the component values of which are electrically integrated to give a resultant reading of metacentric height by means of a pointer traversing a dial similar to an ordinary voltmeter. Thus the action electrically is similar to the tuning of a radio set having two dials except that a variable voltage is produced instead of a variable frequency.





Another "Honorable Mention" went to Mr. A. P. Schat of Utrecht, Holland, who made an unusual effort to secure the medal, even going so far as to make his presentment in the form of large beautifully illustrated pamphlets in the English language. Mr. Schat's device is called a "sea skate" and is an attachment to a life boat which enables it to be launched even with a 46-degree list. The "skate" skids the life boat over plates, bulges, and blisters, and once the water is reached it can be unfastened and sunk.

Mr. Jesse W. Reno of New York, a consulting engineer, received a "Certificate of Honorable Mention" for his life raft or live-saving net. His device consists of an extremely light raft or net made of balsa wood, the individual floats of which are joined by flexible connections, so that the net may easily be folded into a compact space for storage aboard the ship. When people are in the net in a rough sea, the lightness of the floats prevents injury when they are thrown against them by the sea, and the flexibility of the connections permits the floats to yield so that injury is prevented. Our illustrations give an idea of the device which is cheap, takes up little room, and has much to commend it in place of the ordinary life raft and the life preserver. Mr. Reno has devised a process for waterproofing the balsa wood so that its buoyancy is not impaired by becoming waterlogged.

The competition has served a useful purpose in focusing attention on these eminently practical inventions which are in being and which can be applied on any ship.

RENO LIFE RAFT OR NET

This life raft or net is made of water-proofed balsa wood. The floats are flexibly connected, giving freedom from injury. The device takes up little room and is very light

The Rarest Metal Yet Obtained

A Scientific Account of Research on Protactinium, Element 91, Which Is as Radioactive as Radium

By ARISTID V. GROSSE, Dr.Eng. (Chem.)
Director of the Chemical Research Institute, Shanghai, China

PROTACTINIUM, recently isolated by the writer, is a new, strongly radioactive chemical element. It is a metal like radium, but about two times rarer than the latter and, in fact, the rarest metal yet obtained in the world.

Of the great number of radio-active elements found since the splendid discovery of radium and radioactivity by Madame Curie in 1898, protactinium is the only one besides radium which can be obtained in larger amounts. Whereas the other radioactive elements are so extremely rare that most of them can not be seen even under a microscope, protactinium can be obtained in sufficient quantities to be investigated by the chemist in the same way as the common elements.

THE protactinium atom explodes in the same manner and practically just as violently as radium. While the average life of the radium atom is 2500 years, protactinium lasts about twenty times longer; that is, about 50,000 years.

During the explosion of the protactinium atom the alpha particles (helium atoms), electrons and gamma rays are shot off at enormous speeds. An atom of the element actinium is thus formed and it is from this property that protactinium derives its name (*proto*, meaning in Greek "first"). In addition to actinium a whole series of atomic disintegration products is formed, among which is the gas actinium emanation.

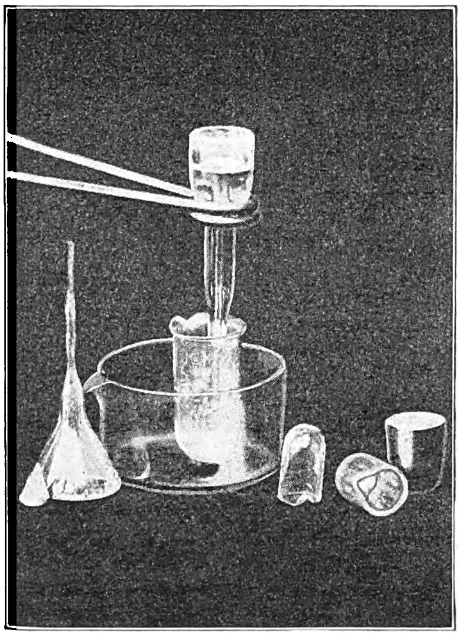
Chemically, protactinium is Element 91, called also "ekatantalum," occupying the ninety-first place in the periodic chart of the elements, between the two heaviest metals known, thorium and uranium.

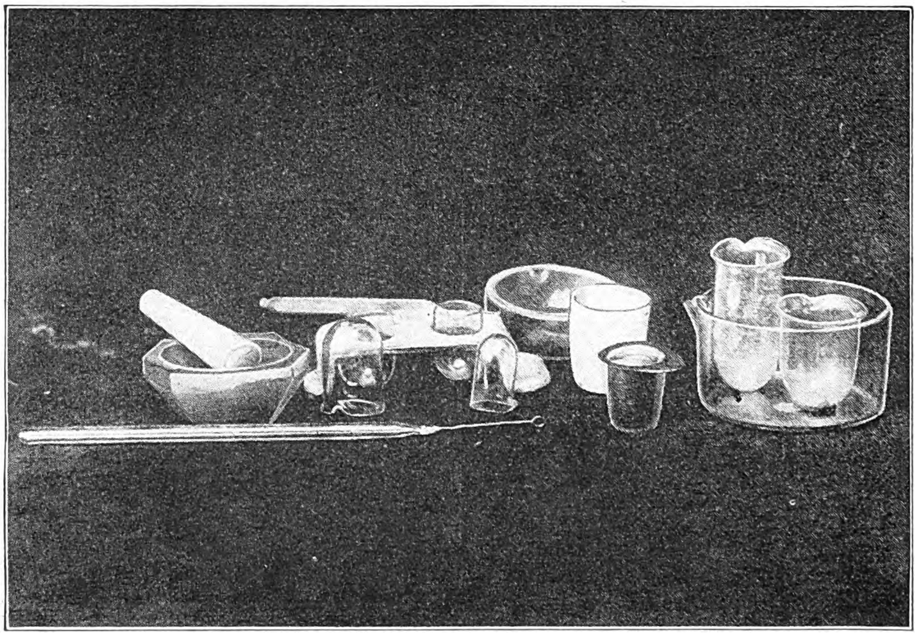
FROM the text of the accompanying article, which was sent the editor from Shanghai, it is difficult to judge whether the author intends to claim the isolation of the pure element protactinium, as stated in the opening paragraph, or of the oxide as mentioned later. Apparently he refers to the latter. In any case his scientific feat is noteworthy. One American authority to whom the article was sent states his opinion that if protactinium comes on the market as a substitute for radium he does not believe the market price will reflect the fact that it can be produced more cheaply than radium but rather the fact that it is rarer. That is, the price would probably be higher than that of radium. This, of course, is put forth as nothing more than an opinion. —*The Editor*

The existence of Element 91 was foretold 60 years ago by the famous Russian scientist D. I. Mendeléeff, when he devised the periodic table of the elements. It was established as a fact in 1917 when Prof. O. Hahn and Prof. L. Meitner in Germany, and simultaneously Frederick Soddy, the distinguished pioneer of radioactivity working in England in collaboration with J. A. Cranston, discovered new alpha rays and proved that they came from a new element which could only be the Element 91, present in great dilution in their material.

DURING the following 10 years all efforts to obtain and isolate the extremely rare protactinium were unsuccessful, owing to the wrong chemical properties being attributed to it, and until 1927 nobody actually saw it. It was generally thought that Element 91 resembled tantalum, just as radium resembles barium; since the latter are always associated, an attempt was made to isolate protactinium by adding tantalum to the raw material and extracting them together.

In November 1926 the writer proposed a new theory of the chemical properties of Element 91, pointing out its difference from tantalum. In the spring of 1927 he had the good fortune of obtaining and seeing for the first time protactinium in the form of its





THE LABORATORY EQUIPMENT

At the left is the filtering apparatus and at the right the crystallizing equipment. As reproduced here each piece is seven eighths actual size, the "doll-house" sizes resulting from the minute, almost microscopic, quantities of materials involved in the work of research pure white oxide, as shown in the illustration. The oxide forms an absolutely white powder with a very high melting point. It shines with a faint glow in the dark, due to the explosions in the atoms.

The difference from tantalum, previously predicted, was therefore established as a fact. It was not even necessary to try the separation of protactinium from tantalum, as it occurred by itself.

In 1927 only two milligrams of protactinium were obtained—just about as much as a needle point. As it was necessary to experiment for weeks with the same scarcely visible material, special equipment was devised to analyze, determine the radioactivity, filter, and crystallize minute quantities of matter. In the photographs, as reproduced, the original apparatus used is shown seven eighths natural size.

Very great care had to be taken during the work in order not to lose the extremely valuable material. Once one of the tiny beakers containing the whole available amount of protactinium slipped out of the writer's fingers and only by a lucky chance was an irreparable loss avoided. The experiments were accomplished during the author's stay in Germany, at the splendidly equipped Kaiser Wilhelm Institute of Chemistry, in Berlin.

COMPARISON of the PHYSICAL PROPERTIES of PROTACTINIUM and RADIUM.

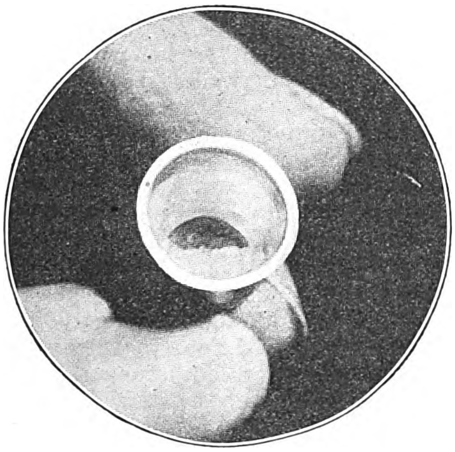
Properties.	Protactinium.	Radium.
Alpha rays:		
Range in centimeters at 15°C.	3.673	3.389
Velocity in kilometers per second.	15,500	15,100
Energy in volts.	2,540,000	2,365,000
Beta rays:		
Maximum energy in volts	318,200	185,000
Gamma rays:		
Wave length of the most penetrating ray in 10^{-11} cm.	38,2	66.0
Maximum energy in volts.	323,000	187,000
Average life of atom in years.	46,000	2,500
Price per gram in dollars.	? ?	65,000

HOW PROTACTINIUM DIFFERS FROM RADIUM

The use of the word "rays," although common, often misleads the layman. Alpha and beta rays are really particles rather than waves such as the gamma rays are. The latter differ from visible light only in wavelength and occur in the ether of space, like radio waves

IN nature protactinium always accompanies radium in uranium minerals and ores. These contain for each gram of radium about 0.6 grams of protactinium. As has already been pointed out, Element 91 is the rarest metal obtained in the world, leaving far behind such rare elements as rhenium, discovered in 1925 by W. and I. Noddack and O. Berg in Germany, and illinium, discovered in 1926 by B. S. Hopkins, L. F. Yntema, and J. A. Harris of the University of Illinois.

In the richest uranium minerals Element 91 is found in the fantastic proportion of only 1 part to 10,000,000 parts of ore. It is therefore necessary to work up tons of raw material to get only grams of the new element. A special procedure is employed to detect the presence of Element 91; it is now possible to determine the amount of protactinium with great accuracy even in a dilution of 1 to 2,000,000,000, thanks to special analytical methods worked out at the Shanghai Institute.



FIRST RESULTS

Tiny crucible with first protactinium ever obtained. Note white oxide powder

While the uranium ore is worked up for radium, the Element 91 accumulates in the insoluble residues which constitute the wastes from radium factories and which previously had no commercial value. These waste residues contain protactinium in a much greater proportion than the natural uranium material, and therefore they represent at present the best raw material for the production of the new element.

One gram of radium now costs 65,000 dollars and, since Element 91 is rarer, one would think that its production cost would be higher. Yet protactinium would not be nearly so expensive as radium because the radium wastes are cheap, because their protactinium content is higher than that of radium in uranium ore, and because the protactinium extraction process is fairly simple.

For further research on protactinium larger quantities than the two milligrams obtained in 1927 were needed, and in 1928 radium wastes could be worked up in an industrial scale, thanks to the great German "dye trust" (*I. G. Farbenindustrie A. G.*). From half a ton of wastes from the old radium factory in Joachimsthal, Bohemia, which was presented by the government of Czechoslovakia, about 40 milligrams, or one hundredth of an ounce, of protactinium were extracted, under the supervision of the writer, at one of the *I. G. Farbenindustrie's* factories at Ludwigshafen on the Rhine.

THE protactinium extraction process is fairly simple—much simpler than the production of radium. This is due to the individual chemical properties of Element 91, which differ very much from any known element. Radium, on the other hand, greatly resembles barium, so that it is difficult to separate the one from the other.

The wastes from radium factories

PERIODIC TABLE OF THE ELEMENTS
(lower right hand corner)
showing the position of the new element .

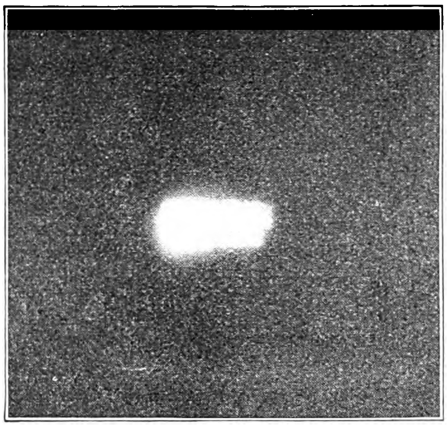
Symbol & atomic No.	Hf 72	Ta 73	W 74	Re 75	Sixth period.
Atomic weight.	178,6	181,5	184,0	188.7	
Symbol & atomic No.	Th 90	Et or Pa 91	U 92		Last period.
Atomic weight.	232,1	?	238,1		

HOW ELEMENT 91 FITS INTO THE PERIODIC TABLE

All of the (presumptive) 92 chemical elements have now been discovered except two, Numbers 85 and 87. Chemists in various laboratories are engaged in more or less persistent efforts to isolate these two and it is unlikely they will be able to "hide out" much longer contain large amounts of silica and iron oxides. They are first boiled with concentrated acids, which dissolve all the iron and other soluble oxides, leaving the "silica residue," which contains Element 91. This residue is melted with alkalies and the melt is extracted with water. This dissolves all the silica and leaves a small precipitate, containing the Element 91 in the concentration of 1 to 10,000. The latter is dissolved in dilute acids and from this solution protactinium is separated, together with the metal zirconium, as a phosphate. By a special method, called by the author the "spiral process," Element 91 is separated from zirconium and freed from all other impurities.

The United States and Belgium are the only two countries in the world which can supply the raw material for protactinium production on a large scale. In the wastes of American radium factories which work up the uranium ores from Utah and Colorado, more than 100 grams (.22 pound) of protactinium are stored, an enormous quantity when we consider that the world radium production since the discovery of that element does not amount to more than 350 grams (three quarters of a pound). Belgium produces radium from rich uranium ore imported from her colonies in Africa. The amount of protactiniferous wastes is much smaller than in the United States, but probably of a better quality.

PROTACTINIUM is thus a very new scientific baby—and nobody knows what use it will find in the future. Nothing has been done as yet to find an industrial and commercial application for it. Evidently much larger quantities than the small amount which constitutes the whole present world production of this element are needed to start experiments. However it is not likely that protactinium will replace radium, for the latter produces in a shorter time a larger amount of effective radioactive disintegration products than protactinium.



PHOTOGRAPHIC EFFECT

Five milligrams of protactinium in a small box placed for a few minutes on a plate wrapped in light-proof paper

In medicine, Element 91 ought to find a different application than radium salts, as protactinium compounds behave quite differently in the body of living beings.

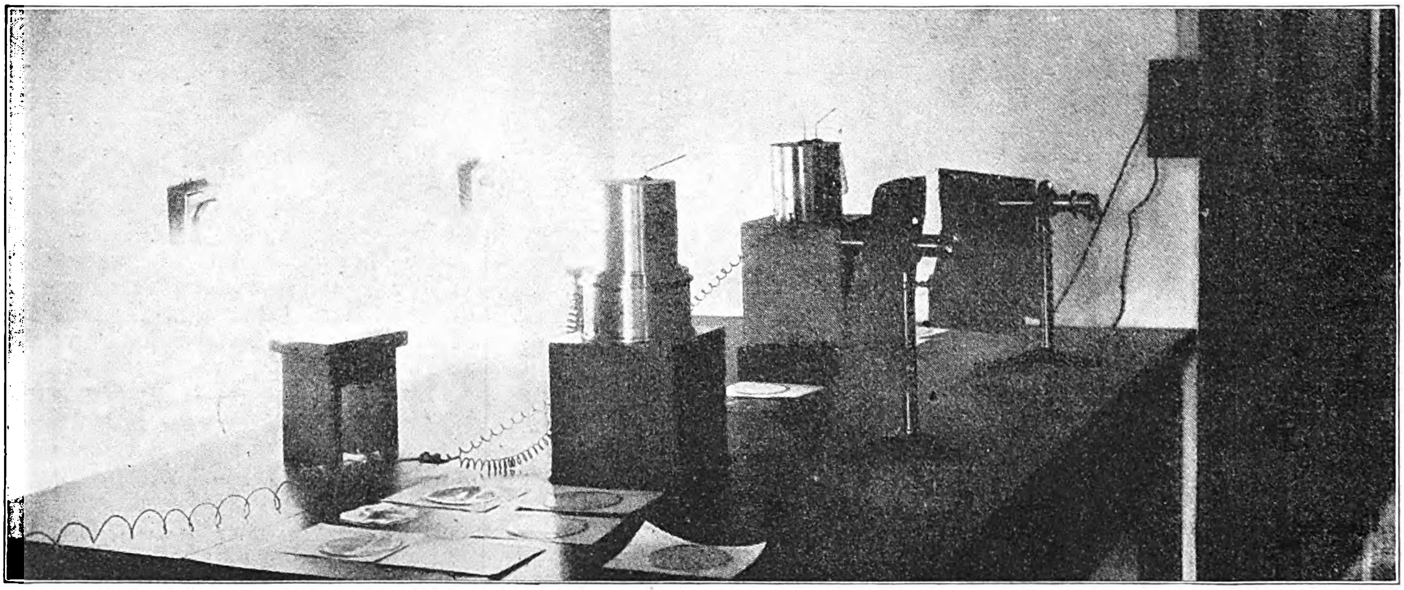
Protactinium is the only radioactive element that can be obtained as a metal. It can therefore be formed into sheet and wire and alloyed with other metals. Perhaps on account of this property protactinium will be of some value later on.

One definite advantage which may accrue from the research is the possibility of getting actinium. This element is 2000 times rarer than Element 91. It has therefore never been seen by human eyes, although it already has a practical application, in extremely diluted form, in radiotherapeutics, as it is over 100 times as active as radium. Actinium atoms are constantly being born from the mother substance, protactinium, and since the latter is now obtainable in a pure state it is extremely easy to separate the "baby," actinium, from protactinium and prepare it in visible quantities.

Large quantities of Element 91 are required for purely scientific research work. When they shall have been obtained it will be possible to answer many important questions about the chemistry and physics of this element. Then the so-called "actinium riddle" which has bothered scientists for 20 years and which Prof. A. S. Russell of Oxford, a leading British radiologist, recently termed "one of the outstanding problems of radioactivity," will be solved. It is the riddle of the origin of protactinium and the actinium which requires an explanation. Since the protactinium atom dies after having lived 50,000 years, and since our mother earth has existed for many millions of years, the birth of protactinium atoms must take place somewhere and from an unknown mother element of long life.

Certainly anything that will bring us a step further in the science of radioactivity is very important, since it is this science that has furnished a great deal of those fundamental facts on which our present day conception of matter, the atom and the way it is made, are based. From this point of view the scientific importance of Element 91 is probably greater than any commercial value it may acquire in the future.

The technical obstacles in the way of large-scale extraction from radium wastes have been overcome and it is hoped that the difficulties in organizing a production of larger amounts of protactinium will be solved as soon as possible, so that its many still unknown properties may be studied.



HIGH-PRECISION ELECTROSCOPES WHICH DETECT MINUTE AMOUNTS OF ELEMENT 91

These electroscopes will measure the amount of protactinium in extreme dilutions of one part in two billions. They are discharged at a measurable rate by the radiations from the element. The rate of discharge is read through small fixed telescopes at the right

Light Airplane Design Contest Winners

First Prize Awarded to an Army Flyer, Second to a Commercial Designer and Third to a Midshipman

THE Committee of Award in the SCIENTIFIC AMERICAN contest for the best design of an airplane to be built around the Cirrus engine, reports as follows:

"We have carefully examined the designs submitted for the Light-Plane Contest on the following rating system:

General suitability of the plane for training and private use and excellency of the design	20 points
Performance	15 points
Power plant installation	15 points
Construction and ease of maintenance	80 points

and have allotted points to the candidates as follows:

Rigby No. 17	125
Huep No. 2	117
Beebe No. 7	100
Boyvey No. 1	91
Brogden No. 11	84
Chase No. 16	73
Sartain No. 4	73
Davidson No. 9	59
Surgeoner No. 19	59
Eames No. 3	56
Brown No. 12	38
Vining No. 14	36
Burnett No. 13	36
Galloway No. 5	27
Roman No. 8	3
Boer No. 10	3
Hamburger No. 15	3
Elset	Disqualified, Wrong Motor
Melve	

"In the opinion of all three of us, Mr. Rigby's design was undoubtedly the best both from the point of view of original conception and presentation, and deserves the prize.

"Mr. Huep's design deserves honorable mention.

"It has given us great pleasure to co-operate with you on this, which has undoubtedly done much to further thought in the realm of Light-Plane design."

Sincerely yours
Amelia Earhart
George Palmer Putnam
Alexander Klemin

PRIVATE JAMES P. RIGBY, 65 Squadron, Luke Field, T. H., therefore receives the SCIENTIFIC AMERICAN Gold Aviation Medal and 500 dollars. F. R. Huep, 1613—9th Street, Des Moines, Iowa, receives a similar silver medal and Midshipman R. P. Beebe, United States Naval Academy, Annapolis, Maryland, receives the bronze medal. It is interesting to observe that all three branches of our flying activities are represented among the winners.

Because the winners are so widely scattered, it was impossible to make a personal presentation and the prizes were sent to each without further ceremony. In our February issue we will publish details of the winning design.

ALTHOUGH a cablegram was dispatched to Mr. Rigby in Hawaii immediately upon receiving the decision of the Committee, we have not, at the time of going to press, received a photograph of him, or the interesting details of his career such as we publish below for the second and third prize winners. Therefore, we will include these when we publish the details of the winning design.

F. R. HUEP, 28 years old, was born and received his technical education in Germany. He was a designer for the Heinkel and Albatross airplane factories, later becoming assistant to Dr. Lackmann, co-inventor of the slotted wing and other safety devices. In 1926 he came to the United States and designed the Hurd low-wing monoplane H. M. I., and is at present chief designer for the Bolte Aircraft Company of Des Moines, Iowa, for whom he has designed and built three types of low-wing planes. He is a member of the S. A. E.

MIDSHIPMAN R. P. BEEBE first became interested in airplanes in Manila where his father, Col. R. E. Beebe, was then stationed. He has passed through all stages from model building to flying solo. In his high school days he spent many hours in the Air Service Library at Washington studying design. A brother is in the same class at West Point.

Congratulations to the winner and appreciative thanks to the Committee who so helpfully and efficiently worked out the *modus operandi* and rendered their decision. Thanks are also due to Col. R. Potter Campbell for his generous support of aviation by providing the prizes in this contest.

How Well Does the Car Stand Up?

Grueling Tests on Proving Ground Show Capabilities and Characteristics of Cars

By H. F. OLMSTED

"ONE hundred and twelve miles an hour! What if a tire should blow out?" The speaker stood along the inside rim of one of the high banked turns of the Packard Motor Car Company's proving ground 2½-mile speedway and watched as Colonel Charles A. Lindbergh roared past every 80 seconds at the fastest speed he had ever made on the ground.

But "Lindy," who was driving the car as a lark, was as safe from any danger in case a tire had blown out as if in his own *Spirit of St. Louis*. One or all four tires on the Packard speedster which he was driving could have blown on either of the two big curves of the track and the car would have kept going without wavering from its course. The track is so built that when a car once enters one of the turns it will hold to its course without a hand on the steering wheel. It actually can be steered by the accelerator pedal.

This is one of the many interesting features in the big 500-acre plant which is used for testing Packard cars. A crew of experts who the year 'round drive cars about the big concrete oval at top speed, bounce them over roads as rough as they can be and still have any claims to being roads, or put them through any of the many other tests with which the proving grounds abound, have found that blowing tires at 75 or 100 miles an hour is one of the least of the dangers confronting them at high speed.

Sleep probably would be numbered by any one of the drivers as the greatest menace to safety. Ring-neck pheasants would be the next. Collision with other cars would not enter at all nor would the blowing of tires. Sleep has caused the only accidents which have occurred on the track. Pheasants several times have threatened accidents.

Stamina of a motor car is tested by starting it out on the track at the fastest speed of which it is capable and holding the throttle wide open for many days and nights with stops only for gas, oil, water, or the changing of tires or drivers. Monotony grows with ceaseless circling of the track. Screaming of the wind made by the speed of the car, blending into the singing of the tires on the concrete, the drivers have found, is as effective a sleep producer as the croon of a southern mammy's lullaby.

A year ago the driver of a sedan under test went to sleep while travelling 80 miles an hour. He woke up as the car was leaving the track on its first bounce. It rolled over five times. The driver escaped without a scratch and the car was unharmed. It was an extra, impromptu, but most effective test of the stamina of the body construction. Since then precautions are taken constantly to guard against sleep.

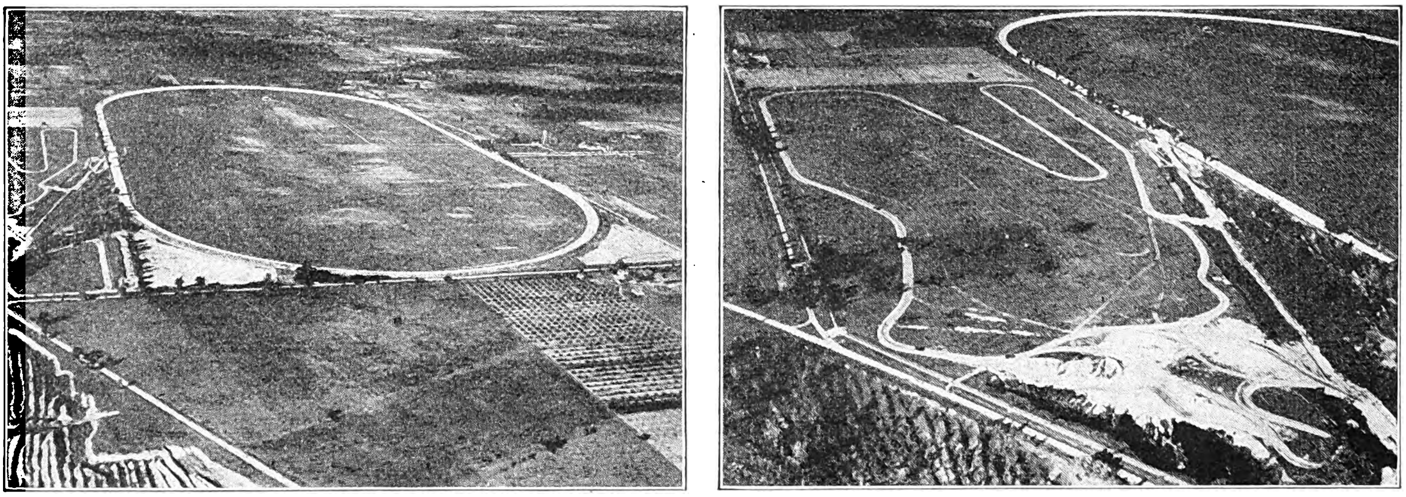
THE proving grounds are located near the village of Utica, 20 miles north of the company's factories in Detroit. It is a section abundantly supplied with small game, most numerous of which are ring-neck pheasants. Several encounters have occurred between the pheasants and cars and each time the car has scored "dead bird."

LIKE A COUNTRY ROAD

One of the test roads on the Packard Proving Ground, simulating an unpaved, rough byroad such as is often found

Pheasants are fast-flying birds and travel with the directness of an arrow. Several times they have been struck when shooting across the track. Each time the car was an enclosed model and the bird failed even to crack the non-shatterable glass of the windshield against which it struck. Drivers think of the pheasants as an actual menace while traveling at high speed in open cars with the windshields folded down. They also say it is humanly impossible not to "duck" the head down when a bird crashes into a windshield or window of an enclosed car, although knowing the glass can do no more than crack, without flying into pieces as would ordinary glass.

It is considered remarkable that accidents, even those of slight nature, are most infrequent, as the day's work of the testers consists of putting cars through the most severe kinds of

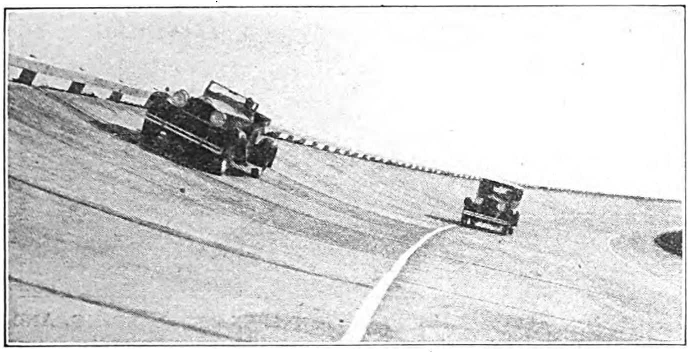


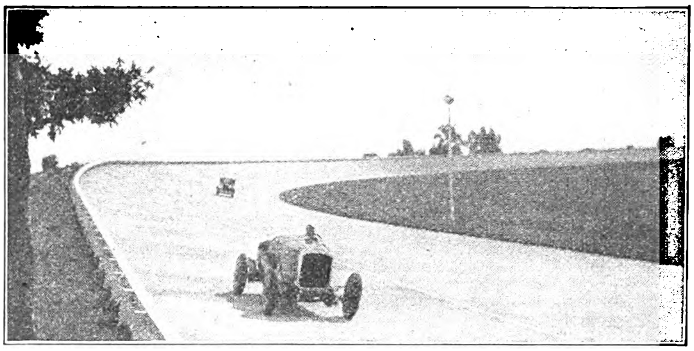
SPEED AND MANEUVERABILITY

At the left is shown the oval track on which speed tests are made. On the irregular track at the right, cars are run at high speed, around sharp curves, through sand traps, up difficult inclines, and over bumpy ground. Several cars may be seen on track

ON THE CURVE

The corners on the oval speedway are so curved transversely that a car, traveling at speed, will steer itself if a tire should blow out





ON THE STRAIGHT-AWAY

This track is so safe that the worst thing the drivers have to contend with is sleep due to the monotonous hour-by-hour grind

trials many times with the avowed purpose of trying to cause some part to break.

The proving grounds extend for a mile along one of the main highways leading from Detroit to Northern Michigan. In the whole establishment the company has combined a vast amount of beauty with the utility of the place. In a large lodge house set back some distance from the main highway in a profusion of trees and shrubbery are living quarters for the superintendent, offices, quarters for drivers and engineers, a large garage, and a complete short-wave radio broadcasting station.

ANOTHER building in the rear and across a paved court from the main lodge houses a complete installation of testing apparatus, including dynamometers and a machine shop. It also contains the boiler room which provides heat for all of the buildings, and houses machinery of the water pumping system, a plant large enough for a small city.

A double drive from the buildings to the track is flanked by a putting green and a four-hole "golf course."

The timing stand is at the end of the drive where also is located the main entrance to the track. A complete equipment for recording weather conditions is located in the timing stand where the electric timing device also is set up.

The testing track is an oval consisting of two parallel straight-aways each three quarters of a mile long, joined at each end by a half circle one half mile long. The inner circumference is two and a half miles. The curves at each end consist of three sections; the first has a slope of one degree for drainage, the second rises 11 degrees, and the third section 29 degrees. Driving around the curve, one has a strange optical illusion. The first section seems to slope sharply toward the rest of the track. Often during heavy rains water draining off the track seems actually to be running up hill.

On the center section, with the slope of 11 degrees and the large radius of curvature, any side thrust is canceled at 60 miles an hour, so that at this speed a car will steer itself. Higher speed carries a car up onto the third or high-speed section. Here there is no side thrust at 100 miles an hour and a car actually would steer itself at this speed.

So scientifically planned was the track that it has the record for the fastest time ever made on any circular speedway in the world. This was established by Leon Duray, well known race driver, when he made one lap with his special racing car at the rate of 148.17 miles an hour.

Inside the track is a 265-acre landing field, with mile-long runways, which is used by the company for testing planes equipped with the aircraft motors which it builds. It was from this field that the first airplane powered with a Diesel type engine was flown. A hangar at one end of the field houses the test planes.

One of the most serious construction problems encountered was presented by the landing field. It was a waste of sand, a miniature desert, and farmers of the district shook their heads when they learned that it was planned to develop the area into a lawn. Experts were called in. One hundred tons of fertilizer were used and 41,000 pounds of grass seed were planted while at the same time the whole field was sowed with oats which, it was believed, would take root quickly and hold the sand long enough for the grass seed to germinate and make a stand strong enough to hold the sand alone. The entire field is now covered with a thick sod.

BEYOND the testing track is the "rough ground" and the test roads. The roads—gravel, sand, and plain old-time country dirt—turn and twist all over the place and are so designed as to give the hardest kind of a test to all parts of the car, including the steering gear.

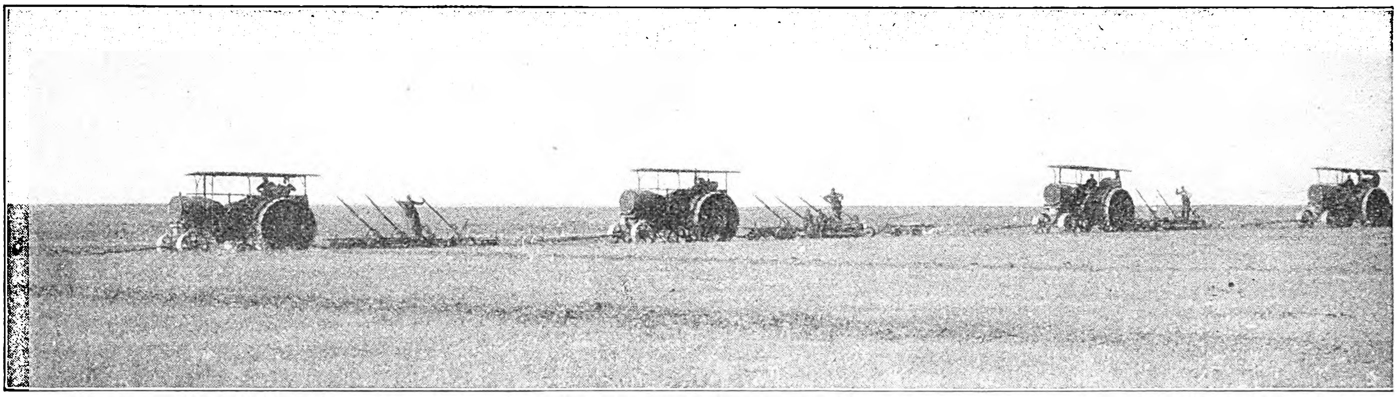
At one point along the test roads there are two artificial hills which, with other dips, give the effect of a roller coaster. Another much steeper hill has been built up so high that an excellent view from the top is obtained of the whole proving grounds and the surrounding country. A miniature desert is provided at another point. It is enveloped in a cloud of dust when cars are sent plowing through its deep sand during test work.

While hills are located along the test roads, enigmatical as it sounds, real hill climbing tests are conducted on the level stretches of the speedway. On the flat concrete, mountains of any grade and of any length are simulated perfectly by a device known as a towing dynamometer.

The towing dynamometer is a car which is towed behind the car under test. An air compressor takes the place of the motor to give the dynamometer car the most powerful braking effect. The frame is loaded with hundreds of pounds of lead to give the wheels greater traction. The towing bar has a piston at one end which works in a hydraulic cylinder. Pressure in this cylinder is registered on gages on the dash so that there is a constant record of the draw-bar pull.

Compression in the air compressor can be regulated through relief valves at the will of the observer in the driver's seat of the towing dynamometer. If a heavy grade is desired the relief valves are set to the proper point. They are so calibrated that any percentage of grade can be maintained.

THE big Packard proving grounds well illustrate to what extent some companies in the automotive industry go in constantly striving to better the quality of their product. It is the largest plant created for proving and improving just one kind of car and represents an investment of well over 1,000,000 dollars. Only a few years ago proving grounds were unnecessary for all motor cars, as engineers had no difficulty in finding many ways of making improvements. Motor cars of better quality, however, have now reached a state of refinement where the most enhaustive tests are necessary to discover means of betterment and to make certain that the quality of the car is being constantly maintained.



ESTABLISHING A WORLD'S RECORD BY PLOWING, DISKING, SEEDING, AND

Mass Production

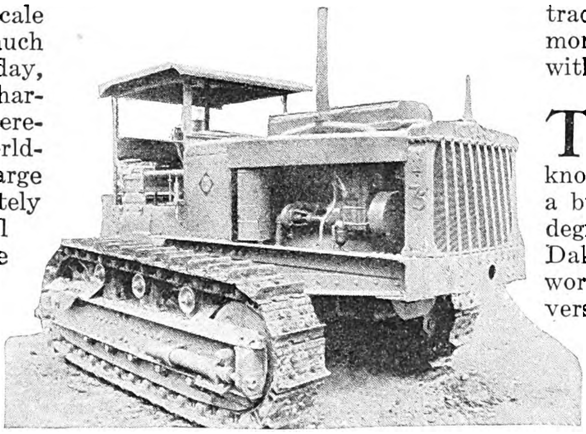
Large-Scale Farming Operations May Be Revolutionized

By HENRY

WHEELS—big wheels and little wheels—with ample power to keep them turning day and night until the last of the fleet of tractor-drawn combines has threshed its last bushel of grain—that is the story of harvest-time at the 95,000-acre farm of the Campbell Farming Corporation, which occupies part of the Crow Indian Reservation in Montana. Agriculture a-la-Detroit is the *pièce de résistance* on this tremendous farm, where the production of nearly a million bushels of wheat a year is accomplished by means of the most advanced farm machinery, mass-production methods of operation, and an up-to-date system of cost accounting.

Power is obviously a factor of paramount importance in such large-scale farming operations, where as much as 1000 acres can be plowed in a day, and 2000 acres can be seeded or harvested. One is not surprised, therefore, that the attention of the world-famous agricultural engineer in charge of these operations has been lately focused on the most economical power source yet perfected—the Diesel oil-engine.

SEVERAL tractor manufacturing concerns have been experimenting with Diesel engines, and recent experiments and field tests in a 400-acre field on the Campbell farm indicate that the gasoline-driven tractor is perhaps soon to become as obsolete as its steam-driven forerunner.



Courtesy Allis-Chalmers Manufacturing Company

A DIESEL-POWERED TRACTOR

Tests on the Campbell farm with this tractor powered with a Diesel engine inaugurated a new era in power farming operations of the type practiced in the west

The tests were revolutionary, according to Mr. Thomas D. Campbell, President of the Campbell Farming Corporation. "With an Allis-Chalmers Monarch tractor powered with a Diesel engine operating on furnace oil, plowing costs were cut to about one seventh the usual figure. Pulling 10 plows at a depth of about 10 inches the tractor plowed the 400-acre tract at a rate of 36 acres per ten hours of operation. With more efficient operating methods, I am confident that the Diesel engine will enable us to reduce our expense for heavy plowing to about one tenth the usual cost when operating tractors powered with gasoline engines.

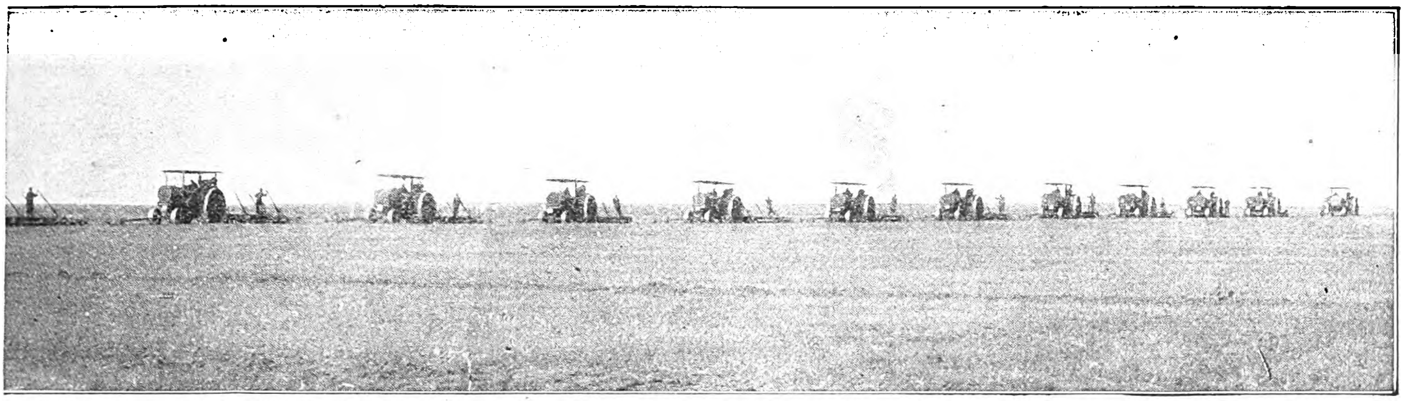
"Of course the Diesel engine is somewhat heavier than other types of internal combustion engines. However, in a tractor this factor is an asset rather than a liability, particularly when operating with a heavy drag. I believe that the next ten years will be an era of Diesel-driven tractors. This development is of outstanding importance, for more power is required to plow the farm lands of the United States, in the time they should be plowed, than is needed to operate all other industries together, including our great transportation systems."

Agricultural engineers have observed and analyzed Mr. Campbell's operating and production methods, and have studied his simple but highly successful system of cost accounting. Farmers, economists, and the general public have listened to his enthusiastic description of the Campbell brand of farming, seeing in the far-flung operations of the corporation a more scientific scheme for feeding the world. Manufacturers of farm machinery seem to regard the Campbell farm as a proving ground for various types of new equipment designed to increase production of agricultural products on a more economical basis.

A "farm hand" would be as much of a novelty as a horse or a cow on this farm; the workers are mechanics, who are paid mechanics' wages, or work on a basis of mileage covered with an attractive cash bonus at the end of the season. High wages, comfortable living quarters, and a relatively large degree of individual responsibility attract skilled workers of an uncommonly high type, many of them men with technical training.

TOM CAMPBELL, as the head of the corporation is generally known, is an engineer, a farmer, and a business man. After receiving two degrees at the University of North Dakota, and taking post-graduate work in engineering at Cornell University, he took over the management of the family farm in the Red River Valley in North Dakota. A few years later he was engaged in various large-scale agricultural development projects in California. When the war-torn nations of Europe turned to the United States for emergency supplies of wheat, Mr. Campbell secured the financial backing of a group of internationally prominent bankers and began to raise wheat on an unprecedented scale, making use of large areas of unproductive government land.

"Dry farming" on the semi-arid plains of the west has broken the spirit of thousands of homesteaders farming relatively small tracts with unscientific methods and inadequate



Packing 640 Acres In One Day, Without a Halt For Mechanical Trouble

In Agriculture

By Means of Tractors Powered With Diesel Engines

W. HOUGH

equipment. To raise a paying crop on barren prairies with only about 15 inches of rainfall a year and temperature variations from 40 degrees below zero to more than 100 degrees above, is an undertaking that requires sound knowledge, skillful management, and a reasonable amount of luck. About the time Mr. Campbell was launching his project in southeastern Montana, agriculture in that region went through the worst period in its history; parching drought destroyed one crop, myriads of grasshoppers consumed another, and the first good crop was made valueless by the utter collapse of the wheat maket.

THOUSANDS of farms were abandoned, but Mr. Campbell secured new capital and carried forward his carefully made plans. Planting only half the usual amount of seed to the acre, in order that whatever moisture might be available would be used to best advantage, he raised a good crop and marketed it at a substantial profit. Since then his operations have been successful every year, and as the total acreage in crop increases, production costs go down. When he wishes to increase his output, Mr. Campbell pays his men higher wages and the average production per man increases to a new high level.

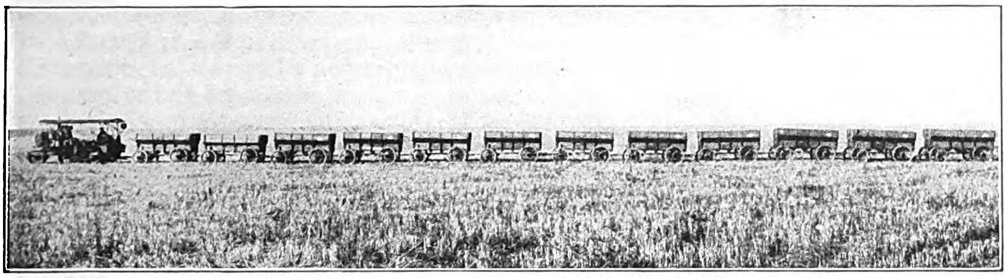
The total acreage of the Campbell properties is sub-divided into units of from 5000 to 32,000 acres. With 640 acres to one square mile, it will be seen that the Campbell farm occupies about 150 square miles. To take an inventory of the equipment would seem to be a good job for an aerial photographer; when listed, the more important types of machinery represented would include 56 tractors, 72 binders, 21 combines, 11 threshing machines, 500 plows, 60 12-foot drills, 200 wagons, 20 motor trucks, and 10 automobiles. Gasoline is received from Montana or Wyoming refineries in tank cars consigned to the Campbell Farming Corporation at Hardin. There is gasoline storage capacity on the farm for approximately 70,000 gallons.

Maintenance is an item of great importance, for few man-made machines can withstand the punishment imposed by almost uninterrupted operation over rough ground at a speed of three miles an hour, often working both day and night. Every piece of new equipment is reinforced before it goes to the field. At the company headquarters in Hardin, the farming corporation maintains a large repair shop, which saves about 2000 dollars a month on maintenance costs, according to Mr. Campbell. It includes a forge shop, machine shop, brass foundry, and complete equipment for welding. The 200 skilled men who operate the tractors, combines, and other machinery, are able to make most mechanical repairs in the field. The busy season is from the first of September to the first of December. When this period closes, all of the equipment is overhauled completely and put in shape for the coming season. A crew of about 50 selected men attend to the necessary work during the winter months when most of the crop is in the ground.

Winter wheat is the principal product of the Campbell farm, although large areas are also used for raising spring wheat and flax. Growing conditions in eastern Montana are particularly favorable for raising these crops, but producing spring wheat is relatively hazardous because of the hot, dry winds of the summer which are likely to wither and shrivel grain planted in the spring.

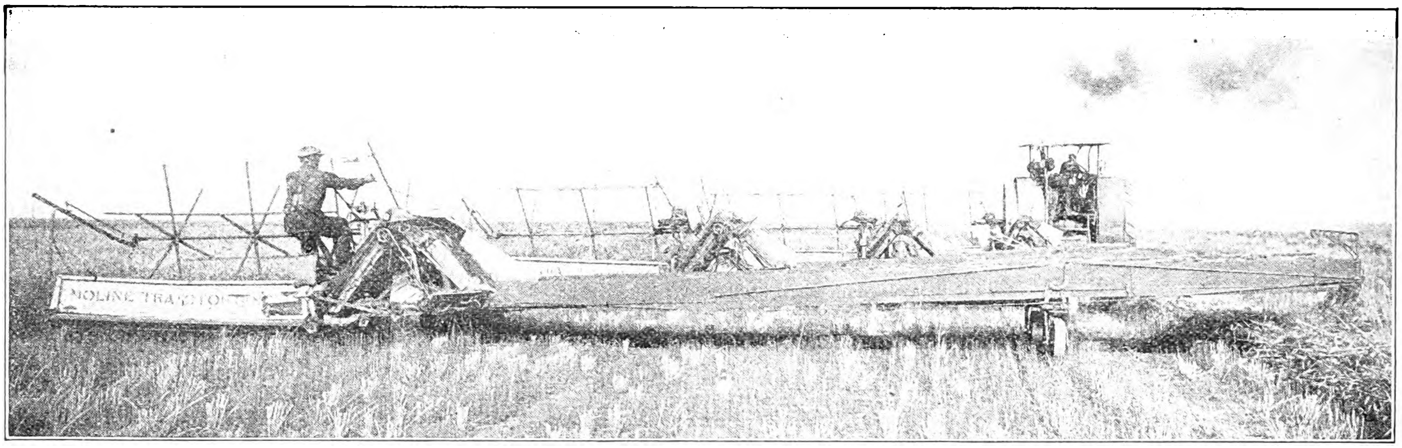
PREPARING the ground for the seed is the most important part of farming operations on the semi-arid prairies. The scant rainfall and snow do not provide sufficient moisture for maturing the crop unless the moisture of the previous season has been well stored in the soil. Summer fallow one season in three gives the soil an opportunity to replenish its supply of growth-giving constituents and moisture. After the harvest, the land is disked to enable the fall rain and winter snow to soak deep into the soil. Early in the spring the fields are disked again, and then left fallow until May. By that time there is considerable growth of weeds and volunteer wheat, which is plowed under for fertilizer, usually with a light duckfoot plow. The soil is pulverized with a spike-tooth harrow later in the summer, and seeding begins early, usually about the middle of September, in order to give the grain time to get sufficiently well established so that it will withstand the rigors of winter.

For the first crop the ground is



THIS LITTLE WAGON TRAIN GOES TO MARKET

Long trains of grain wagons drawn by tractors are supplemented by fast grain trucks hauling two or three trailers, in harvest season. Trains rush the crop to the markets



HARVESTING GRAIN BY THE "WINDROW" METHOD DEVELOPED BY THOMAS D. CAMPBELL

After the wheat or flax is cut and piled loosely in long rows to cure, a tractor-drawn "combine" picks up the grain and threshes it. This method makes the use of the combine practical in almost any agricultural region on relatively small farms as well as large ones.

plowed and disked, but the following year it is simply double-disked, turning under the stubble and the straw scattered by the combines. Plowing costs have been reduced to about two dollars an acre, but disking can be done for less than one fourth that amount. In 1924 the Campbell farm established a world's record by plowing, disking, seeding, and packing 640 acres in one day of 16 hours. Fifteen tractor-drawn assemblies were kept in operation without a halt for mechanical trouble of any kind; the tractors were refueled without making a stop. Now the rate of a section a day can be continued as long as is necessary properly to plant the crop, and 1000 acres a day can be put in when desired.

Profiting by his experience the year of the severe drought, Mr. Campbell uses only about 20 pounds of seed to the acre, or about half the amount of his first seedings. For the second crop only 10 pounds of seed to the acre is used. The usual yield is about 15 bushels to the acre, although in 1924 the yield averaged 30 bushels.

Another world's record was established in 1924. Threshing, now done in most of the important wheat-producing regions with tractor-drawn combines, was then done with stationary threshing machines powered from nearby tractors. With one standard Case threshing machine outfit, 4321 bushels of wheat were threshed in one day of 14 hours. The record is one that will probably stand for all time, because it is now considered more economical to use combines, harvesting "on the run." Threshing as much as 30,000 bushels a day, from 10 to 20 combines are drawn around the enormous fields. An arm with a spread of from 20 to 30 feet cuts the wheat and passes it into the thresher, which pours the grain into a hopper or into a wagon attached to the combine.

Harvesting with combines was impractical under certain conditions, and to remedy this objectionable feature Mr. Campbell developed the "windrow," which is recognized as one of the most important advances in harvesting since the invention of the binder. Using four partly dismantled binders drawn by a light tractor, a 40-foot swath of grain is cut and transferred unbound to a long row, where the loose grain is allowed to mature for a few days before threshing. Then a combine is hauled down the long row, picking up the grain with a hay loader, and threshing it in the usual manner. This method effects a saving of two dollars an acre on harvesting costs, compared to the old method with binders, bound shocks, and stationary threshers. Due to the extra width of the spread or swath cut, the cost of the two windrow operations is comparable to that when combines are used in the regular manner.

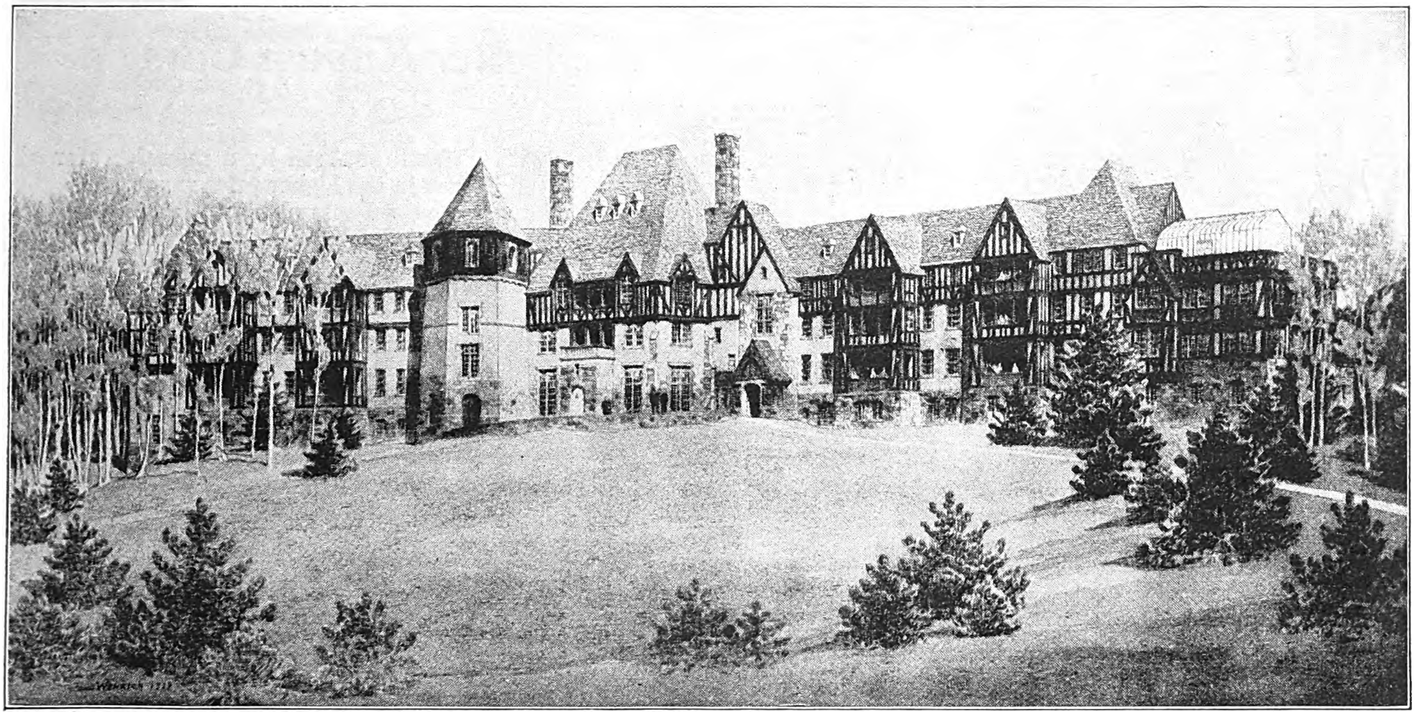
LONG wagon trains drawn by tractors, supplemented by motor trucks equipped with large bins and drawing two trailers, transport the grain to the railroad, elevators, or storage bins. Most of the Campbell grain goes to Minneapolis, the largest flour producing city in the world. Millers feature flour made with Montana wheat, and pay extra premiums for the Montana grain because of its unusually high protein content. The premium on high-protein wheat varies from two cents to about 30 cents, according to the milling demands and the abundance of the premium grain. On the Campbell properties near Hardin there is storage space for about 150,000 bushels of grain, for protection against an unfavorable market.

When one contrasts the high-speed, mass-production methods of modern industrialized agriculture with the more leisurely, more enjoyable, but obviously less economical practices still in vogue in most of our agricultural regions, it is not hard to realize that 30 percent of our farmers produce 80 percent of our crops and livestock. During the past 20 years about five million people have left the farms, but the total agricultural output has increased; by 1950 there will probably be about 150 million people in the United States, and they will be fed by fewer farmers than were required in 1850 to feed only 25 million people. Three men operating a tractor combine can do the work of 18 threshers, and it now requires only 10 minutes of human labor to produce one bushel of wheat whereas it formerly required about three hours.

What the farmer really needs, in the opinion of the world's largest wheat grower, is better machinery, improved inland waterways, closer co-operation between farmers and business men, more agricultural research, education regarding economical production methods, tariff protection, better co-operative marketing associations, and improved equipment to provide cheap power for farming operations. Anyone who intelligently follows the advice of the Department of Agriculture and the agricultural colleges can make farming pay, especially if trained in engineering practices. Mr. Campbell expects to be operating his tractors with individual electric motors supplied with power distributed from a central generating plant on his farm, within another 10 years. In the meantime, he considers the Diesel engine the most economical power source for use on farms.

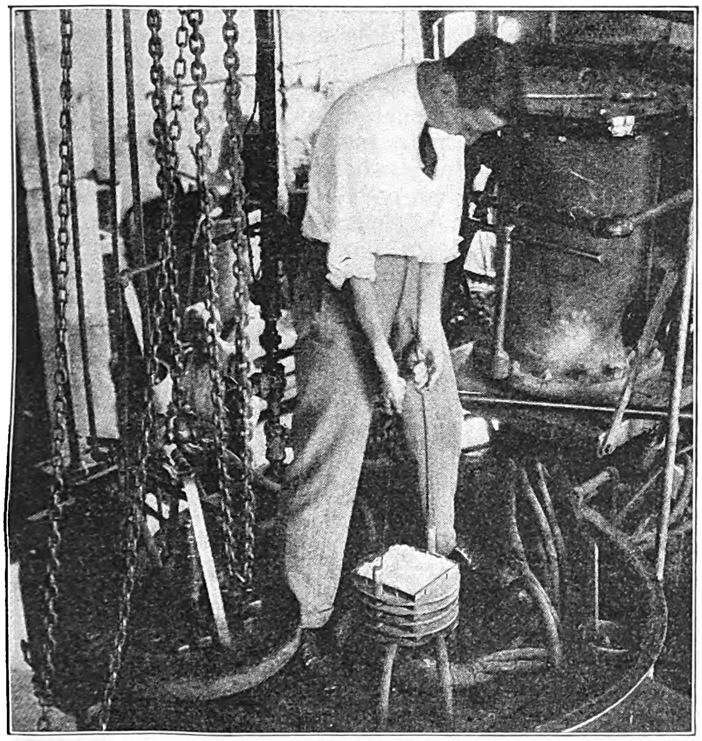
It is Mr. Campbell's belief that the greatest industrial opportunity of the present time is in agricultural engineering, both as a life work and as a sound financial investment. In a recent issue of *Mechanical Engineering,* the editor said, "Mr. Campbell's experience indicates that the application of machinery on a large scale is successful in producing wheat and flax at low cost. It is logical to believe that the principles he has developed and used so successfully can be applied to other farm products. As engineering skill has made over industry generally, so it can remodel agriculture, transforming it from a method of making a living to a sound industry that will attract the best brains and capital."

Fuzed Quartz for Ultra-violet Rays



THE NEW FUSED QUARTZ SOLARIUM

The enclosure, entirely of quartz panes, is shown (upper right hand corner) on the roof of the National Vaudeville Artists' Sanatorium



PLACING TRAYS OF CRUSHED CRYSTAL QUARTZ IN FURNACE

INSPECTING PANES OF THE FUSED AND FINISHED PRODUCT

IN order to permit patients to receive indoors the maximum percentage of the especially valuable short wavelength ultraviolet radiation of the natural sunlight the sanatorium shown above, at Saranac Lake, New York, has installed an expensive solarium walled and roofed entirely with panes of fused quartz, 1200 of them, each 7½ inches square and ¼ inch thick. Common window glass, transparent to the visible rays of light, is almost totally opaque in the short-wave ultra-violet part of the spectrum. Various special glasses and glass substitutes transmit up to about 50 percent of these rays, while fused quartz transmits the greater part of them. The quartz panes were made by the General Electric Company, using a special technique developed by Professor Elihu Thomson of that company, who is also a Corresponding Editor of this journal. Quartz is difficult to work because it melts only at 3200 degrees, Fahrenheit—three times the temperature required to melt glass. Even then it is thick, ropy, and viscous. In making the window panes, natural quartz crystal is crushed to ¼ inch mesh size and spread on graphite trays between graphite slabs. Several trays are stacked as shown above, placed in a high temperature furnace and fused. The troublesome bubbles imprisoned in the mass are compressed to a minimum size under 150 pounds per square inch of inert gas (nitrogen) admitted to the furnace. The panes are cooled, their edges are squared by grinding, and they are ready for use.

Your 1930 Car

A Survey, in Brief, of Developments, Improvements, and Changes in Design of Some of the Better Known Cars

By F. D. McHUGH

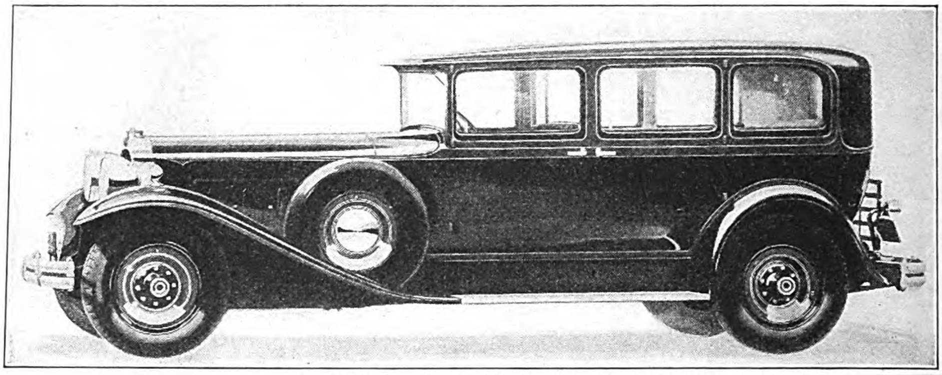
WHEN you come to the task of selecting your new car this year, you will find that you have taken upon yourself a more difficult job then heretofore—unless, of course, you are partial to a particular make. Practically all the better known cars have refinements that will appeal to your desire for speed, for safety, for appearance, et cetera; but, in general, many of these features balance each other in different makes so that, to a large extent, you will have to guide you only the limitations of your purse and the knowledge you already have as to car performance and reliability.

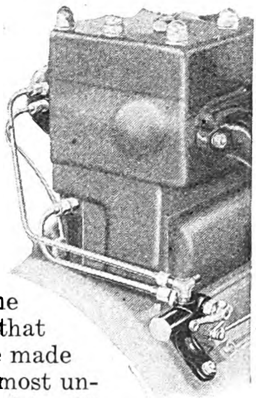
And yet with all the refinements that have been made, mechanical improvements this year are not numerous. Some outstanding ones, however, indicate the intention of the manufacturers to build for you an ever finer, safer, more powerful, or more attractive car.

ON page 9 of this issue, Mr. C. F. Kettering outlines this development problem and describes the constant research that it is necessary for the manufacturer to conduct, but he does not stress the fact that whatever improvements are made come very gradually and almost unknown to the average motorist. We shall therefore outline briefly what appear to us to be the most noteworthy refinements and improvements that have been made recently and others that are to be announced shortly.

In general, it may be said that improvements are limited to such details as spring shackles, carbureters, rumble seat doors, and the more general adoption of four-wheel brakes, of safety glass, and of other safety features. Several manufacturers, however, have greatly increased engine power. A few cars have been equipped with newly developed devices which add much to engine capacity, to riding comfort, or to ease of driving.

The desire for color, fostered by the judicial use of it for several years and by almost a sunburst effect in the cars of 1929, is proving to be no fad but a method of expressing the car owner's individuality. In 1930 there will be a marked increase in color used on many cars. In fact, color has become such an important factor in the production of automobiles that manufacturers have employed color directors—artistic experts who know how to harmonize color combinations with individual designs.





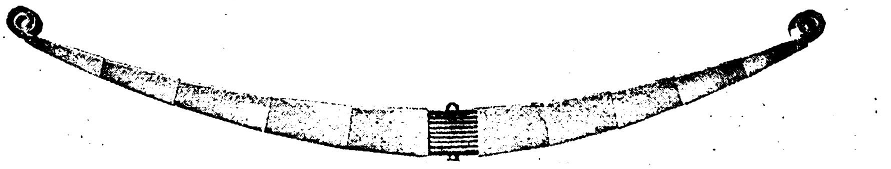
PACKARD LIMOUSINE AND PISTON OILER

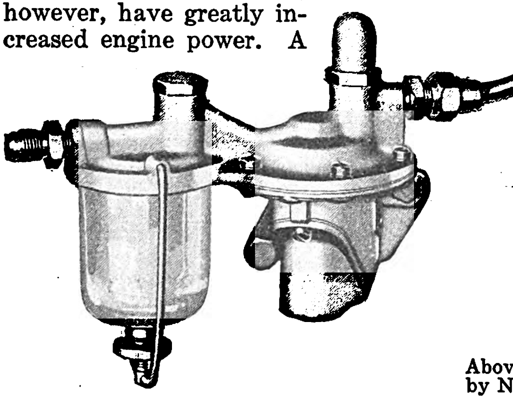
The luxurious seven-passenger sedan limousine presents a striking appearance. At the left is the choke-operated valve which sprays oil into each cylinder

Before going into further detail, we wish to refer you to the article on the Cord front-drive automobile on page 28. This is the most radically new design in American passenger automobiles for 1930. Besides this car, several makers of sixes have recently announced production of new eights and it is rumored that others will come into the market soon. Also, it has been stated authoritatively that a new 16-cylinder passenger car will be announced in March or April by a manufacturer of cars in the higher price range.

New Packard eights announced in the fall, characteristically Packard in appearance but with subtle changes that add much to their already famous beauty, have several outstanding improvements. Both the driver's seats and the steering wheels are adjustable. Unusual vision is given in the front compartment by a front body pillar that has been narrowed, yet retains the same body strength. All windshields and windows are of non-shatterable glass. The left front spring trunnion, developed by this company a year ago to eliminate "shimmy" and wheel "whip," has been retained. The chassis lubricating system has been extended to include 43 points on the chassis which are oiled every day by turning a pump handle mounted within easy reach at the base of the steering column.

PACKARD has also developed a new carbureter which is said to have many advantages in smoothness of operation, acceleration, safety, quietness, economy, and easy starting. Steel-backed bearings and several other features found by the company to be of advantage in building airplane models are incorporated in the new engines. As in previous Packards, the



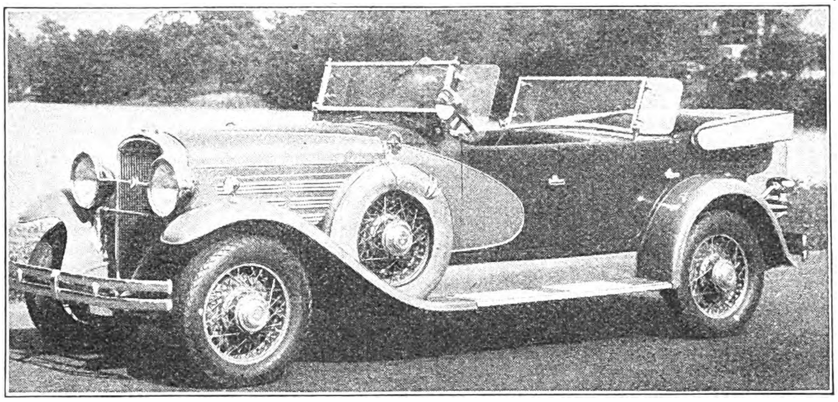


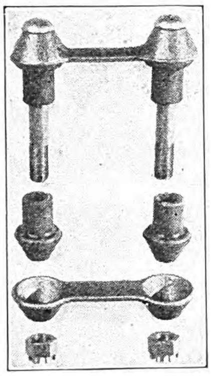
NASH DEVELOPMENTS ON THE TWIN-IGNITION EIGHT

Above is shown the manner in which the springs are steel-jacketed on the new eight announced by Nash. At the left is the gasoline filter and fuel pump which makes positive fuel feed possible pistons are automatically lubricated when the choke rod of the motor is pulled out, an arrangement which pumps oil onto the cylinder walls at the time it is most needed.

With three complete lines, each comprising 11 different types, and an almost unlimited choice of individual custom bodies by the best body builders, Packard may now be said to cover completely the fine car field.

One of the eights recently announced by a maker of sixes is the Nash twin-ignition straight-eight which the Nash Motor Company claims is the first of its kind in the world. Included in the announcement were details of a twin-ignition six and a single six. The new eight is powered by an eight-in-line twin-ignition, valve-in-head, nine-bearing motor with an integrally counterbalanced, hollow-pin crankshaft; with aluminum alloy Invar-strut piston and aluminum alloy connecting rods capped at the crankshaft with case-hardened steel. It develops 100 horsepower.





JORDAN "PLAYBOY" AND SPRING SHACKLE

An attractive sport touring car. At the left is shown the rubber insulated spring shackle, disassembled to show parts. Rubber sections are dark

NEW features of the Nash eight include: steel-jacketed lifetime-lubricated springs, individually tailored to the weight of each car; cable-actuated internal-expanding four-wheel brakes which are self-energizing forward and backward; thermostatically controlled radiator shutters; Bijur centralized lubricating system to oil, by pressure on a foot pedal, 21 chassis points, including shackles; dash-bottom starting controls; et cetera.

Various mechanical and body refinements have been incorporated in the Nash eight. These include air-craft-type spark plugs, positive fuel-pump gasoline feed, solid chain-operated camshaft, improved clutch, and road-shock insulator. Most of these features will be found also in the two sixes while both the eight and the sixes have non-shatterable glass in windows and windshield.

Hupmobile is another producer of a new eight in the medium price class. This car is manufactured in five body styles, one of which, the cabriolet, has a patented top construction. The new eight develops 100 horsepower, is said to attain an 80-mile-an-hour speed, and accelerates rapidly.

In these new Hupmobile eights, the radiator is higher and narrower, has built-in shutters, a new emblem, and a narrow chromium-plated shell. Among other improvements, this car has also adopted the road-shock eliminator attached to the rear end of the left front spring, and force-feed lubrication to all main, connecting rod, and piston pin bearings—46 points in all.

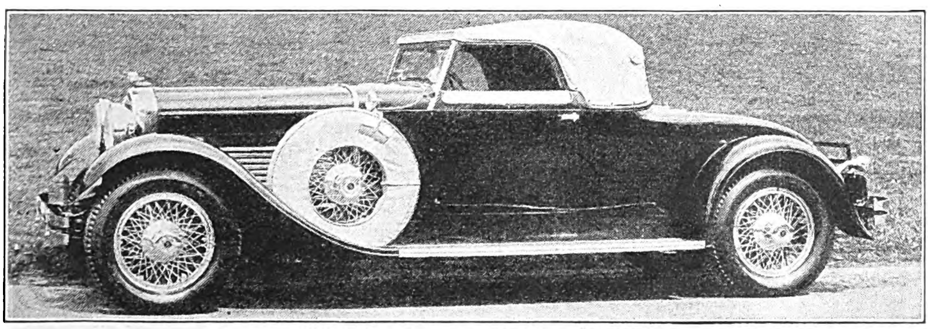
A third new eight is the Gardner with an eight-in-line motor and optional four-speed transmission. This new car comes in two series, in each of which there are eight models. Information concerning mechanical details of this new eight are not available but it is said to have several improvements.

Several features of the "Great Line Ninety," an eight by Jordan, with a 75 horsepower, eight-in-line motor, reflect this company's claim of "scientific engineering." This eight has a crankshaft that is both statically and dynamically balanced and is therefore free from periodic vibration; it has pressure lubrication of main and connecting rod bearings, a double breaker ignition distributor, and other distinctly Jordan developments. Other features are: soft type chassis springs of special alloy steel, Houdaille shock absorbers, seat cushion springs which are said to be synchronized with the chassis springs, and new patented shackles, mounted in rubber to eliminate rattles and squeaks.

The Stutz Motor Car Company continues to stress the built-in safety features of Stutz and Blackhawk cars. The contribution to safety of the low-slung bodies of these two cars—made possible by the worm gear drive; of the safety glass used in both; of side bumper running boards; of four-speed transmission; and of the vacuum booster on the hydraulic brakes of the Stutz, has been added to within the year by the Noback, an exclusive Stutz engineering achievement which is now on both the Stutz and the Blackhawk.

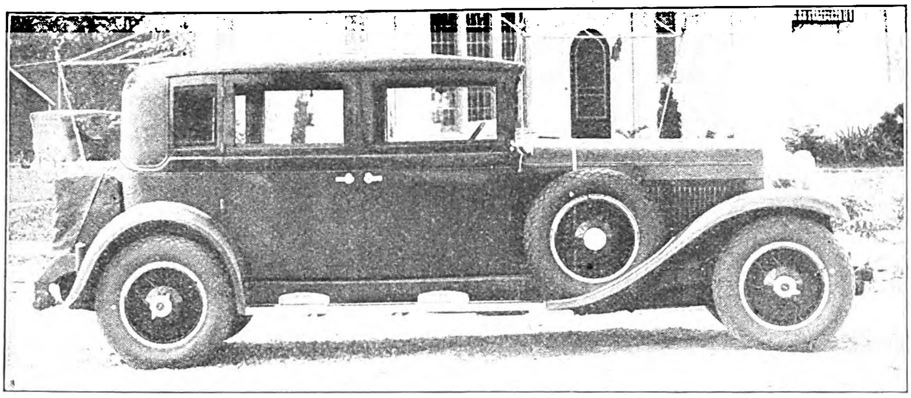
THE Noback, which the writer considers one of the most important contributions to car safety to be developed in recent years, is a brake with an automatic actuating mechanism. Installed between the rear of the transmission main shaft and the parking brake drum, this device prevents dangerous backward rolling of a Stutz or Blackhawk when a stop is made on an incline, so that it is entirely unnecessary to use the brakes for holding the car. To push one of these cars backward it is necessary to throw the gear-shift lever into reverse and then throw it back into neutral. The car may then be pushed or allowed to roll backward; but when a forward motion has taken place, Noback again holds the car as before until the operation is repeated. This company has also adopted, as optional equipment, the first stock supercharger to be used on anything but racing cars and airplanes.

Stutz has just announced a new streamlined aluminum-body speedster, the Torpedo, in which are incorporated many of the features of last year's Blackhawk. Four-speed transmission,



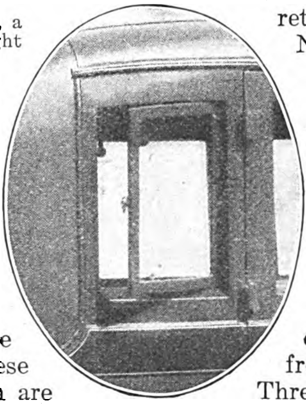
STUTZ, THE LOW-WEIGHTED

This model typifies the low center of gravity characteristic of all Stutz cars. Safety of all models is stressed because of the many safety features, the most recent of which is the Noback



KISSEL DELUXE BROUGHAM SEDAN

In this model may be seen the new "No-draft" ventilating rear side window, a close-up of which, in the open position, is shown in the oval illustration at the right



Noback, the new vacuum-operated hydraulic brakes, and low center of gravity, provide ease of driving and safety for the occupants.

Balance and low center of gravity have become factors of major importance along with increase in engine power and speed. Thus the announcement of Studebaker that the new President eight and Commander eights and sixes are built with double drop frames, reveals a noteworthy development in both safety and balance for the Studebaker line. The low over-all height and low center of gravity made possible by this double drop frame, together with the recently adopted non-shatterable glass for Studebaker windshields, represent the most recent improvements in this line of cars.

THE Kissel Motor Car Company has adopted for all models in series 95 and series 126 a four-speed transmission which the company says is the result of two years of experiment and research work. The result achieved is smoothness of operation and improved road performance, a slowing down of engine and propeller-shaft speeds, and, consequently, decreased vibration. The only other mechanical improvement in series 126 is the adoption of Lovejoy shock absorbers. The bodies of some Kissel models have been enlarged and body lines have been revised. The 1930 De Luxe Brougham has a new style of ventilating rear side window. Exclusively a Kissel feature, this window swings on hinges like a residence casement window. The rear oval window of this model lowers the same as the door window glasses.

Duesenberg, Inc., displayed at the Chicago salon in November nine models built on the regular 265-horsepower Duesenberg chassis. Many new and luxurious features have been incorporated in these new bodies, three of which are by Murphy, two by Willoughby, and one each by LeBaron, Weyman, Derham, and Judkins.

Marmon has re-entered the fine car field with the production of the Marmon Big Eight. Powered with a straight-eight engine of 125 horsepower, this car is equipped with four-speed transmission and especially designed mechanical features such as: a double-dome cylinder head; invariable mechanical four-wheel brakes with cable linkage completely enclosed in lubricant-packed, sealed metal conduits; and mono-control windshield.

ADDITION of this car, built in nine body styles for the higher price class, enables the Marmon Company to blanket the price field since it already produces the Roosevelt in the low price range and the Marmon 66 and 78 in the medium price range. Further information concerning new models will be given out early in 1930.

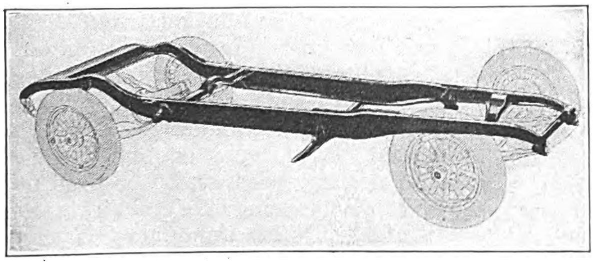
The 1930 Buick will be offered in 14 models in three series known as the "40," "50," and "60" Series. Longer wheel-bases; lower, longer, and more beautiful bodies; and many mechanical improvements and refinements characterize these new Buicks. Additional power is given by the increase of ⅛ inch in the cylinder bore of engines of all models. Other advances achieved are: semi-elliptical rear springs; double-acting shock absorbers; sloping, non-glare windshield; re-designed transmission and clutch; larger rubber motor mountings; thermostatically controlled radiator shutters; and a wider frame. The carburetion system has been improved by a newly designed gasoline pump and the elimination of the low-speed carbureter adjustment.

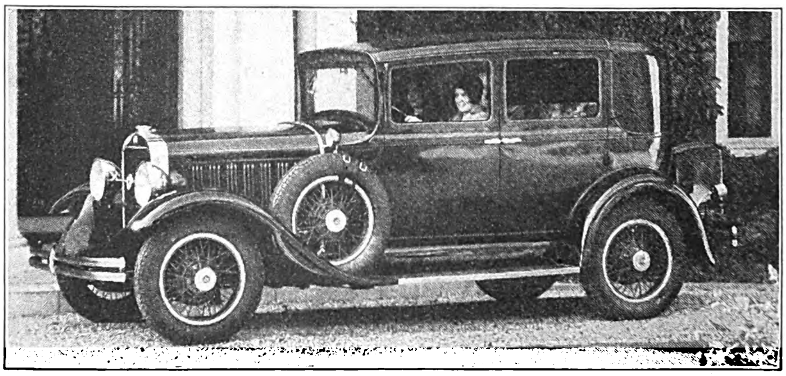
No radical changes have been made in the duPont. The eight models of the new eight which were recently announced are distinctive in design, showing as they do the French body style influence. They have a higher radiator and cowl, with heavily crowned fenders brought to a point in front.

Three new Chryslers, the "77," "70," and "66," were recently added to this well-known line. Noteworthy features in the "77" and the "70" are: multi-range, four-speed gear shift; a down-draft carbureter; larger and more powerful engines; Paraflex spring suspension; and chimney-type, rubber, shock insulators.

IN the "down-draft fuelization" system, the carbureter is mounted above the engine instead of at the side, thus allowing a gravity flow of the explosive mixture.

Another new feature found in these two series is the de-carbonizer, a device employing a new fluid called Carbosalve for dissolving the engine carbon deposits. This device includes a fluid container mounted on the dash under the hood, a connection to the inlet manifold, and a plunger located on the dash. With the engine running, a quantity of the fluid is sent into the cylinders by means of the plunger. After the engine rests several hours and is then started up, the dissolved carbon particles are blown out the exhaust. Chrysler has also adopted a

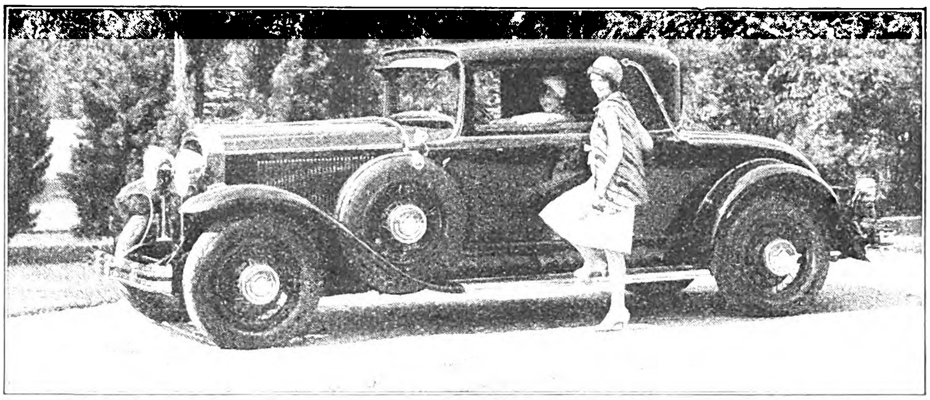




STUDEBAKER CHASSIS AND MODEL

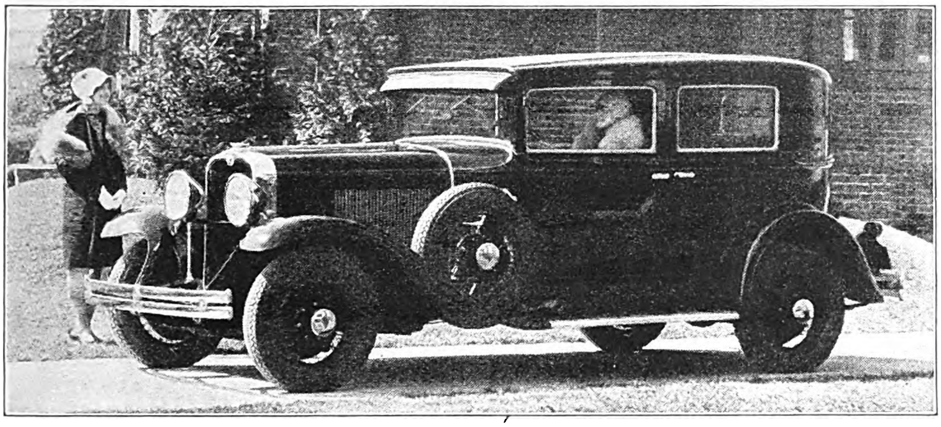
Above is shown the new double-drop frame which gives a low center of gravity and reduces body-line height of the President eight and Commander eights and sixes. At right is the Dictator Eight Brougham rust-proofing process which is claimed to insure a permanent finish and longer life for fenders and other exposed parts. An interesting Chrysler innovation is the rumble seat door which has been added to the Imperial roadster.

Pierce-Arrow, in 1930, will build three groups of cars, all of them straight-eights, although no changes will be made in general appearance or body design. In these cars will be incorporated several improvements over current production which, as a matter of fact, is new, since Pierce-Arrow's first straight-eight car was introduced early in 1929. Among the refinements are some which affect the manifolding; and the latest improvement—a very important one—is the adoption of stainless steel for more than 350 parts including small pieces, nuts, and bolts which would ordinarily be subject to rust or corrosion.



BUICK WILL COME IN 14 MODELS

The 1930 Buicks will have longer wheel-bases and be characterized by many mechanical refinements. Their engines have been given increased power by a larger cylinder bore

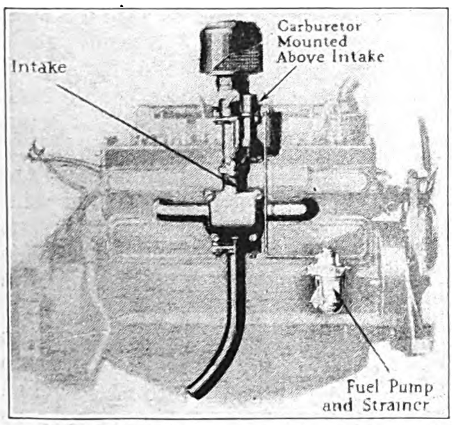


VIKING EIGHT BROUGHAM

This four-door brougham is one of three new models which will be displayed at the annual automobile show in New York in January. Improvements will be announced then

Striking body designs will feature the exhibit of the Oldsmobile six at the New York Automobile Show. The body types on display will include the four-door sedan, two-door sedan, business coupe, sport coupe, convertible roadster, and phaeton, in standard, special, and deluxe models.

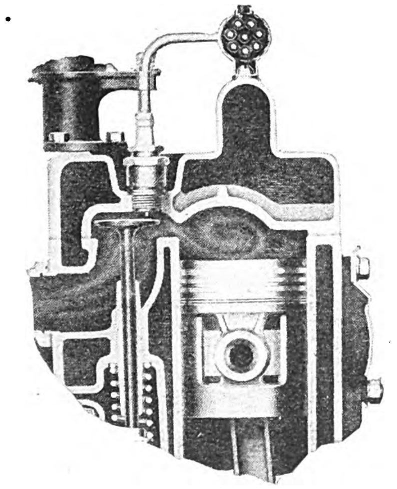
The Viking eight, companion car of the Oldsmobile six will be seen in three distinctive models at this show. Designed by Oldsmobile engineers with the resources of the General Motors research laboratories and proving ground at their command, the Viking has improved engine design.



CHRYSLER FUELIZATION SYSTEM

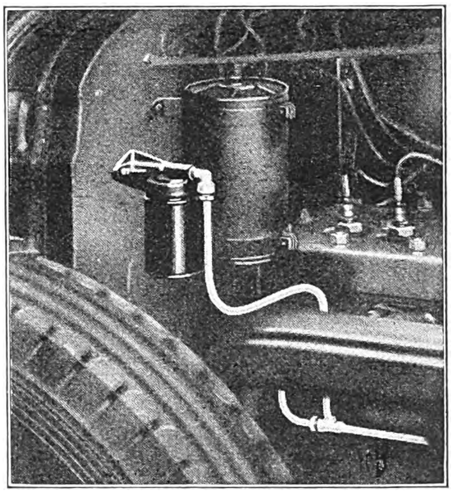
"Down-draft carburetion" is said to give more power, speed, and easier starting

We wish here to extend our thanks to the companies already mentioned for their co-operation with us in the preparation of this article and to express our appreciation to the following who have made an effort to supply us with material but could not release it early enough: Willys-Knight and Whippet, Chevrolet, Auburn, Oakland, the Dodge-DeSoto-Plymouth line, Peerless, and Stearns-Knight. Those who had no information available before the first of the year are: Franklin, Cadillac and LaSalle, Hudson and Essex, Ford and Lincoln, Durant, Moon, Graham-Paige, and Reo.



MARMON CYLINDER HEAD

A sectional view of the new double-dome cylinder head of the new Big Eight

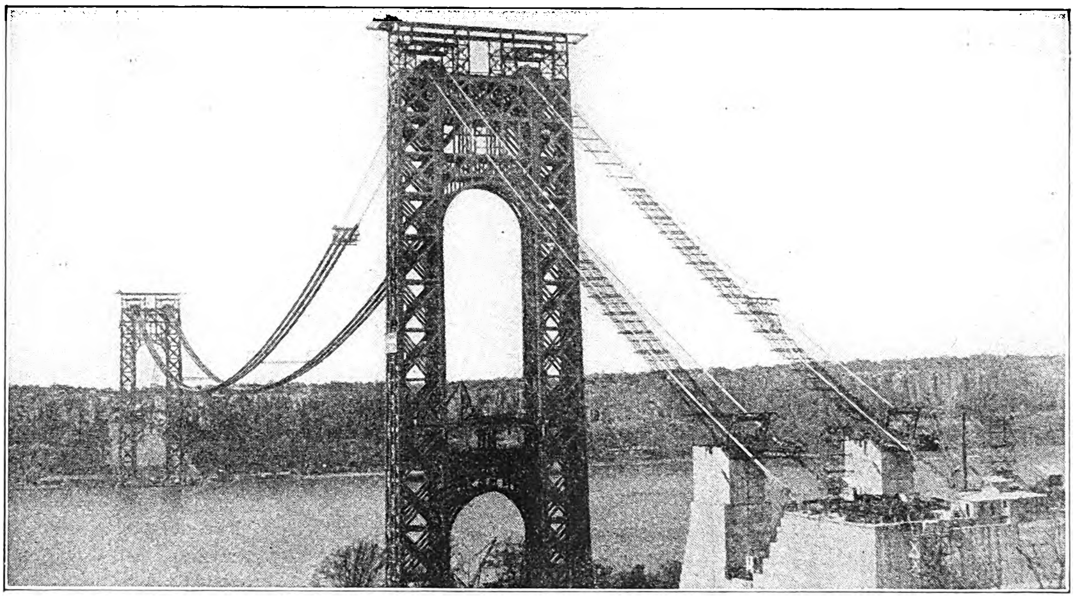


CHRYSLER DE-CARBONIZER

Mounting of the new device designed to keep the engine always free of carbon

A review of the automobile field gives the impression that manufacturers anticipate no great let-up in car buying in 1930 despite the recent disastrous stock market crash. It has been asserted that whatever effect it may have had will shortly be offset by a normal car sale and that the output in 1930 will be greater than ever.

Most of the 1930 cars, at least in the medium and higher price range, it will be noted, are finer, more luxurious, or so greatly improved as to indicate the belief of the manufacturers in the continuation of our general prosperity. In the low price field, the prices of the 20 models of Fords have been lowered by amounts varying from 15 to 200 dollars. To explain this, Edsel Ford is quoted as saying, "It is our belief that, basically, the industry and business of the country is sound. We are reducing prices now because we feel that such a step is the best contribution that can be made to assure a continuation of good business throughout the country."



ALMOST READY FOR SPINNING THE CABLES

When this photograph was taken, the catwalk cables had been raised to position and the catwalk was almost complete. A carrier, loaded with sections of which this walk is built, may be seen on center span

Four Cables: 106,000 Miles of Wire

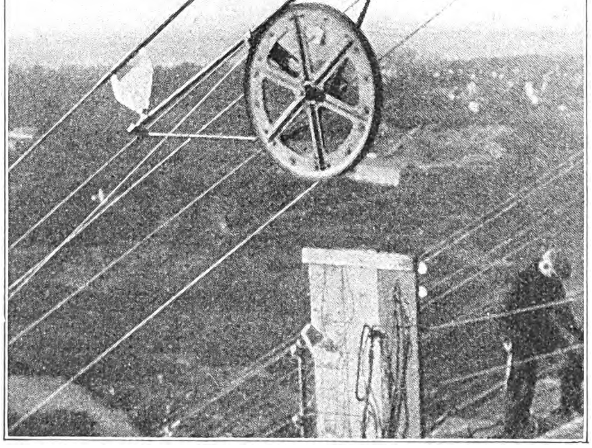
As Spinning of Cables Begins, the Hudson River Bridge From New York City to New Jersey Becomes a Giant "Loom"

By A. E. CRIPPS*

HIGH above the icy waters of the Hudson river workmen are now spinning the steel wire cables from which will be suspended the roadway of the huge bridge which will soon connect the states of New York and New Jersey. Going about their appointed tasks like human spiders, these fearless men, indifferent in the face of danger made doubly dangerous by the ice on the catwalks, guide the spinning wheel as it weaves its way back and forth across the river, seize the individual wires, and clamp them into place at proper intervals. Day after day for a year the wires will be spun from the Palisades to Riverside Drive and back again without cessation until the 105,896 wires are strung into place.

In a previous article (December, 1929, SCIENTIFIC AMERICAN.—*Editor*) the preliminary work attendant upon the erection of the main cables was described. That article ended with the stringing of the catwalk suspender ropes. After these ropes were in position it was necessary to install the suspended structure and floors of the catwalks. This work was carried out by the use of carriers which rode upon the ropes, traveling from the top of either tower and loaded with catwalk sections. The carrier was lowered to the center of the span by means of a motor driven windlass; and, starting from the center, the catwalk sections were placed in position one by one.

The catwalks on the back, or end, spans between the towers and the anchorages, have been made in a series of steps with landings, because of the steep angle of the cables in these positions and the hazard to the men.



THE SPINNING WHEEL

Two of these work continually on each of the four cables, traveling back and forth across the bridge many times carrying wires that will form the cables

There are two catwalks, or footbridges, each of which is to take care of the spinning of the two cables on a side; each is 25 feet wide, made up of a light steel frame, covered with wood planking. Heavy wire netting is placed over the gaps, not only to lessen danger for the men, but to prevent loss of tools into the river below. In the main span, five crosswalks connect the two catwalks so that workmen may pass from one to the other without the necessity of going up to a tower and crossing over.

In spinning the cables, two batteries or sets of reeling machines, each composed of four reels, are placed on each side of the river so that, altogether, there are 16 reels of wire working simultaneously. Special reels have been constructed from steel channels and boiler plate, each to contain 160,000 feet of wire. These are placed on a freight car near the reeling machines and are then pushed into position and lifted onto the machine by means of an electrical lifting device which centers the reel and allows it to revolve.

To facilitate handling of the wires as they are spun, each cable will be made up into 61 so-called strands of parallel wire, each to contain 434 wires, making the total for each cable 26,474 wires.

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* Of John A. Roebling's Sons Company

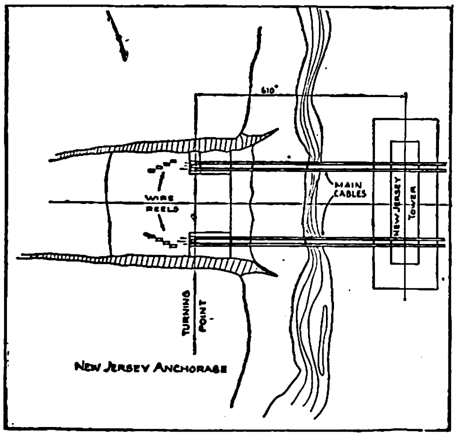
The connecting of the wire strands to the eyebars is made possible by means of steel castings known as strand shoes. These are constructed to hold the 217 loops of wire formed by the 434 wires of each strand. In the strand shoe there is a 10-inch hole through which a pin can be placed so that the whole assembly can be connected to an eyebar.

Four tramway systems have been erected, one for each cable. Each of these consists of an endless rope which passes from one anchorage, over the towers to the other anchorage, around a sheave, and back to the point of origin. These ropes are supported at 200-foot intervals by specially designed sheaves and towers; and in order to overcome any sag of rope between the sheaves, a tension carriage, which exerts a tension on the ropes equivalent to a pull of 12,500 pounds, is incorporated.

As will be explained later, these tramway ropes will move continually across the river like giant traveling belts, the motive power being supplied by an electric motor which allows operation in either direction. Two spinning wheels or sheaves each four feet in diameter are attached diametrically opposite each other on each tramway cable loop; that is, when one wheel is on the New Jersey side of the river the other will be on the New York side.

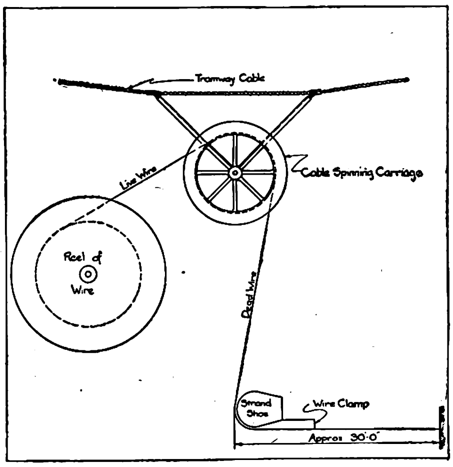
The preliminary details being complete, the actual work of spinning the cables can begin. By referring to the diagrams captioned "The shuttle and loom," the following explanation will make the principle clear.

The spinning of the four cables must all be done at the same time so that the weight of the wire placed on the towers—constantly being added to as the wires are pulled across—will be equal at all times. Bearing in mind that the spinning is conducted from both sides of the river simultaneously and that the speed of the reeling machine is synchronized by hydraulic equipment with the speed of the tramway on which the spinning wheels travel, we are ready to begin operations.

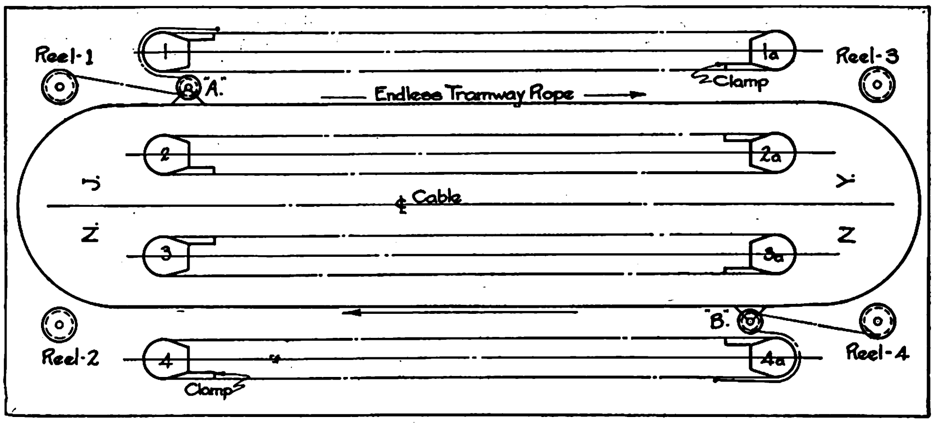


THE WIRE REELS
The New Jersey approach to the bridge, showing location of the reels of wire

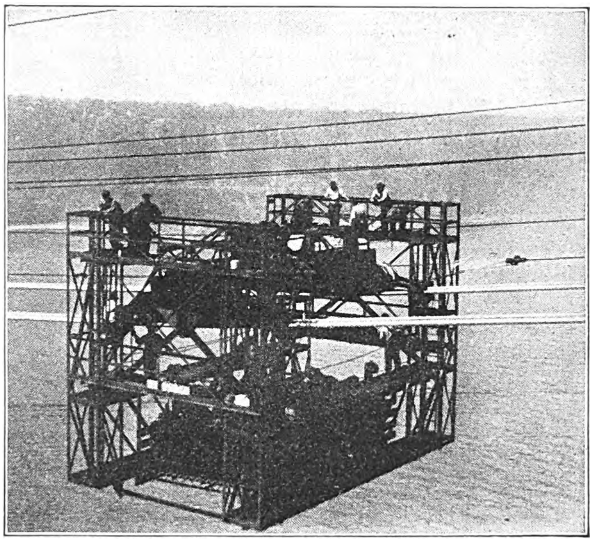
For the first trip, which took place October 21, 1929, the end of the wire was taken from reel Number 1 on the New Jersey side, and joined to Number 1 strand shoe (see diagram). The loop thus formed was placed over the "spinning" wheel, or traveling sheave "A" attached to the endless hauling rope or tramway cable. The same procedure was followed on the New York side, a wire being connected to strand shoe Number 4-a and the loop thus formed placed over sheave "B."



THE SHUTTLE AND LOOM
The diagram at the right shows the manner in which a wire is taken off a reel, passed over the spinning wheel, and fastened to the strand shoe. The diagram below, flattened out for easier reading, is described in detail in the text



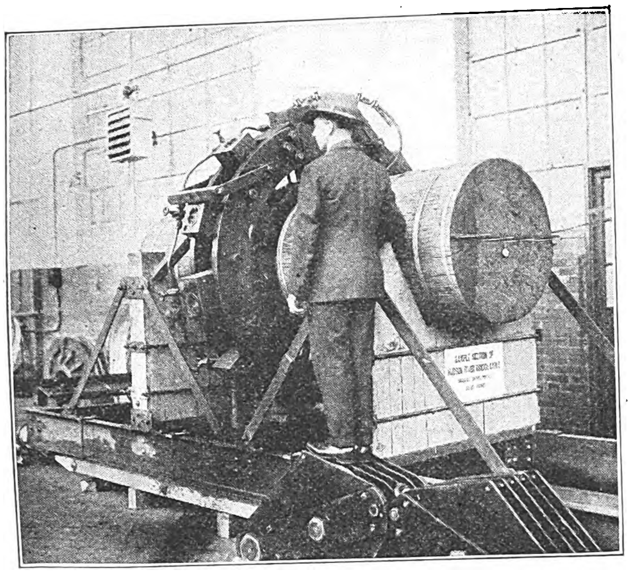
As the endless rope traveled, sheave "A" with its loop was carried to the New York side, while sheave "B" went over to the New Jersey side. When "A" reached its destination, the loop of wire was taken off and placed on shoe 1-a. At the New York anchorage another loop was then formed from reel Number 3, the end being fastened to strand shoe Number 2-a. Shoe "A" then traveled back to its first position, passing on the way sheave "B," which had performed the same operation on the New Jersey side. The loop taken from reel Number 3 was carried across and placed over strand shoe Number 2, while the loop on sheave "B" which was taken from reel Number 2 was then carried to the New York side and placed on strand shoe 3-a. Each trip of the spinning wheels, the two going in opposite directions at one time, takes approximately 10 minutes.



BUILDING THE CATWALK
One of the carriers which were suspended from the catwalk cables and used to construct the walk itself

The stationary wire—that is, the branch of the loop the end of which was attached at the starting point—was successively adjusted behind the spinning wheel so that it hung at a predetermined sag in the first side span and in the main span. After the loop was placed around the strand shoe at the far side, the dead wire was successively adjusted in the last side span, the main span, and the first span. It was then placed around the strand shoe at the point of its beginning, thus forming another loop to be pulled across by the spinning wheel.

This operation will be repeated for each strand until the 217 loops, or



HYDRAULIC JACK PRESS

A sample section of cable the size of the Hudson bridge cables, and the device which will press them to shape

pairs of wires which go to make up the strand, have been placed. On reaching the end of the last loop of the strand, the end of the wire is then connected to the beginning of the first loop. The completed strand thus formed is therefore a continuous length of wire approximately 428 miles long. Instead of returning the wheel empty to its point of origin it is used to pick up a wire loop from a second reel, thus beginning a new strand.

Each spinning wheel travels 209 miles in spinning one strand, or a total of 12,749 miles in spinning each main cable; and, since there are four such cables, there will be an approximate mileage of 50,996 miles traveled by the spinning wheels in fabricating these four cables—a distance comparable to twice around the earth at the equator.

As the strands of each of the four cables are spun, the individual wires are seized and placed in their predetermined positions on the tower saddles. The first strand of each cable is adjusted to the correct deflection and the proper sag is determined by means of precision instruments. The remaining strands are then placed in correct relation to the first as they are spun, and irregularities in length are adjusted by means of shims—thin steel plates—at the strand shoe located at the anchorage.

The above procedure is carried out with each of the strands until the total of 61 which completes one cable is in place. With the full number of strands in place, bunched together, the cross-section of each cable at this stage is hexagonal. It is of interest to learn that the deflection in the center of the span changes about 25 feet during the spinning of these great cables and that the towers compress two inches during the loading.

The next step is the compacting or squeezing of the cables to give them a circular cross-section. This will be done by means of a circular frame in which are mounted in radial formation 12 hydraulic jacks, each of which actuates a concave-faced shoe. This compactor is capable of exerting a pressure of 720 tons although it may be necessary to apply only 300 or 400 tons. The compactor is first applied at the center of the main span encircling the cable, and then half way up each side of the main span. Pressure is then exerted at approximately each 200 feet and finally about every three feet. This method has been decided upon as the best method of preventing "bunching" of the strands at the tower saddles.

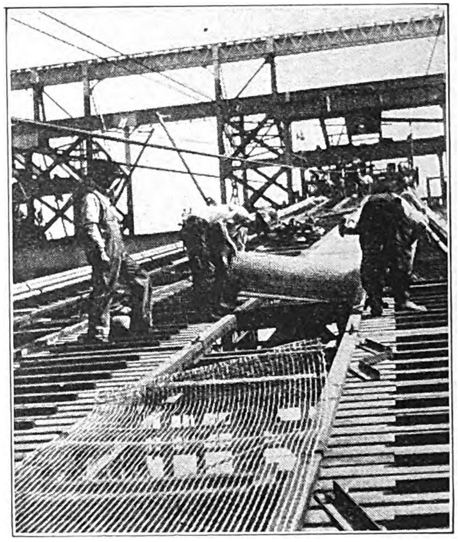
While the compactor is squeezing the cable, a wrapping of wires will be made on each side of the compactor in order to hold the cable into its final cylindrical form. This is called "seizing."

From this point, cable bands of cast steel will be placed at regular intervals along the length of the main cables to carry the suspender ropes. (These suspender ropes will be cut from the ropes which now carry the catwalks.) After the cable bands are in place, the suspender ropes will be fitted to them by means of special bridge connections. These ropes will support the roadway susperstructure.

When part of the dead load of the superstructure has been placed on the cables, they will be wrapped concentrically with a soft galvanized wire as a protection againt rust and corrosion. The cables will then be given several coats of paint as a further protection, and everything will be ready for the final touches to be put to the structure.

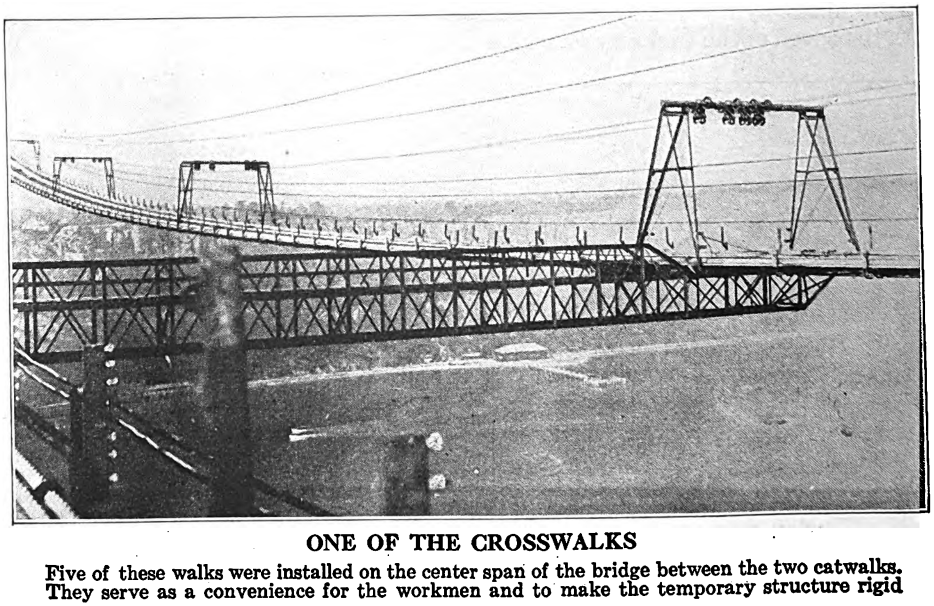
New methods have been invented by the engineers of the John A. Roebling's Sons Company to speed the spinning of these mammoth cables, and although the system employed in spinning is primarily the same as was used by them on such structures as the Brooklyn and Williamsburg Bridges, later improved methods and design will speed up the work considerably.

This speeding up of the work of spinning is strikingly shown by a comparison of the 21 months' time it took to spin the relatively small cables of the Brooklyn Bridge with the short time of one year which will elapse before the cables are ready to receive the superstructure of that new monument to American engineering ability, the Hudson River Bridge.



COMPLETING THE CATWALK

Wire netting was placed between the sections of catwalks. Note uphill slope



ONE OF THE CROSSWALKS

Five of these walks were installed on the center span of the bridge between the two catwalks. They serve as a convenience for the workmen and to make the temporary structure rigid

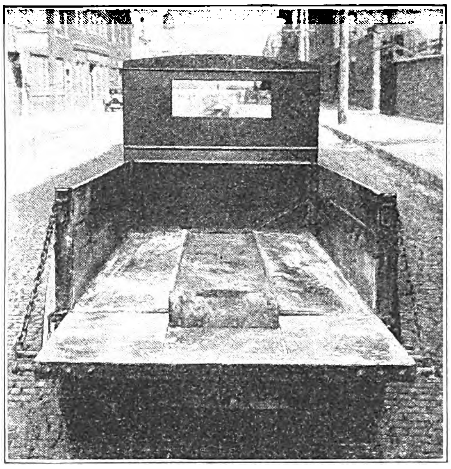
Expediting Truck Deliveries

Conveyor Belt Unit on Truck Delivers Load With Ease and Speed

IN present practice, the load in an ordinary motor truck body is dumped by means of a power hoist of some sort, either hand or hydraulically operated. Under favorable circumstances the load may be dumped through a manhole in the pavement and the material placed directly in its storage space or the load is dumped on the ground and recovered by hand and shovel power. In the latter and more usual instance this means an extra handling of the load with the consequent additional expense.

A new self-unloading motor truck body, recently placed in production, is designed so that the material can be placed directly in the storage space. This body is firmly attached to the chassis and arranged with its bottom slanting from each end toward its center. In the center is a conveyor section which, in turn, is connected with a hinged conveyor attached to the body outlet in such a manner that the flow of the material is mechanically forced. The actuating power is derived from the transmission of the truck.

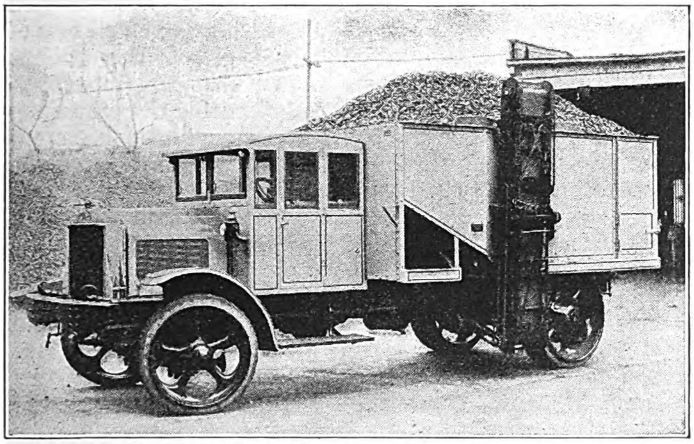
In obtaining this power an additional clutch is necessary and this is governed by a lever in the cab at the right of the emergency brake lever. The clutch is in a housing attached to the main transmission housing. When the lever is moved, the propelling shaft clutch of the vehicle is disengaged and the additional clutch comes into play.



NON-TILTING TRUCK BODY

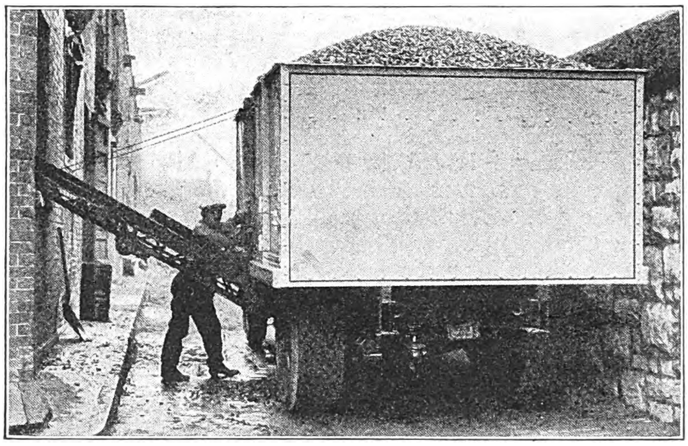
Small truck with floor arranged in rigid position, the conveyor covered

Since the truck body is stationary, the elimination of a hoisting device reduces the dead-weight of the truck by more than a ton without reducing the strength of the body. The bodies are built for any chassis from two and a half tons up to the largest size.



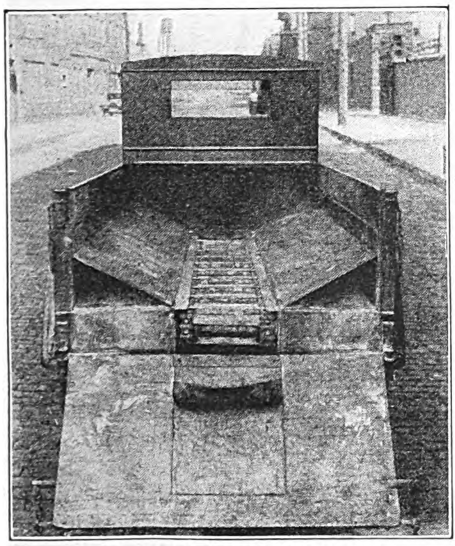
LARGE TRUCK AND ITS CONVEYOR

A 10-ton truck loaded with coal showing how conveyor is carried and the chain-drive method of obtaining power from the transmission



EMPTYING A LOAD "UPHILL"

Unloading 10 tons of coal into a bin, the opening to which is six feet above the ground. The driver regulates the speed of flow



THE DISCHARGE TROUGH

Conveyor for small trucks. It runs length-wise of floor; the sides are sloped

WITH this new device, trucks can be unloaded at a speed of one ton a minute and, under favorable conditions, this speed can be bettered. By using the outlet opposite to the conveyor-equipped outlet and reversing the conveyor section located in the bottom of the body the material can be run off the truck through an ordinary chute into a basement or into a receptacle below the street level, at a rate of two tons a minute. The chauffeur or driver can regulate the flow of material, running it fast or slow as required, as the speed of the apparatus is under his control.

Another advantage is flexibility in delivery. The truck may be placed close beside and parallel to the curb, thus allowing other vehicles to pass on the driveway. In delivering coal there is also the advantage that the coal entrance may be placed at almost any height in the wall, for the conveyor can be raised almost perpendicularly and still place the fuel in the bin with but little slowing up of speed.

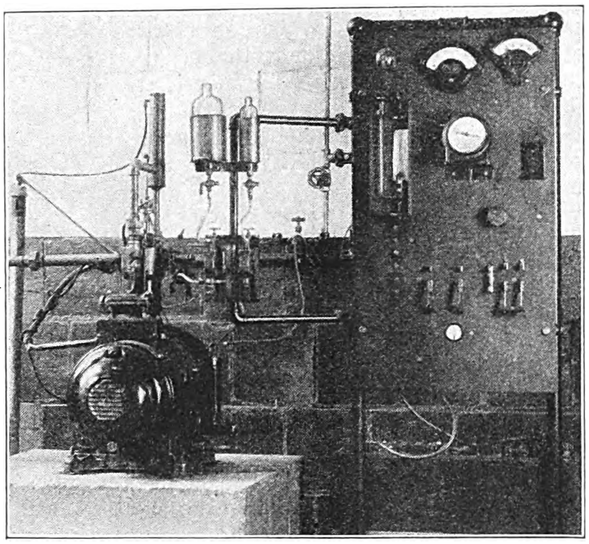
For a chassis under two and a half tons in capacity there has been arranged a modification of the idea just described. This arrangement is called the "all-purpose body" and the conveyor at the bottom of the body is placed to run lengthwise of it. The bottom of the body is raised at the sides, forming a trough through which the conveyor operates and when the body is needed for carrying lumber, ice, or other like material, the sides of the trough can be lowered in less than a minute, making an ordinary truck body available. Material that can be handled by conveyor apparatus can be unloaded from these small bodies at the rate of three tons a minute. The actuating power is also derived from the transmission and can be controlled just as effectively as in the larger bodies described above.

Defeating the Gasoline Knock

Gasoline to Which Tetraethyl Lead Is to Be Added, Must Be Carefully Tested to Insure a Definite Quality

By **GRAHAM EDGAR**

DURING the last few months thousands of visitors to the General Motors Pier at Atlantic City have paused in front of a shining little gasoline engine mounted under a glass case and connected with various indicating instruments. They have watched levers move automatically and mysteriously, changing the engine's fuel from a red to a colorless one. They have heard the engine begin to "knock," and have seen the indicators register a drop in speed and power as the engine labors. Then again the levers move, the fuel is changed to the red liquid, the knock dies down and disappears, up comes the speed and power, and the engine purrs silently and smoothly. The red fuel contains tetraethyl lead, and the engine and its equipment constitute an automatic demonstration of the effectiveness of this now well known substance in eliminating the knock in an internal combustion engine.



COMMERCIAL KNOCK TESTER

With this small engine and equipment, gasolines are tested. These outfits are now being made and sold

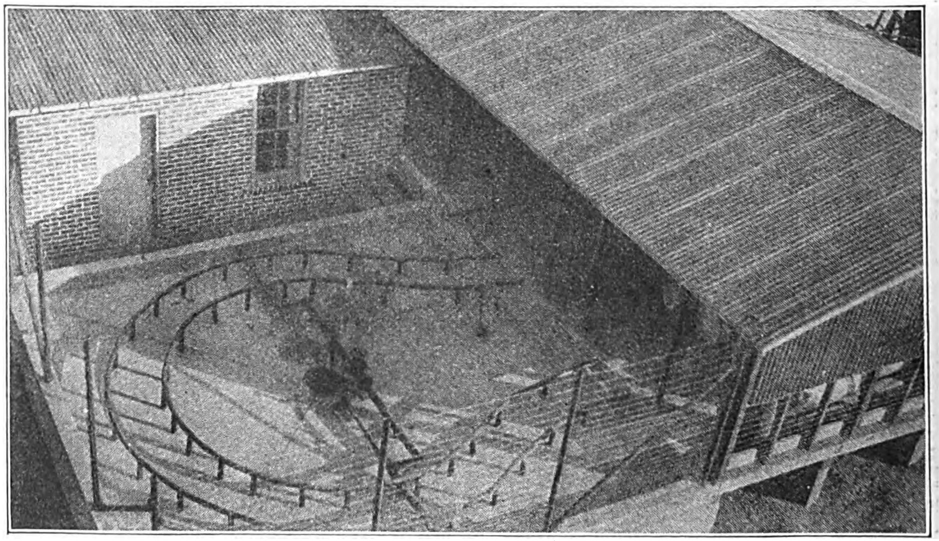
IT is doubtful if many of the visitors who witness the demonstration are at all familiar with the story of tetraethyl lead, or realize how, in a few years' time, this substance has come to play an important rôle in the oil and automotive industry.

The early investigations of the cause of the knock in automobile engines; the discovery that certain chemicals, added to the fuel in small amounts, were capable of eliminating this knock; and the many experiments which led to the discovery, by Thomas Midgley, Jr., of the most effective "anti-knock" known today—tetraethyl lead—would make an interesting story but one much too long for this article. But the developments of the few years which have elapsed since gasoline containing tetraethyl lead was first used commercially are worth a short story of their own.

On February 1, 1923, the Refiners Oil Company placed on sale at a single station in Dayton, Ohio, a new gasoline to which the name of "Ethyl gasoline" had been given. Automobilists who tried the new product, perhaps largely out of curiosity, little knew that the eyes of many engineers were focused upon this particular station, or guessed that the new gasoline was destined to influence profoundly both the oil refiner and the automotive engineer.

The little station at Dayton prospered, the new product seemed a success. One by one new stations were added, and other oil companies arranged with the General Motors Research Corporation to add tetraethyl lead to their own gasoline. In 1924, the Ethyl Gasoline Corporation was formed, not to sell Ethyl gasoline, but to take charge of the manufacture and distribution of "Ethyl fluid," the blend of tetraethyl lead and other ingredients which, when added to gasoline, converts it into Ethyl gasoline. Since that time one oil refiner after another has added Ethyl to his list of products, and today more than 60 refiners, selling altogether 65 percent of the gasoline used in the United States and Canada, are marketers of the different brands of Ethyl gasoline which the motorist finds throughout the entire country.

BUT the rapid increase in the use of this anti-knock gasoline is only a part of the motorist's debt to the investigators who discovered tetraethyl lead. The discovery of this substance focused the attention of the automotive engineer and the oil refiner upon the knock and its removal, and opened the way for increasing the efficiency of the automobile engine. For it has long been known that the most important factor in limiting the efficiency of the automobile engine is its compression ratio, that is, the ratio of the total volume of the cylinder and cylinder head when the piston is at the bottom of its stroke, to the volume when the piston is at the top of its stroke. The higher this ratio, the more power may be developed when a given amount of fuel is burned. But the knocking tendency of internal combustion engines limits the extent to which the compression ratio can be raised when using ordinary gasoline, for the knock brings with it a drop in power. Tetraethyl lead added to



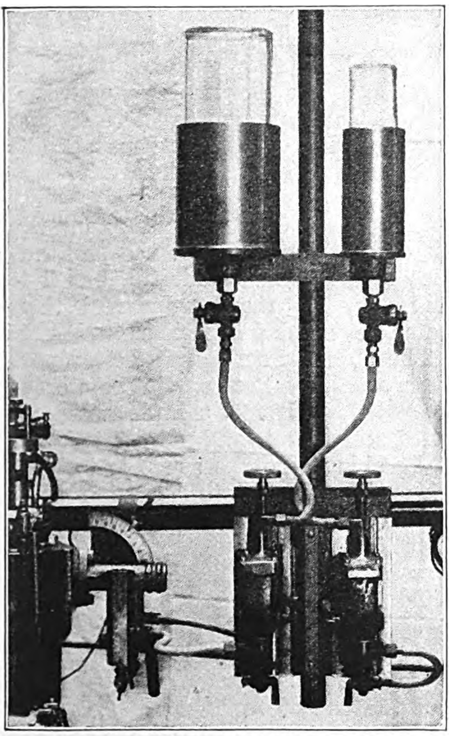
ETHYL FLUID-GASOLINE MIXING PLANT

Drums of the fluid are rolled out on the circular track. Gasoline, pumped from a tank through transverse pipes, creates suction which draws fluid from pipe which leads from drum gasoline limits knocking and permits a higher compression ratio to be employed than could be used without it, thus resulting in increasing the power which a given amount of fuel and a given size engine could produce. And although all such developments must be gradual, it is interesting to note that the average compression ratio of American automobile engines (and hence the efficiency) has increased markedly in the last few years.

Furthermore, the oil refiner has had his attention directed to the anti-knock quality of his gasoline, and by carefully studying the different crude oils which he may have available and selecting the best of them; by developing and employing refining processes which improve the anti-knock value of gasoline; by utilizing tetraethyl lead; or by combining such methods; he has made available for the motorist and the automotive engineer fuels far higher in anti-knock value than any which were available a few years ago.

THIS result, however, has not been achieved without intensive work on the technical aspects of the problem. In the case of Ethyl gasoline, which is produced by blending Ethyl fluid with a wide variety of gasolines, it has been necessary to establish certain definite standards both for the quality—volatility, sulfur, gum, et cetera—of the base gasoline, and for the anti-knock value of the finished product, and to devise a mechanism by which these standards can be maintained by all of the different oil refiners who sell some brand of Ethyl gasoline.

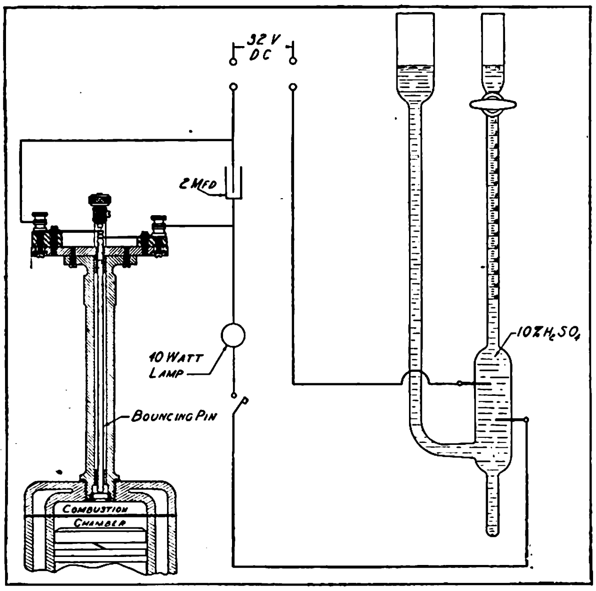
To set these standards is easy; to maintain them is more difficult. The system which has been evolved has necessitated the establishment of a number of laboratories and the close co-operation of these laboratories with the various oil refiners. First there must be a laboratory at Deepwater, New Jersey, where tetraethyl lead is manufactured and blended into Ethyl fluid, and where it is determined that the concentrated product which goes to the oil refiner is uniform in quality.



FLOAT-BOWL CARBURETER

Detail of double carbureter which enables shift from one gasoline to another quickly

Then there must be laboratories at strategic points to which the refiner may send samples of the particular gasoline which is to be blended with Ethyl fluid. These samples must be tested accurately to determine just how much tetraethyl lead must be added to them to make them equal in anti-knock value to the set standard. Only when these tests have been made, and the correct amount of anti-knock has been given to the gasoline, is the product ready to be sold as Ethyl gasoline. Finally, a corps of inspectors is continually on the road buying samples of the different brands of Ethyl gasoline and sending them to the nearest laboratory for checking, in order to detect any failure to maintain the standard.



"BOUNCING PIN" DETONATION TEST

Explosion in cylinder bulges diaphragm on which rests a pin; pin is thrown upward, closing an electrical circuit; electricity passes through solution; and gas liberated in burette over period of time measures knock

IN this way the automobilist is protected from the danger of purchasing gasoline below a definite standard of anti-knock value, and the automobile engineer who desires to raise the compression ratio of his engine and thus increase its efficiency knows that at least so far as one commercial fuel is concerned, he can count on its meeting certain anti-knock specifications.

It may be of interest to explain how it is that the laboratory determined how much tetraethyl lead must be added to a given gasoline to give it a definite anti-knock value. The determination is not simple, and the working out of the technique has involved years of study. It has been necessary to develop and build engines specially equipped for the purpose. The engines employed by the Ethyl Gasoline Corporation laboratories (at Yonkers, Detroit, Omaha, and New Orleans) are single-cylinder affairs of very high compression. They are equipped with double carbureters to enable the operator to shift from one fuel to another; and with instruments for recording the intensity of the knock. Naturally, the conditions of the test — speed, temperature, et cetera—must be held very constant. The operator adjusts the engine to a moderate knock on a standard reference fuel, and records the intensity of this knock. He then shifts rapidly to the fuel under investigation and records again the intensity of knock. He then adds tetraethyl lead to the unknown fuel until he finds the knock exactly equal to that of the reference fuel. The double carbureter permits him to shift back and forth from reference standard to unknown until there is no doubt about the result.

But the work of the laboratories is not finished with the production and distribution of a satisfactory product. High compression, like almost any other engineering feature, presents quite definite problems. The most effective type of cylinder head, the location and design of spark plugs, materials for the construction of exhaust valves—these and many other problems have needed study. To promote co-operation between the oil refiner and the automotive engineer, the corporation has established an engineering research laboratory at Detroit which has aided the research organizations of many manufacturers in the solution of their problems. There are other problems also of a more chemical nature. The theoretical aspects of the knock and the action of anti-knocks, the chemical constituents of gasoline and their relation to its anti-knock value, and other allied problems, are being always studied at the research laboratory at Yonkers, New York.

The last few years have seen, therefore, not only a large commercial extension of Ethyl gasoline, but a corresponding technical development, on the one hand helping the automotive engineer and the oil refiner to solve their mutual problems; on the other hand assuring the motorist that his gasoline shall not fall below certain definite standards of quality.

A Memory Trick

At the Cost of An Hour's Intensive Study You May Learn a Mnemonic System Which Will Mystify and Entertain Your Friends. But Memory "Cures" Are Unscientific

By DAVID SPENCE HILL, Ph.D., LL.D.

Member American Psychological Association; late President Southern Society for Philosophy and Psychology; Fellow of the American Association for the Advancement of Science

UNUSUAL happenings like hypnosis, dreams, delirum, appeal invariably to the keen curiosity of human beings. When a charlatan or a "professor of memory" performs in public a seemingly impossible task, interest is quickly aroused. Thousands of persons, after witnessing such a feat, have paid considerable sums of money in order to learn how "to improve their memory."

The fact is, while persons of high intelligence may have excellent memory powers, nevertheless the ability to memorize certain things is not a general mark of intelligence. Cases are on record where imbeciles have been able to do amazing stunts of memory.

Attempts to invent devices to help defective memories have been frequent since ancient times. In comparatively modern times the Englishman, Pick, aroused excitement in England with his mnemonic systems. Some seventy-five years ago a man named Loisette, afterwards called an imposter, gained momentary respect and fame in Washington, D. C., because of his claim of inventing a valuable mnemonic system.

Everyone uses every day some kind of device to help to remember; for example, numbers on houses, monuments, trademarks. The success of advertising depends not only upon arousing attention but also upon creating lasting impressions. Most high school and college work depends upon successful memorization.

It is not surprising, therefore, that artificial, or formal, mnemonic devices continue to be sold to the unwary. By means of some of them seemingly, amazing things can be done by almost any person of fair intelligence who is willing to devote two or three hours to mastering such a system as the one explained herewith. This was devised by the writer and was built upon the following two psychological principles:

First, whatever we learn must be related to something we know already. This principle is technically called the "doctrine of apperception." Second, thoughts once vividly brought together in consciousness tend to persist. This is the principle of "association."

I. The first nine words of the system shown within the box begin with letters of the alphabet in numerical order. For example, A is No. 1 of alphabet (*Air*); B is No. 2, (*Bar*); C is No. 3 (*Car*) and so on. In the first nine mnemonics the final *R* has no particular significance.

1.	Air	11.	Ambrosia	21.	Boa	31.	Cocoa	41.	Dahlia
2.	Bar	12.	Arab	22.	Bib	32.	Cub	42.	Daub
3.	Car	13.	Arc	23.	Boric	33.	Comic	43.	Diabetic
4.	Deer	14.	Almond	24.	Bed	34.	Card	44.	Diamond
5.	Ear	15.	Ape	25.	Bee	35.	Cane	45.	Dice
6.	Fur	16.	Aloof	26.	Beef	36.	Calf	46.	Dwarf
7.	Gar	17.	Aching	27.	Bug	37.	Cog	47.	Dog
8.	Hair	18.	Arch	28.	Bunch	38.	Cash	48.	Dish
9.	Indicator	19.	Alkali	29.	Biloxi	39.	Cacti	49.	Delphi
10.	Acorn	20.	Bun	30.	Can	40.	Dun	50.	Emulsion

II. Final N always represents zero, including and after the tenth mnemonic. For example, 10th mnemonic is Acor*n*, 20th mnemonic is Bu*n*, 30th mnemonic is Ca*n*, 40th is Du*n*, 50th mnemonic is Emulsio*n*.

III. Including and after the tenth mnemonic, for the numerals, either the *initial* or *final* A always stands for 1, B for 2, C for 3, D for 4, E for 5, F for 6, G for 7, H for 8, I for 9, and N for zero. For example the 11th mnemonic is *Ambrosia*; the 20th is *Bun*; the 25th is *Bee*, and so on.

THE above facts make it easy to fix permanently in mind the whole list of mnemonics, each in its proper number or order. After accomplishing this, then picture with as vivid imagination as possible, what each mnemonic stands for. *Air*, picture, for example, a tank of compressed air; *Bar*, a big iron bar; *Car*, a railroad box-car; *Ear*, your own right ear, and so on through the list, making up your own list of associations. Make each mental picture definite and vivid. About one hour of undisturbed, concentrated study should be sufficient for you to fix in mind this list of mnemonics.

For a first experiment, or test, ask a friend to write and to number, say 25 or 30 names of simple objects, such as floor, tree, dog, clock, flower, house; that is, common nouns, only. Such words are easy to memorize after you have heard them read once, very slowly, with the number of each word spoken as it is read, and after you have pictured each word with a mnemonic in consecutive order.

When the first word has been read (say, "*floor*") immediately imagine strongly, some picture connecting *A*ir (mnemonic No. 1) with floor. Perhaps you will visualize "an air tank in the middle of the floor." After definitely forming this mental picture, say "all right" as the signal for the second word to be spoken. Suppose the second word is "*dog*." Thereupon imagine vividly a dog being struck by an iron bar (Bar is mnemonic No. 2). Say "all right" again, and then call for the third word. Whatever it means to you is to be similarly associated with the third mnemonic (Car). This process is to be continued throughout the list.

Afterwards when recalling a word, first ask for its number. Suppose one says "Give number 2." This makes you think of *Bar* (see the table or "system") and *Bar* makes you think of *dog*. Thus you may repeat after one hearing a list of simple names of objects, in any order backward or forward.

To one who does not understand the use of this formal device the performance seems to be wonderful, but it is in reality no more wonderful than facts of every-day experience.

The ability thus acquired to repeat after one slow hearing, in any order requested, a list of simple words is quite startling to the uninitiated, and to be able to do the stunt is to have the means for a surprising amount of fun at a social gathering, or at dinner clubs. The performance, well done, invariably awakens interest.

To illustrate an important psychological principle and for amusement, this mnemonic device is valuable, but it can not increase native capacity, and the use of any formal mnemonic system is cumbersome and awkward in practical life. It is no cure-all for defective memory.

With the Historians of Science

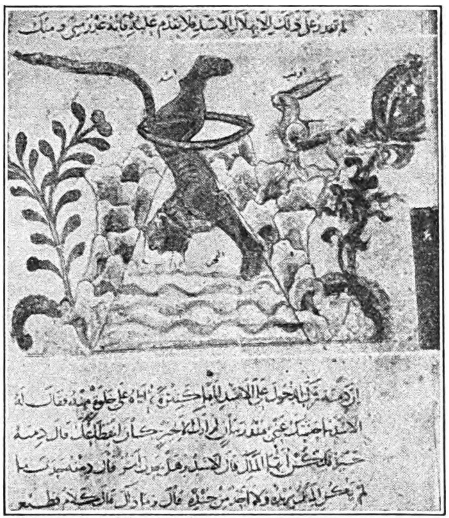
Himera's Doric Temple Being Excavated

HIMERA on the north coast of Sicily is being excavated. The present excavations are being undertaken near the Doric Temple which was dedicated to Minerva. The government is helping by ordering the expropriation of the houses which cover the site. A number of broken columns have been unearthed as well as a great deal of the base, the facings for the walls, the architrave, frieze, and cornice.

Unearthing the History of the Crossroads of East and West

FRENCH archeologists in Syria have made important discoveries at what might be termed the crossroads of East and West on the Mediterranean coast near the old town of Latakieh. In a poor Alawit village a palace of 1300 B.C. was discovered. This is at approximately the period of the Exodus. A vast necropolis with princely tombs was also discovered. These tombs have been plundered, but enough remains to give indications of the religious rites of the builders. A library of tablets was also found which may indicate (when deciphered) the world's first alphabet. It will probably be some time before the experts can identify the letters with sufficient clarity to make up a language.

At Katna in the middle Syrian desert, other discoveries have been made. Three towns are built, on one another. In the second town the explorers found a temple to the Goddess Nin-Egal, "Lady Ef Katna," and an inscription identifying the town at Katna, one of the celebrated cities of antiquity. Count du Mesnil found two chapels where sacrifices were made to the bloody Goddess. In large basins of clay were traces of a brownish substance which was sent to Paris where police experts declared it to be bulls' blood at least 4000 years old. Vases and jars have been discovered containing skeletons of children.


Courtesy of the Oriental Institute

BRER RABBIT TRAPS THE LION
Exploits of the rabbit in an Arabic manuscript of the Thirteenth Century, showing the ending Uncle Remus describes

An Antecedent of Soap

THE ancients did not use soap, but removed dirt by "erasing." Fortunately we have examples of the scrapers as used by the Greeks and Romans, and now we have examples of the "bathing plaques" of Mesopotamia, 13 of which are in The Metropolitan Museum of Art. We should be inclined to call them "hide scrapers" and their application must have been anything but gentle, for the undecorated, or we should call it the "business" side, was roughened by adding small stone chips before firing. The plaques were probably executed by artist-sculptors rather than potters.

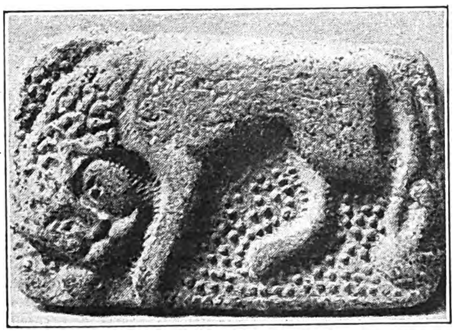
The conquest of Persia, Mesopotamia, Syria, and Asia Minor by the Seljykian Turks, nomads who came from Central Asia in the 11th Century, begins a new era of artistic development of the Mohammedan countries. These bath "stones" are assigned to a period between the 11th and 13th Centuries of the Christian Era.

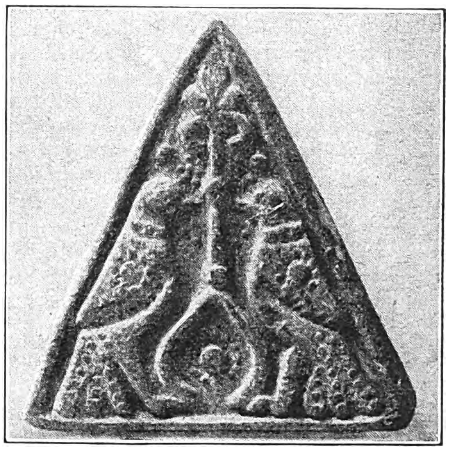
Ancient "Uncle Remus" Stories

THE Oriental Institute of Chicago is engaged in the investigation of an ancient work which, next to the Bible, has become the most widely distributed and translated book in the entire history of literature. This book is of particular interest to Americans, with whom the animal stories of Uncle Remus have become a household treasury. It is quite evident that this body of negro folk-lore contains fundamental elements which have migrated to America from the slave markets of Africa, having crossed the Dark Continent from the eastern to the western coast. Nothing has been easier than for tales of Arabia and even India to reach the east coast of Africa, and in this way they have eventually migrated to the plantations of our own South. Brer Rabbit thus emerges with an ancient oriental ancestry which probably few of our people have suspected.

These animal stories have also reached us by a northern route through England. In 1888 it was calculated that these animal tales had been translated "into 38 languages, in 112 different versions, which have passed into about 180 editions." These various versions are sometimes disguised under the title, the "Fables of Bidpai," or the "Fables of Pilpai." It is of no little interest that the illustrations which we already find embellishing the Egyptian animal tales, should also have been regarded as an essential part of the East Indian cycle. They are quite commonly found in the Arabic versions surviving at the present day, and here we may see Brer Rabbit over the discomfited Lion who is disclosed head downward at the bottom of the well in precisely the same uncomfortable situation into which Uncle Remus tells us Brer Rabbit betrayed him.

MOHAMMEDAN BATHING PLAQUE
An animal group on the decorated side. The reverse was roughened by adding stone chips before the plaque was fired


A LION BATHING PLAQUE
This is supposed to illustrate a lion and dates from the Eleventh to the Thirteenth Centuries of the Christian Era

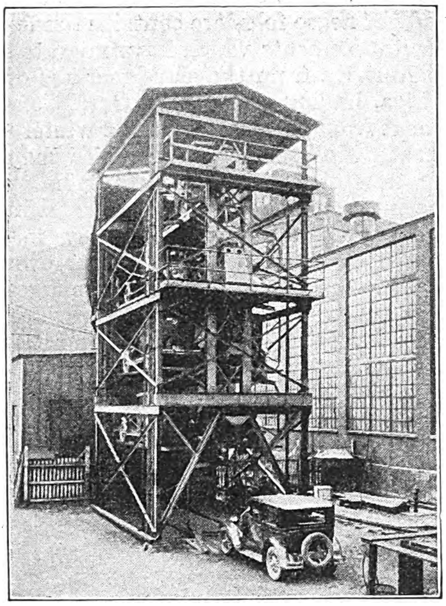

THE AFFRONTED BIRDS
A highly artistic piece from Mesopotamia, modern in treatment. This was found in a public bath where it was originally used

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

A "Ferris Wheel" Car Parking Machine

WE have become so accustomed to automatic devices that we expect the pushing of a button to give us any desired result. In our own homes we press a button to turn on the lights or to start a fan. If there is an elevator in the building, we call the car to the landing by operating a button. The immense presses printing our newspapers and magazines are controlled by push buttons, as are many other machines in daily use. It will, therefore, seem reasonable to have a parking place for our automobile where we can call the car to the driveway level by pushing a button.

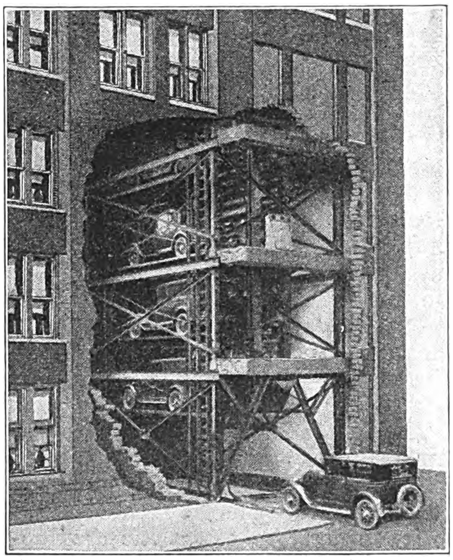


The experimental car parking machine developed by Westinghouse

This has recently been accomplished by the design of an automatic parking machine, resembling an elongated Ferris wheel, which can be installed in hotels, apartment houses, theaters, department stores, and office buildings as well as in garages. The cars are placed on platform cages suspended between endless chains which pass over wheels at the top and bottom of the building. The chains are operated by an electric motor provided with a push-button controller which will stop the machine when the designated cage is opposite the driveway. When a car is driven on a cage, automatic means are provided for moving another empty cage to the driveway so that the machine is always ready to receive another car. The cars remain on the machine until called for.

The part of the building in which the machine is located has no floors and may be merely an enclosure surrounding the machine or it may be a portion of a building used for other purposes. The machine may be removed at any time and floors placed in the building for other uses. The operation of the machine is quiet so that the ordinary separation walls that would be provided in the building will prevent the sound from being carried through the building. After the machine has been started, its motion is continuous until the specified car has reached the driveway.

A very ingenious arrangement is used to transfer the cars from one side to the other at the top and bottom of the building. This consists in carrying the car on an arm that extends from the side of the chain. During the vertical motion the cage and chain travel at the same speed but at each end of travel, the car moves in a circle having a radius of about double that of the chain. This causes the car to travel at twice the speed of the chain and moves it out of the way of the next car. The arrangement enables ordinary passenger cars to be placed eight feet apart in the vertical position. A building 100 feet high will provide for a 24-car machine which occupies a ground area of approximately 16 feet by 24 feet; this is about the same space that is occupied by an ordinary two-car garage. There is no particular limit to the vertical height of the machine as this will usually be determined by the building limitations and also by the time required to bring the car from the top of the building to the driveway level. The machines which have been constructed have had a chain speed of 100 feet per minute which would bring the car from the top to the bottom of a 100-foot building in one minute. Higher speeds can be used where the conditions make it desirable to do so.



Manner in which the car parking machine is built into a building

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Giant Hog Was Big as Auto

THE fossil skeleton of a giant hog which stood seven feet tall has just been mounted in Morrell Hall at the University of Nebraska. The terrible pig in his prehistoric day was as high as the tallest modern automobile and had a "wheel base" of about 140 inches.

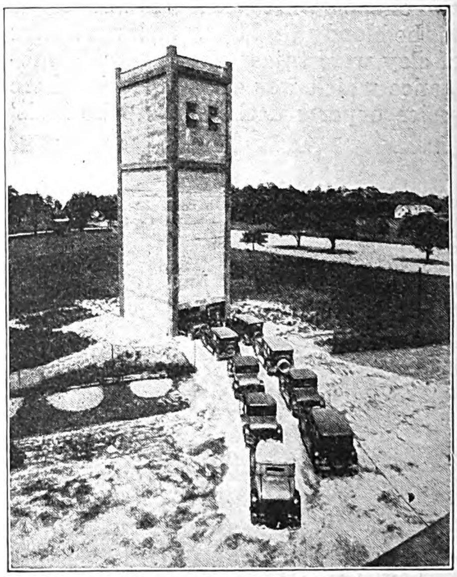
The fossil was dug up in Sioux County, Nebraska. Only two of the giants have ever been discovered, the other being smaller than the university's specimen. The pig, scientifically termed *Dinohyus hollandi*, lived during the late Oligocene or the early Miocene age, which would give him an antiquity of some 12,000,000 years.—*Science Service.*

Cape-to-Cairo Highway Improved

IN the article "Pioneering for a Cape-to-Cairo Highway" which was published in our August issue, the author, Mr. Gerry Bouwer, made the statement that, "northward from Bulawayo there was nothing but dense African forest with only native paths for a road . . ." Mr. E. J. Hutton-Brown, Superintendent of the Southern Rhodesia Publicity Bureau, apprehensive lest this statement deter tourists who contemplate a visit to Southern Rhodesia by road, calls attention to the fact that the highway has been considerably improved since Mr. Bouwer's trips. To prevent any misconception as to the present state of the highway in question, we publish below a part of Mr. Hutton-Brown's letter:

"For the past 12 months the road from the Transvaal border, that is, from the ford through the Limpopo River to the Victoria Falls via Bulawayo, has been clearly defined and maintained in good order by the Southern Rhodesia Roads Department. The road has been widened out from the original track, and made up wherever bad places occurred. Signposts have been erected at all important deviations, and, when it is stated that approximately 10,000 automobiles used this road for pleasure purposes during the past season, it will be realized that the pristine conditions of which Mr. Bouwer wrote, no longer exist.

"A tour by road to the Victoria Falls during the correct season, that is, from May 1 to September 30, has become deservedly popular with every visitor to



Car parking tower, an independent invention which is operated on practically the same principle as the one described and illustrated above. It was invented by Mr. J. E. Morton of Sandusky, Ohio

South Africa from overseas, and visitors do not consider their arrangements are complete unless they include this wonderful trip through some of the most magnificent of Southern Rhodesia's forest scenery. Furthermore, since Mr. Bouwer passed through, the Victoria Falls Hotel, situated on the edge of nature's most mighty masterpiece, has been renovated and enlarged, and now provides accommodation and attention for travelers which is amazing, considering its far-flung position.

"At the beginning of the month of August an ornate high level road and railway bridge, over 1500 feet in length, spanning the Limpopo River, was opened for . . . tourists traffic, so that there is no longer any necessity for automobiles to be towed across the river as is depicted in the photograph accompanying Mr. Bouwer's article."

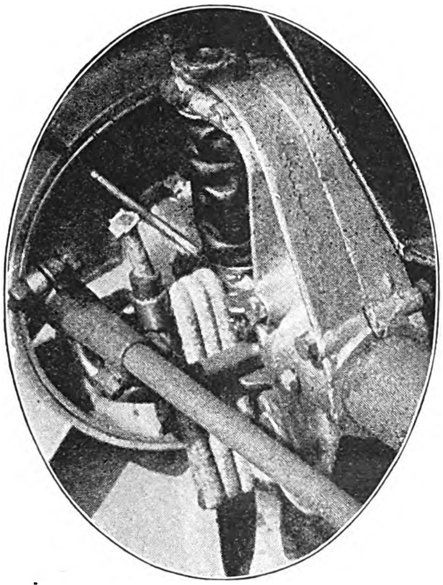
"Baby" Car for United States Market

IT has been announced that within the next year a small automobile seating two people comfortably, weighing 600 pounds, and equipped with a four-cylinder air-cooled engine, and with all moving parts, except the engine, greased for the life of the car, will appear on the market in the United States. The car has been designed in its entirety by James V. Martin of Garden City, Long Island, who is well known in the aviation field; in fact the car itself is an outgrowth of Mr. Martin's experimental work in aviation.

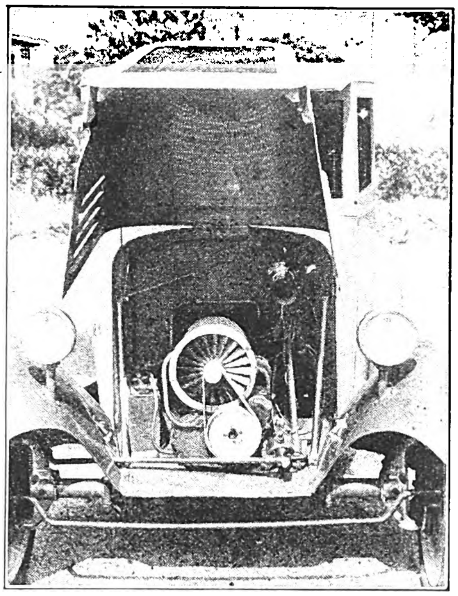
The photographs give some idea of the construction of this tiny car which has no chassis, the body frame serving as the support for the suspension for the front and rear ends. There are no springs, the wheels being separately suspended by means of rubber shock-absorber cords such as are employed in many types of airplanes. This suspension allows each wheel to work independently of the other three and reduces the "unsprung" weight to a minimum. It is claimed that these shock-absorber cords will function perfectly for 25,000 miles of operation and that they can be replaced by anyone quickly and at a very low cost.

In the rear end there is a universal joint on each side of the differential and another in each wheel. Because of this construction, power can be transmitted directly to the wheels without any axle housing. The wheels are suspended with the shock-absorber cord and work independently of any other part of the car; in fact the differential is fastened rigidly to the underpart of the body.

This little car has a wheel-base of only 60 inches and uses small rubber tires, yet in a demonstration given to the writer of this item, the car held the road perfectly at 60 miles per hour and was as comfortable as a much larger and heavier car. During the demonstration, the automobile was driven over a rough plowed field with an absolute absence of the racking rebound which would be found under the same conditions with a car suspended by ordinary springs.



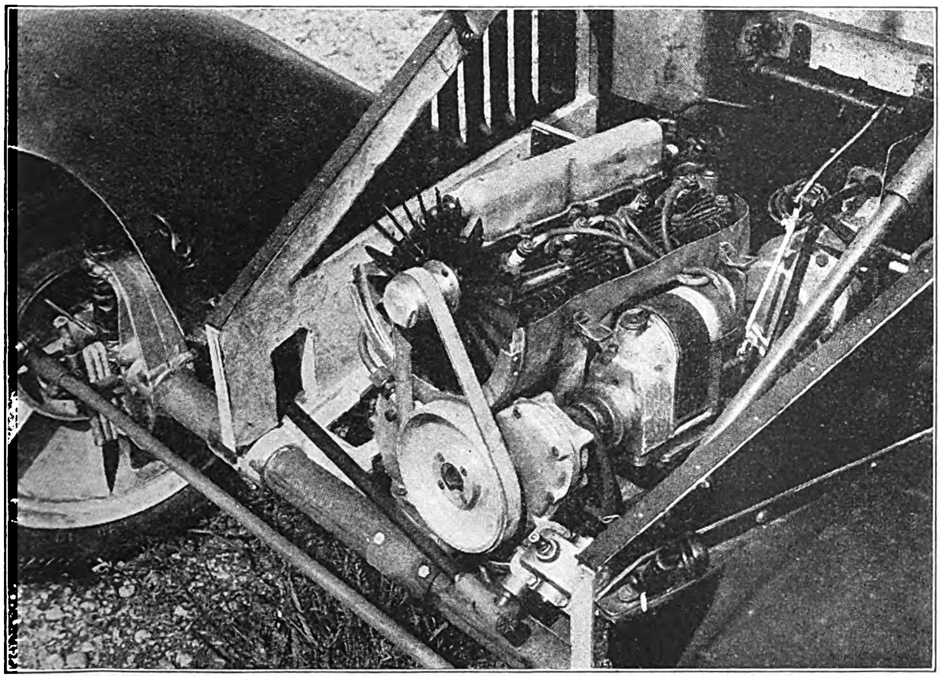
Detail of the airplane shock-absorber cord mounting of a wheel of the "baby" car. The wheel spindle rides on a vertical shaft enclosed in a leather dust protector. The entire weight of the car rests on the rubber cord, being suspended from the wheel spindle



Front view of small car with cowl in place on the air-cooled motor

It is intended to sell this small car at about 200 dollars including a large waterproof packing case which may be used as a garage for housing the car. At the present time, however, plans for production have not matured and it is impossible to state when these small cars will be available to the general public.

The present plans and specifications call for an electric starter or a mechanical starter operated by foot pressure, a gasoline tank mounted under the cowl, a standard 3-speed and reverse selective gear shift, a 4-cylinder air-cooled motor equipped with a large fan, disk wheels of new ribbed construction, and a two-passenger body in which there is more than ample leg room for both driver and passenger.



A view of one of the experimental models of the "baby" car, with the hood raised, showing the motor with the air-current-directing cowl removed to show the fan and the cylinder heads. At the extreme left of the photograph may be seen one of the separately suspended wheels shown in detail above

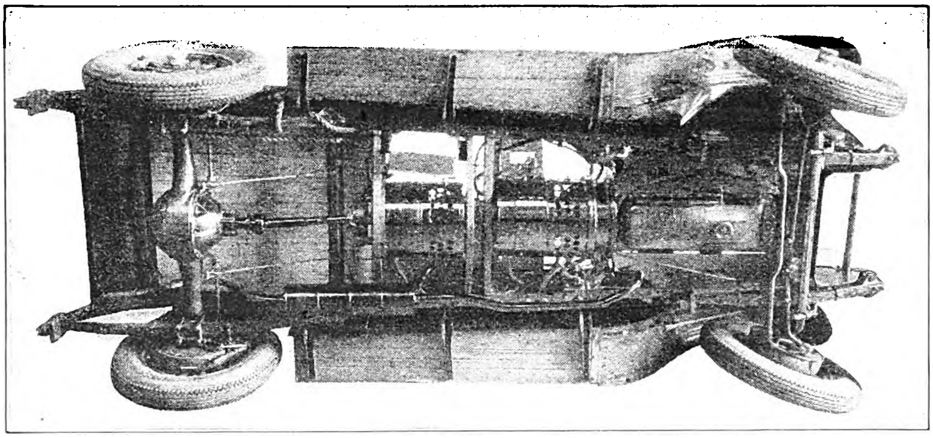
Japanese Navy Correction

IN Dr. Oscar Parkes' illuminating discussion of the newly built ships of the Japanese navy appearing in our November, 1929, issue, a typographical error occured in giving the dimensions of the cruiser *Nachi*. She was quoted as having a draft of 86½ feet whereas this should have been 16½ feet. Please make this correction in your file copy of the issue.

A High-Speed Gasoline-Electric Automobile

A NEW type pleasure automobile with no clutch or gears to shift, and capable of quick pick up and fast speed on the hills—a combination 60 horsepower gasoline and electric car—has been delivered to Colonel E. H. R. Green, son of the late Hetty Green, world's richest woman, at his South Dartmouth, Massachusetts, estate. It is the first automobile of its kind ever built, and is the result of combined experimental work by engineers of the General Electric Company and the Rauch and Lang Corporation of Massachusetts.

In external appearances it looks just like any gasoline driven car, except for a windshield double the average height. This was made especially for Colonel Green so that when the top is raised he may get in and out of the car without stooping over. The real difference is in the mechanism under the floor boards and in the controls. There



View underneath a Willys-Knight chassis equipped with electric drive. The generator is directly behind the engine and the motor behind the generator

are but two foot pedals, one for the brake and one for the gas. The clutch pedal and the gear-shift rod, or lever, to the right of the driver in ordinary cars, are eliminated. The emergency brake to the left of the driver and the starting button to the far right are the same as in other cars.

In addition to the absence of the clutch and gear shift, other features of the new car are that it is impossible to stall the engine without actually shutting off the ignition and it is impossible to start with a jerk. Even though the accelerator pedal is jammed down to the floor board, the pick-up will be gradual and smooth because of the automatic electric equipment. There is also an outstanding safety feature, for the driver can keep both hands on the wheel and his eyes on the road at all times after the car has once started to move. When the car is brought to a stop, the idling of the gas engine is not sufficient to cause the generator to generate enough electricity to turn the motor. All that is required to get the car under way again is to remove the foot from the brake pedal and step on the gas. The more gas, the faster the speed.

This particular car for Colonel Green is geared to make 40 miles an hour. However, by changing the gear ratio on the rear axle, it can be made to operate at speeds comparable with gas driven cars, according to engineers of the General Electric Company.

The electric generator is mounted directly on the fly wheel housing of the gas engine, the generator armature revolving at exactly the same speed as the engine. A few inches back on the generator, or approximately under the front seat, is the electric motor, connected by cable to the generator and coupled by a short drive shaft to the rear axle. As the generator is speeded up, more electricity is fed to the motor, and as the motor picks up, so does the speed of the car. To reverse the car, a small lever is moved, reversing the operation of the motor.

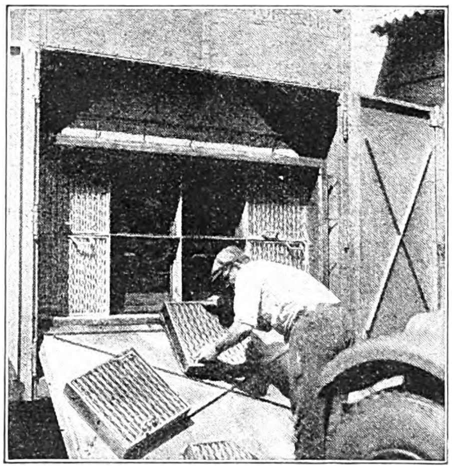
As the motor operates at high speed, the gear ratio on the rear axle was made a worm drive of from $8\frac{1}{4}$ to 1, instead of the standard $4\frac{7}{16}$ to 1 gear reduction for cars of this type.

On its arrival at Round Hill, his South Dartmouth estate, Colonel Green insisted on taking the steering wheel himself and for the first time in his life, drove a gasoline operated automobile. Although he now has 25 cars of various types and makes, he has never been able to manipulate the clutch pedal and gear shift and heretofore has used a small electric storage-battery car in his daily drives about his estate.

Colonel Green has ordered a second car of this type with a limousine body and is planning a third, of the touring car type in which the driver will occupy an elevated seat in the rear, for use at his Miami, Florida, winter estate.

Truck Removes Cellar Ashes Pneumatically

THE cellar ash-can is facing extermination. Ashes can now be removed expeditiously and economically, with a minimum of labor and with no diffusion of dust, by an electric-pneumatic suction system through a pipe-line from sidewalk to ash-pit.



Ventilating fan and sectional air filter screens of the pneumatic ash conveyor system for trucks

The equipment comprises an ash-handling truck containing a large hopper into which the ashes are drawn by suction, and from which they are conveyed by a totally enclosed belt-conveyor to a carrier-truck which takes them away.

The ash-handling truck is equipped with the gas-electric drive now in wide use for heavier vehicles and already introduced for automobiles of the ordinary type. Power for operating the suction system and the conveyor-belt is obtained by connecting the electric generator to the proper motor and running the engine at suitable speed while the truck is parked.

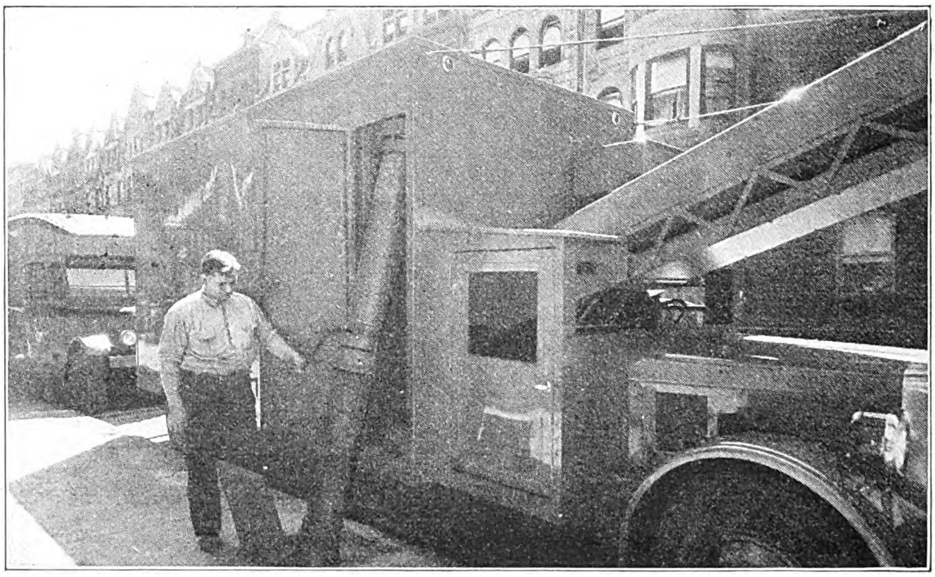
The first of these new ash-handling trucks has been put in service in New York City by the Pneumatic Conveyors Corporation. It was designed and built by the American Car and Foundry Motors Company, and was electrically equipped by the General Electric Company.

Suction is provided by a centrifugal compressor, rated at 6000 cubic feet per minute at a speed of 3500 revolutions per minute and driven by a 40-horsepower motor. The truck is equipped with piping capacity permitting a suction of 2800 cubic feet per minute, equivalent to a velocity of 145 feet per second in the intake pipe. This means that ashes equivalent to the contents of a dozen standard ash-cans can be drawn up every minute to a distance of 30 feet.

Later there will be undertaken the design of a smaller unit, provided with a flexible pipe-line, which can be used for removing ashes from the cellars of residences. The present unit, intended for large buildings, is equipped with a permanent rigid pipe-line extending from sidewalk to ash-pit.

The conveyor truck connects to this pipe-line at the sidewalk opening by means of a pipe section attached to the truck and connecting to the hopper. This pipe section is lowered into place and tightly connected at the sidewalk with the permanent pipe-line so that no dust escapes to the outside air at any point.

In addition to the removal of ashes from cellars, the pneumatic conveyor truck can function with efficiency and economy in unloading coal barges. In that field of application it is expected the truck will prove as useful in proportion as in the elimination of ash-can handling and dust-

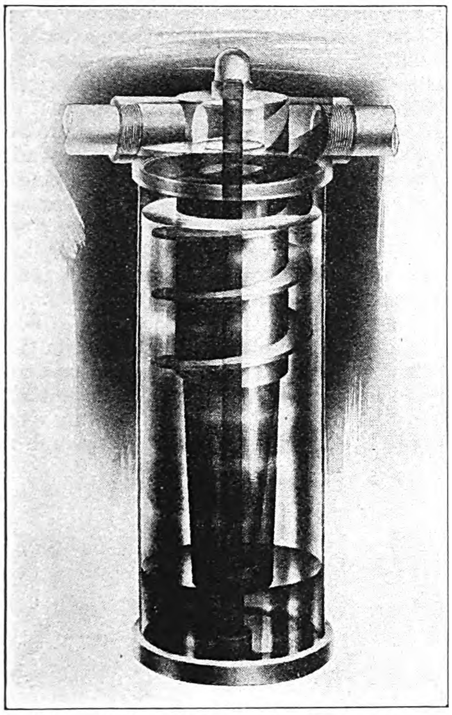


Ashes being carried from a basement to an ash truck by suction. Over the driver's seat is the conveyor which transfers ashes into a dumping truck filled air which are now aggravating accompaniments of the removal of ashes from cellars in cities and towns.

Centrifugal Separator of Water and Gasoline

WHEN you buzz along the road in your car and water gets into the carburetor—you coast along and stop. But when water gets into the gas of an airplane, the plane is apt to stop quickly—meaning a forced landing or, as sometimes happens, a serious crack-up.

To assure water-free gas, every Bowser aviation fueling pit is equipped with a centrifugal water separator like that illustrated. Gasoline flowing into it is forcefully swirled and the water, being heavier than the gasoline, is thrown to the outside and trapped in the water chamber, which can be emptied periodically. The action is similar to that used in cream separators for separating cream from milk. As a further protection, the storage tanks of Bowser systems may be equipped with a float-suction which removes the topmost liquid first, and all are equipped with several fine-mesh strainers for removing sediment and dirt from the gasoline.


The device that separates water from gasoline by a swirling action

Unbreakable Truck Tail-light

INVESTIGATION has shown that truck fleet owners as a rule do not know how much the tail-light problem costs them a year because it is not generally accounted for under one heading. But if those who do not know will add up the costs of tail lamps, material, time lost on lamp replacements, time lost on summonses, liability damage suits due to no tail-light, for a single year, they will find the total is much greater than it should be.

Many of these vehicles resort to the old barn lantern for a tail light. The barn lantern detracts from the appearance of any modern vehicle, is a makeshift, is a considerable fire risk, and as most users know is easily broken.

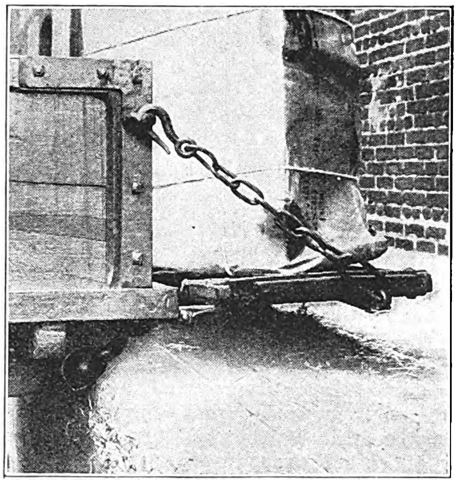
A new unbreakable tail-light called the Bull lamp, and manufactured by the Champion Rubber Lamp Company of New York City, is made especially for trucks, commercial vehicles, trailers and tractors. These vehicles find it impossible to keep the ordinary pleasure-car tail lamp in commission, due to collision, impact, and vibration.

The Bull lamp is made entirely of rubber, the lens of a special unbreakable compound, and the electric bulb is suspended and protected so that vibration does not affect it. The lamp and fittings are rugged and when properly attached to a vehicle cannot be sheared off. It is easily and quickly attached to any vehicle.

Hydraulic Shock Absorber Installed at an Angle

THE ups and downs of automobiling are not the only jouncing discomforts that a motorist experiences. Starting jerks—braking—sudden stops—sideway lurching—these also exist.

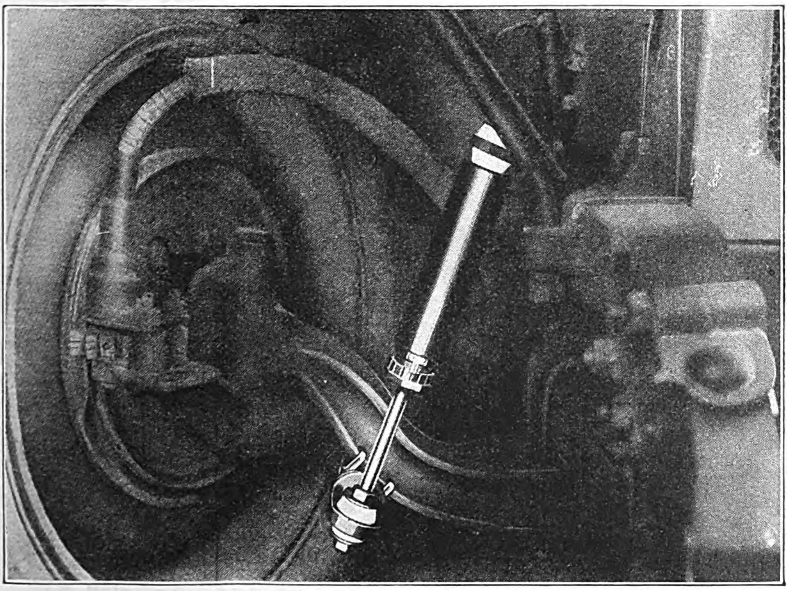
For six years past, a radically simplified type of shock-control device has been going through its test paces. Conceived by a staff of engineers who recognized the magnitude of the problem, this new-type shock absorber was subjected to many tests—laboratory tests far exaggerating the conditions of the road—and tests on the road that attempted to break down the laboratory result. It has been placed on the market under the name of Hydraulicator.

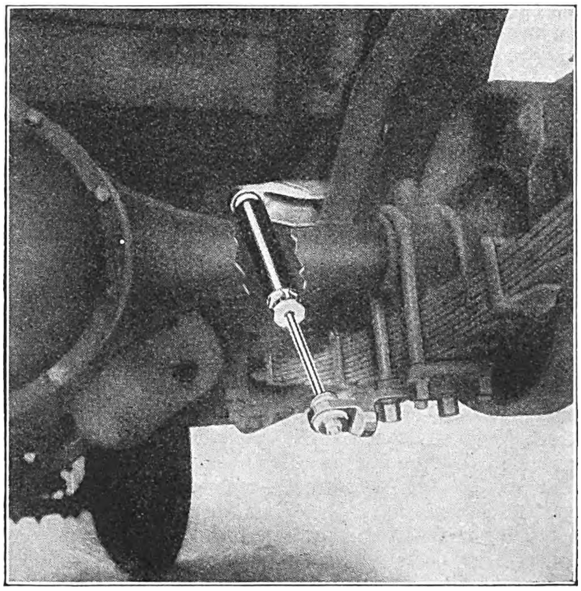

The truck rear-end bumps into a platform but tail light is unharmed

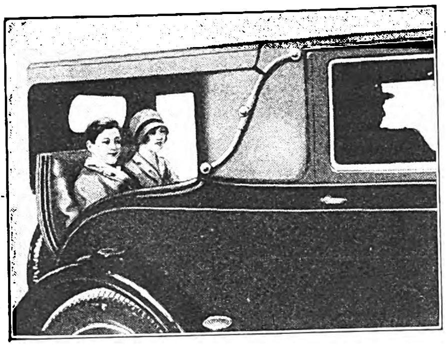
In distinct variance to all former methods of installation, the Hydraulicator is not installed in true vertical position. The rear axle units are inclined forward; the front axle units inward—a revolutionary method of installation that provides efficient, all-angle shock control.

Angular installation eliminates "shimmy." In tests on a well-known car that "shimmied" excessively at only 25 miles per hour, the angular installation of Hydraulicators eliminated the condition entirely, even at excessive speeds for a car of this light type and short wheel-base. Hydraulicators are claimed to prevent "bottoming" of the springs. The new shock absorber cushions the shock in a full half-pint of fluid, every drop of which is in constant, active use.

The Hydraulicator is a simple unit of cylinder and piston. The piston is provided with ports or by-passes to permit the passage of the piston through the fluid. When the unit is mounted between the chassis frame and axle of a car, the resistance created by the passage of the fluid through


The hydraulic shock absorber is mounted at an angle to both the vertical and horizontal, on the front axle beam of a car


On the rear end of a car, the shock absorber takes angles different from those on front



The new rumble seat cover

the ports is proportioned to control the spring action to any desired degree.

Although the unit is a two-way device, the resistance offered is not the same on the up, or compression stroke of the spring, as on the down, or recoil stroke. On the compression stroke a comparatively small amount of check is provided, just enough to prevent the spring from compressing too quickly and "bottoming" on the frame. On the other hand, in order to get riding comfort, the rebound stroke is retarded to the point where the shock is absorbed.

Instead of the customary valves, springs, tubes, et cetera, the piston assembly of the unit is composed of three parts: a piston, a flat steel check washer, and a flanged sleeve. The piston moves or "floats" on the sleeve. On the compression stroke, the pressure of the fluid forces the piston down against the flange of the sleeve, shutting off a predetermined portion of the piston ports. On the rebound, the piston is forced up against the check washer, shutting off a greater portion of the ports, and creating a correspondingly greater amount of check.

A Cover for the Rumble Seat

THERE has long been a demand for a practical top for automobile rumble seats. One recently placed on the market fits any roadster or sports coupé. It can be put up or removed in a few minutes without the aid of tools, and anyone can install it. It affords protection from rain, snow, sleet, wind, or cold, and makes the rumble seat comfortable when the rays of the sun are merciless. "Rumbletop," as the new detachable top is called, can be folded into its small container and stored in a corner of the car when not needed. It can be quickly set up as soon as the weather threatens. There are no screws or bolts to drive into the body.

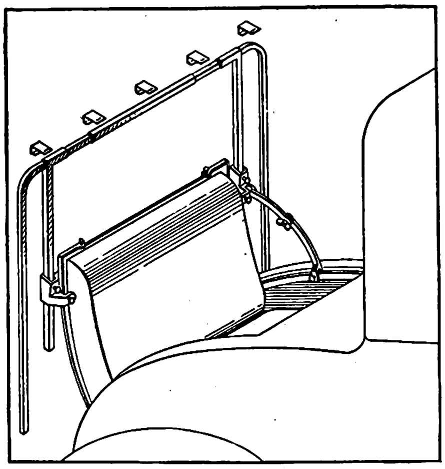
Side curtains are available, if desired, thus affording complete protection against cold weather. The occupants of the rumble seat can get in and out when the top is in place. A pull on the "zipper" underneath the top folds it back, making entrance or exit very convenient.

"Stop-Go" Lights Operated by Car Passing Over Pavement

A MECHANICAL device to direct the movement of traffic in exactly the same manner that a human being would direct it—a device with mechanical senses equivalent to human eyes and a mechanical brain capable of "thinking," "remembering," and of giving orders—has been perfected by the Automatic Signal Corporation of New Haven, Connecticut.

Perhaps the fundamental difference between the corporation's Electro-matic system and the stop-and-go light systems now in use may best be shown by a comparison of the two with the traffic policeman. In every respect the present stop-and-go lights are similar to a traffic policeman sent on duty at an intersection, but blindfolded and with instructions to count 30 seconds on one street and then to turn and count 30 seconds on the other streets, constantly and without regard for the flow of traffic. Even though a dozen cars may be waiting on one street and none on the cross street, the blindfolded policeman will still continue to count 30 seconds before permitting the waiting cars to move.

Installation of the Electro-matic system is the equivalent to the removal of the blindfold. The policeman never keeps a line of cars waiting when there is no cross traffic. He signals them to move ahead just as soon as the intersection is clear. He cares for the safety of every vehicle, but also avoids all unnecessary delay.



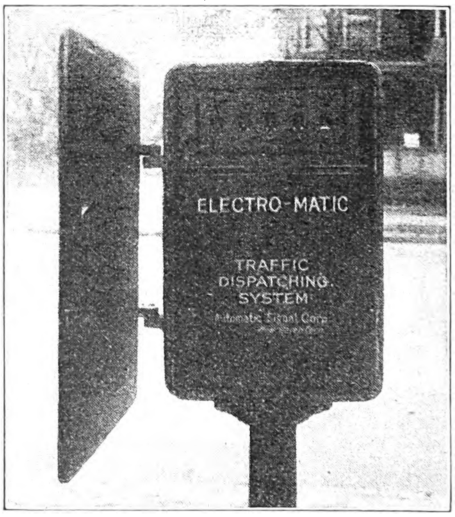
Framework and clips which hold the rumble seat cover in place

With the Electro-matic system, long lines of vehicles receive a continuous right of way. They are never stopped as they are under present automatic systems unless cross traffic actually appears. When opposing traffic does approach, the Electro-matic system waits for a break in the line before turning the signal to the cross street. If no break occurs, it waits for a maximum period of time and then stops the line while the cross street vehicles pass. In any case, however, the long line is never kept waiting unnecessarily. At the instant the cross traffic has cleared, whether it consists of one or a dozen cars, the device "remembers" the waiting line and turns to signal it ahead again.

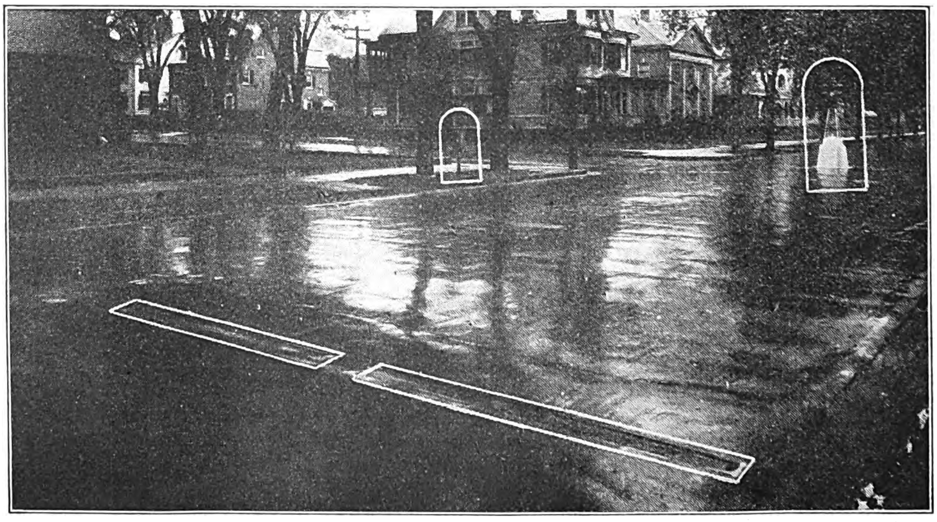
The system consists of three main parts, the most important of which is the control, or "brain" of the system. This is housed in a heavy metal box and is located on one corner of the intersection. Like the human brain, the mechanical brain must have eyes, the second important part of the system. The "eyes" of the Electro-matic system are electrical pressure contacts. These are sunk into the pavement on all streets approaching the intersection, their distance from the corner depending upon the characteristics of the traffic flow at the particular crossing. The third important part is the signal itself, which may be any type of light or signal now in use.

When vehicles pass over the pavement pressure contacts, electrical impulses are flashed over underground cables to the control box. The control then operates the light to meet the exact demands of traffic at the particular moment. The control, however, is capable of more than "seeing" everything that approaches on all sides of it. It is capable of "thinking" and "remembering." Overhead units of a similar type are provided for street cars, and neither snow, rain or ice interfere with their operation.

All of the controls at intersections in the central district of a city may be linked together into a co-ordinated system so that traffic throughout the central area may be moved as expeditiously as it is through a



The street corner control box of the new automatic traffic control



Automobiles passing over the pavement installation outlined in foreground "notify" the control, in center background, which operates lights at right single intersection. When the controls are co-ordinated in this manner, it is possible for traffic on the main arteries to move continuously and uninterrupted by red lights the entire length of the street, regardless of speed. Once past the first light, moving in either direction, vehicles would be able to move without stopping during the entire length of the co-ordinated system. Their speed would not matter. The Electro-matic system is the only one which may be co-ordinated so that traffic will not be forced to move at a fixed rate of speed in order to avoid stops.

Under co-ordination, the controls keep in constant "communication" with each other. The controls at the key intersection at both ends of the main artery telegraph ahead to the next controls the exact number of cars in each block of cars. When the first car in the block reaches the next pavement unit, the light immediately turns green and remains green until the last car has passed. It then turns behind the last car to accommodate cross traffic. This continues until each block of vehicles has passed undelayed.

The controls are exceedingly flexible and are adaptable to any kind of an intersection and to any kind of traffic. They will care for highway traffic as efficiently as city traffic and can be used with equal efficiency at intersections of several streets.

Hydraulic Jacks Installed on Car

DURING the evolution of the automobile from the "one-lunger" of 1900 to the present time, there have been radical improvements in every part of the car with the exception of the method of jacking up the wheels. While automobile jacks have gone through a minor process of refinement, it was not until recently that there was a way to jack up a car without the use of a portable jack.

The development of the Superior four-wheel hydraulic jack provides the first practical method of building into a car a permanent mechanism for raising the wheels. It consists of a set of four hydraulically operated jacks, one for each wheel, to be attached to the axles of the car. The operation of the jacks is controlled from the dash board of the car and each wheel may be raised independently of the others, power for the pumping operation being taken from the engine. The pumping mechanism controls both the raising and the lowering of the jacks. When the jacks are not in operation, they are automatically fastened out of the way and cannot be lowered unless pressure is applied.

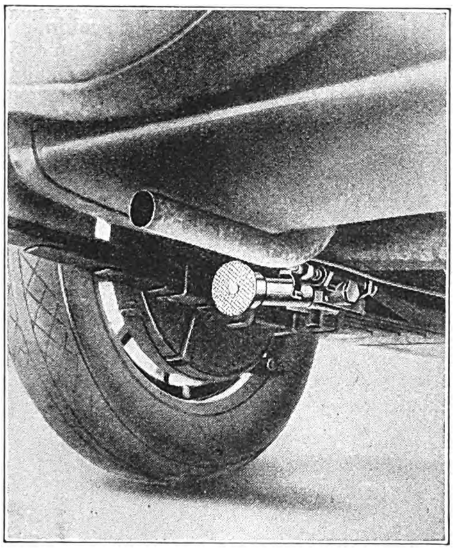
The Superior four-wheel hydraulic jack is not affected by the condition of the road or pavement. The swivel base adapts itself to any angle or surface. The jack is positive in action and will not slip or shift.

The new hydraulic jack can be installed as part of the permanent equipment on pleasure cars, buses, and delivery cars.

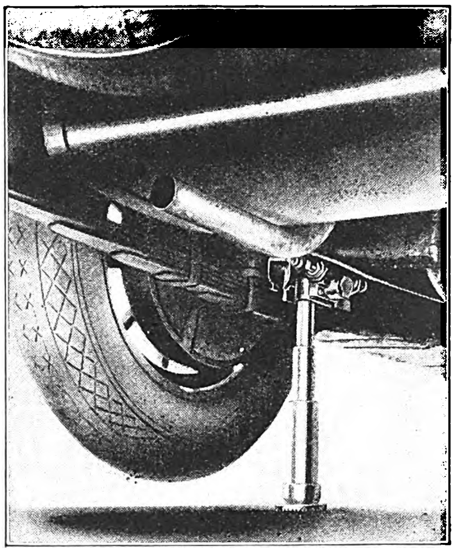
New Type Differential Stops "Spinning Wheel" Evil

A NEW type differential, called the Krohn differential, is said to proportion the engine power to the wheel that can use it and stop the "spinning wheel" evil. It is manufactured by the Krohn Differential Corporation, 209 South La Salle Street, Chicago.

While the device is new to most car owners, many truck operators, and engineers, it is not new in service. It has been successfully used since 1924 and has been quietly distributed to fleet owners who were having trouble making rear-ends stand up in particularly arduous service. This differential, like the conventional type that has been used for years, permits one wheel to turn faster than its mate when rounding a corner. It lets one wheel turn if that wheel is jacked up, but it does not allow one wheel to spin idly, robbing the other of power, when driving on wet paved roads, through mud, or over roads that are slippery with snow and ice.


The permanently installed jack as it is clamped when not in use

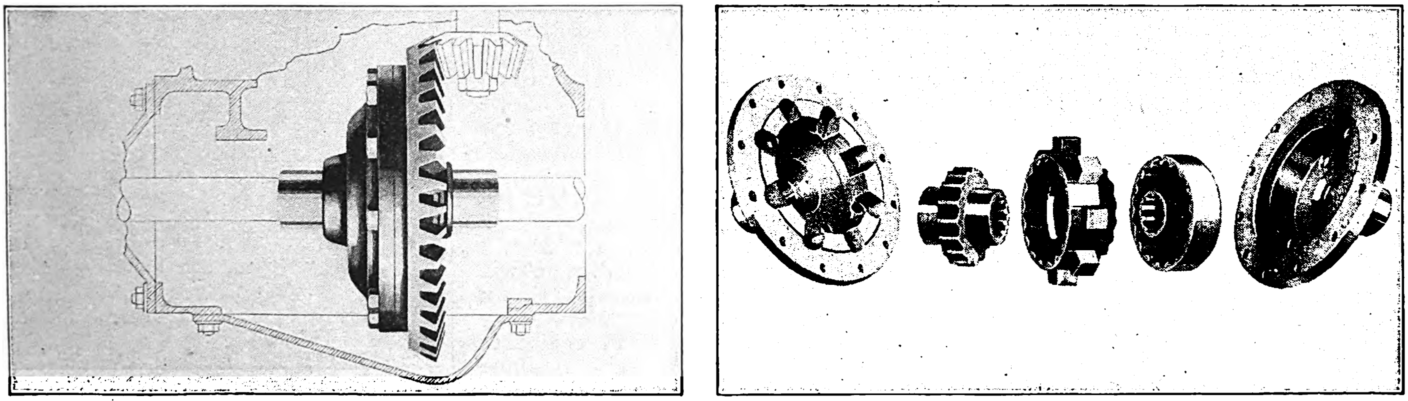
From time to time various specially designed differentials have made their appearance, but these have usually been locking types or intricate mechanisms having more disadvantages than advantages. This new one does not lock. It does not compel the wheels to turn at the same rate of speed, nor is it at all complicated. And while it permits a wheel that is jacked up to turn freely, it utilizes the slightest retardation—even the friction of rubber on wet ice, and employs this resistance to direct the engine power to the wheel having traction.


Hydraulic jack in raised position

The three simple working parts of the Krohn differential are shown in the central part of the illustration. The two halves of the case are at the right and left. A ring gear is mounted on the case, just as with any differential, and the rotation of the case is imparted to the central gear. This, in turn, transmits rotation to the other two gears which are splined on the two drive shafts.

The differential action is obtained, when traction varies, by a difference in the number of teeth in the various gears, which permits the central gear to rotate about the other gears. This allows slight rotation of one driving wheel with respect to the other which is necessary when rounding corners. It does not, however, allow complete freedom of rotation of either driving wheel with respect to the other. And it is this fact which prevents wheel spinning and insures getting power to the wheel that has traction.

In operating a truck, tractor, bus, or pleasure car, this action becomes automatic. The slightest tendency to slip is handled by the Krohn differential before it causes actual slipping. The flow of power is thus constantly directed to the wheel that can use it and the truck becomes seemingly more powerful, shows greater gasoline mileage, and goes up slippery hills and over stretches of ice or snow that could formerly be negotiated only with great difficulty, even with the help of skid chains.


The new differential and its various elements, as described in the text

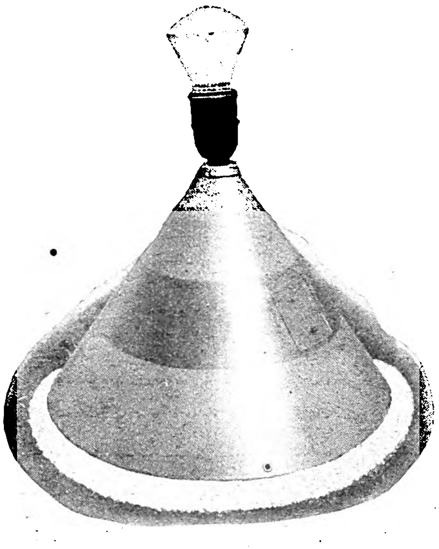
Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

A New Boundary Light

IT is extraordinary how our systems of airport lighting have developed in the last few years, from the primitive methods first used by Army aviators of soaking rags in gasoline and burning them as guides to the incoming pilot. We have now route beacons which guide the pilot to the airport; obstruction lights which mark such hazards as hangars; flood-lights of immense power which illuminate the entire landing area; and finally boundary lights which mark the contour of the field.



Boundary light in working position

The boundary lights, while quite indispensable, offer an element of danger since they must be mounted about ten feet or so above the ground, and may be struck by the plane's undercarriage with disastrous results. The Curtiss-Wright Flying Service is responsible for the construction of a new type of boundary light which avoids this danger.

As shown in our photographs, the new boundary light is supported by a cone which is held in place solely by its own weight. If struck, is overturns easily and disconnects the wiring by pulling a plug through a flexible cable from a weather-proof cutout. Breaking the contact cuts out one light without affecting other lights on the system. This is a decided improvement over the old system of iron pipe standards.

The Problem of Air-Sickness

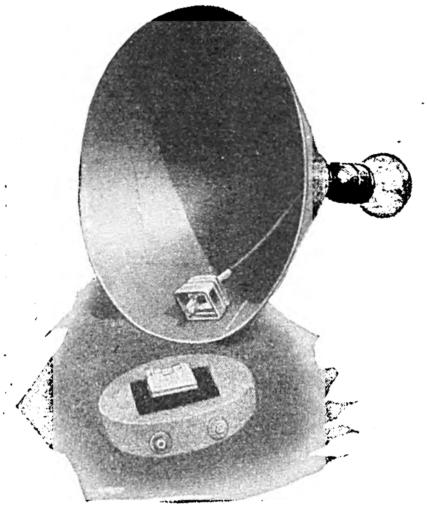
AIR-SICKNESS can be just as unpleasant as sea-sickness and its elimination is a most important problem in air transport.

The Daniel Guggenheim Fund for the Promotion of Aeronautics has therefore done a very useful piece of work by conducting an international inquiry into the subject, consulting American, British, French, German, and Italian authorities, and publishing a survey under the above title, copies of which will be supplied gratis upon application to the offices of the Fund at 598 Madison Avenue, New York City.

There seems to be no doubt that seasickness or air-sickness is primarily due to the action of accelerated motion on the labyrinth of the ear, although the exact phenomenon is not yet clearly understood.

There are, however, many contributing causes. One is psychical. A nervous person, expecting to be air-sick, is certain to have his expectation gratified in rough air. The remedy is distraction of the passenger by the provision of interesting instruments in the cabin, maps of the country passed over, et cetera. In the installation of equipment and furnishings in the cabin, attention should not be directed to the possibility of air-sickness. The mere provision of a special receptacle in full view of the passenger may cause his mind to dwell on the possibility of air-sickness, with unpleasant consequences.

Another contributing cause is visual. The airplane should be flown at a fair height, say 2000 feet or more. At such a height a wide view of the landscape is obtained, and there exists a lessened appreciation of the relative movement of the earth and the horizon. Besides, at heights there is always less bumpiness of the air. The passenger should also have a clear and unobstructed view of the horizon, with no window bars, struts or wings in close proximity to the eye. A high-wing monoplane with ample window space is recommended by a British medical officer



New light overturned when struck

Lack of ventilation always results in air-sickness, but noise is also a contributory cause. Opening the windows wide will give a passenger plenty of fresh air, but will also increase the noise and there is thus a serious conflict in requirements. Designers should strive to place the engines as far as possible from the cabin. Special ear defenders are helpful. But perhaps the most important protective measure is the provision of purely artificial ventilation, in which the opening of windows is entirely dispensed with.

Are medicines helpful? Giddiness cannot be fought by drugs, but the "vegetative effects" by which German doctors politely designate nausea can be checked partially by such European preparations as those termed "Vasano," "Nautisan," et cetera.

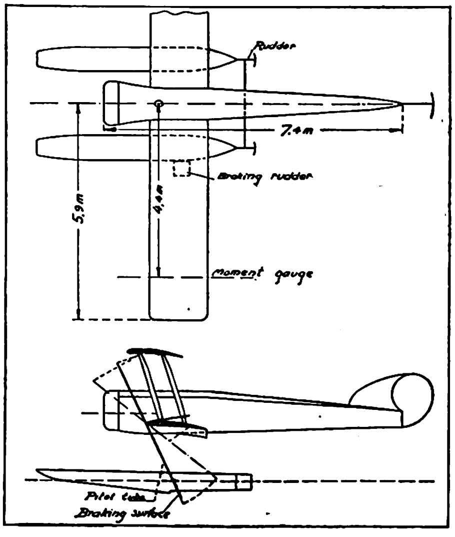
The North German Lloyd employs a further method, known as the Dammert inhalation method. No tablets or powders are involved in this, the medicaments employed being inhaled through a tubular apparatus in a dry and finely diffused state. This is effected by wearing a mask for a period of five to ten minutes. Used on all the North German Lloyd's steamers, this treatment has proved fairly successful. It is not unpleasant and is perfectly harmless.

Problems of Winter Flying

WE understand that it is not uncommon in Sweden for an automobile to be driven out over the ice to a vessel moored in a harbor. Cases are reported of airplanes taking off and landing on frozen waters. Evidently the Swedish aviators also have many winter problems on their hands. One of them is the starting of aircraft engines at low temperatures.

An intensive study of fuels and oils has apparently determined that it is impossible to start an engine at very low temperatures without warming up the engine. With a water-cooled engine a blow lamp applied to the cooling water seems to work out very well. In the air-cooled engine the difficulty is greater. The only practical solution appears to be to warm up the whole engine, a far more difficult job than warming the cooling water only.

With float seaplanes used in Sweden, there arises the problem of being able to land indifferently on water or on snow and



Water rudder and braking rudder used in restricted Swedish waters ice. It is possible to land on snow or ice with ordinary floats, but the wear and tear are prohibitive. The Swedish engineers are experimenting with floats which are elastically mounted and which have elastic bottoms.

While constructors have given much attention to the braking of wheels, they have apparently taken for granted that seaplanes would always have plenty of space to land in. In the narrow Swedish rivers maneuverability becomes more important. Accordingly, water rudders are employed and also braking rudders on the sides of the float. A typical arrangement is shown in our diagrams, by courtesy of the *Royal Aeronautical Society Journal.*

Tailless Light Planes

WE have just received some photographs of low-powered, tailless German planes, which are evidently derivatives of glider practice. While little technical detail is available, these photographs deserve careful study.

The first illustrations show a small two seater, built by Espenlaub, the famous German glider pilot. This plane is equipped with an opposed two-cylinder Bristol Cherub of approximately 20 horsepower, and is provided with a three-wheel landing gear. The main departure from conventional practice lies in the lack of fuselage and tail surfaces

How then is control achieved? The reader will note that the wings have a pronounced sweep-back from their point of attachment at the fuselage. At the tips of the wings there are apparently two hinged rear surfaces on each side. Evidently one pair of these hinged surfaces will act as the conventional ailerons. The other pair, being far back of the center of gravity owing to the sweep-back, will exercise a longitudinal moment about the center of gravity and will act like an elevator. We have therefore both lateral and longitudinal control. Probably also the wing itself has some degree of reverse curvature so as to give fair longitudinal stability while the pronounced sweep-back gives large lateral stability. Apparently the rudder is dispensed with.

In contrast with the conventional airplane, there are, therefore, only two controls instead of three. This involves a novel method of piloting on turns. The pilot banks for a turn with his ailerons, the machine side-slips in the direction of the turn, and the inherent stability of the machine swings it in the right direction and prevents excessive banking. It is plausible to say that the controls have been simplified by the use of only two controls. On the other hand, the control is not so positive as when the three-control system is available. We believe that a greater degree of skill will be necessary with this type than with the conventional plane. On the other hand there are some real advantages.

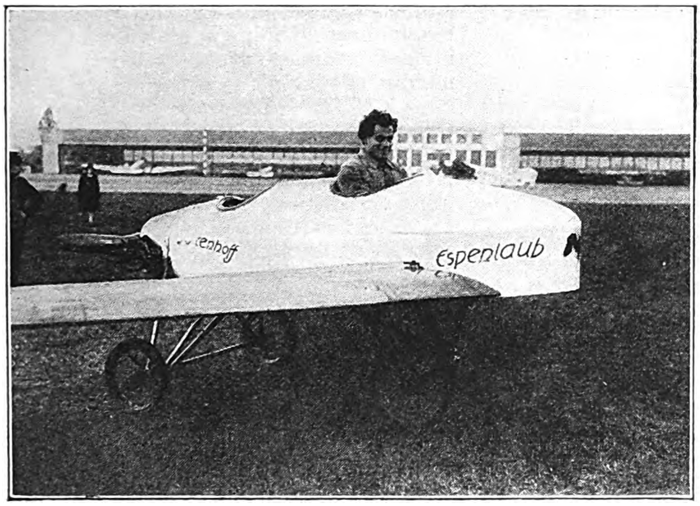
First of all, owing to the absence of the fuselage, there is a decrease in weight and head resistance. Also the cost of the machine is decreased. The use of a three-wheel landing gear is a safeguard against turning over. Therefore, the type has some possibilities for the small sport plane, particularly if a rudder system is added.

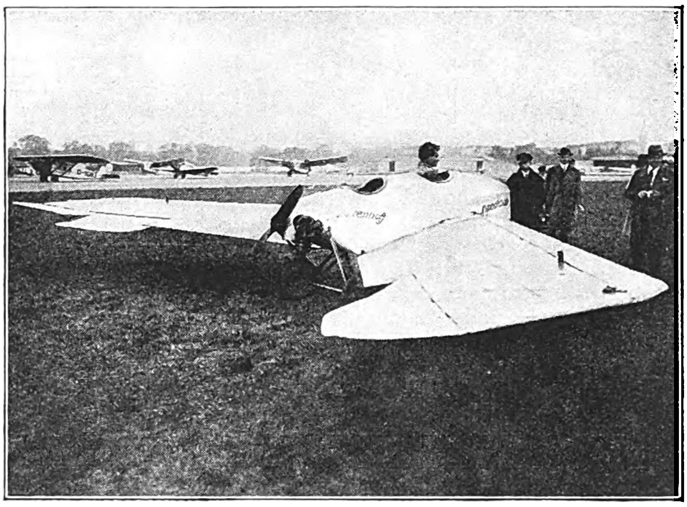
Another tailless light plane is built by the Rhön-Rossiten Gesellschaft, the well known German glider association. This is powered with a D.K.W. engine of only eight horsepower; nevertheless it attains a speed of 77 miles per hour. A closed single-seater cabin is employed and simplification as compared with the conventional airplane is carried still further because there is no landing gear — nothing but a skid under the nacelle, with an attachment at its rear end for launching by means of a rubber catapult.

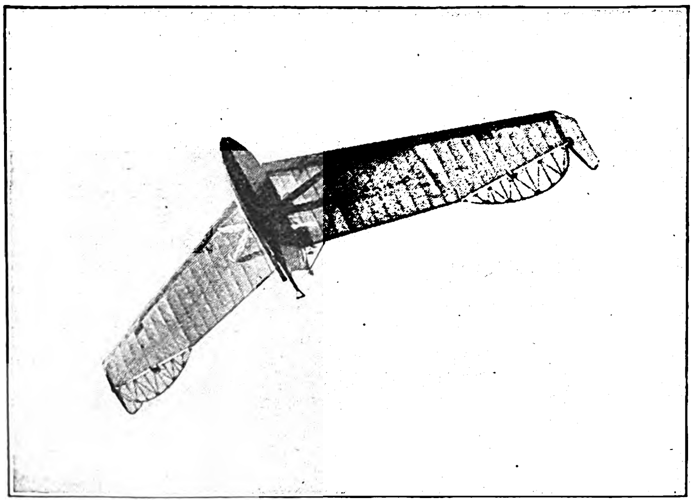
At the tips of the wings are two hinged surfaces, which when moved together evidently serve as an elevator, and when moved separately serve as ailerons. Such independent or simultaneous control is readily achieved by simple mechanical means. At the same time the Rhön-Rossiten light plane is provided with a rudder and fin as can be clearly seen in the photograph, and is therefore a three-axis control machine. The wings are of very high aspect ratio (which shows glider influence) and are braced by external struts.

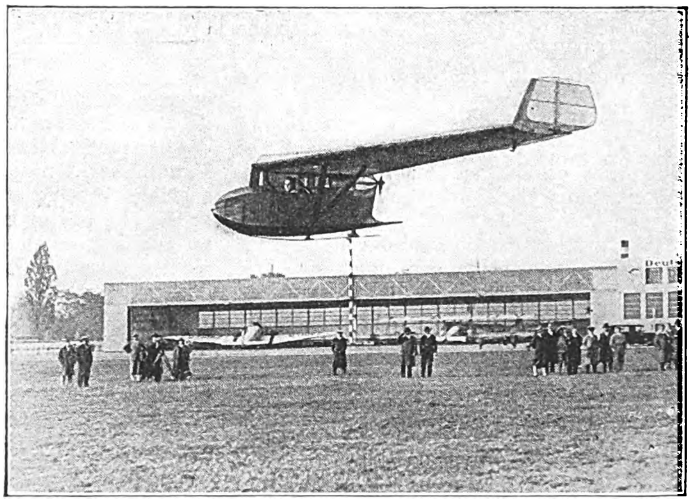
We may add that neither the Espenlaub nor the Rhön-Rossiten tailless planes are novel.

Some time before the war we had the Burgess-Dunne built and flown at Marblehead, Massachusetts, which had similar construction of wings and controls, was ap-

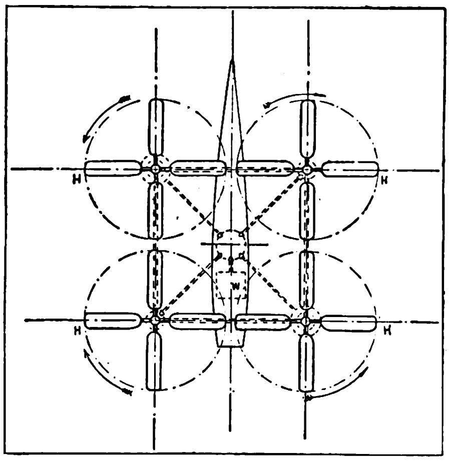




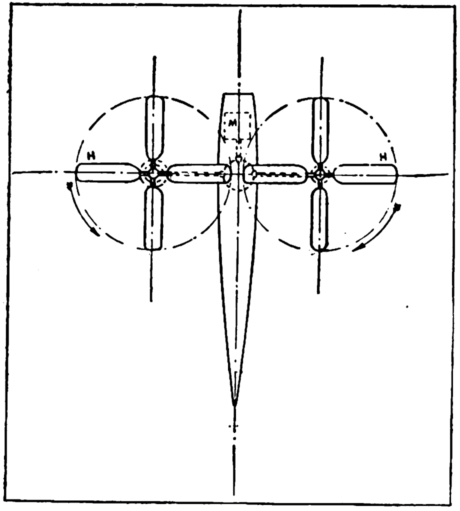




Upper left: Three quarter front view of a light tailless plane, a two-seater using a Bristol Cherub engine. *Upper right*: Three quarter rear view of the same plane, showing the two hinged control surfaces. *Lower left*: The Rhön-Rossiten tailless plane with a skid in lieu of landing wheels. *Lower right*: The same plane landing



***Above:* True helicopter, with four lifting screws. *Below:* Helicopter with only two lifting screws**



parently promising and was only abandoned because it showed too much instability near the ground, and responded to the action of every gust too readily. In England, Captain Hill's Pterodactyl built two or three years ago, was also based on similar principles and gained much interest.

It is peculiar that these tailless, swept-back wing planes come into the limelight from time to time, fly with apparent success and then disappear. Perhaps the Germans will be more persistent in testing their possibilities to a finish.

Classification of Helicopter Systems

IN our issue of July 1929, we discussed the Isacco helicogyre, now being constructed experimentally under the auspices of the British Air Ministry.

Signor Isacco was led to the invention of the helicogyre by a consideration of the difficulties of the various forms of helicopter. Since the helicopter is of perennial interest, it may be of interest to review the various systems which Isacco studied prior to the design of his own machine, and which he discussed in a paper presented before the Royal Aeronautical Society.

The broad classifications of the direct-lift machine are somewhat as follows:

1. The true helicopter; that is, a craft without fixed sustaining surfaces.
2. The helicopter-airplane, in which lifting screws work in conjunction with fixed airplane surfaces.

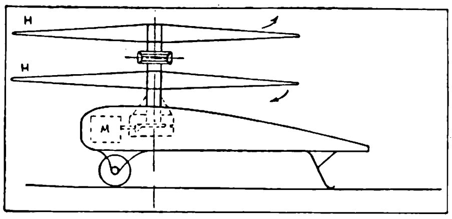
The true helicopter has been built with four lifting airscrews, each on a separate axis. This type is shown diagrammatically. Machines of this type have been built by Breguet and Oehmichen in France, and by De Bothezat in the United States. The airscrews turn, two by two, in opposite directions. The possibilities of such craft at first appear attractive.

With four airscrews, it is possible to have a large lifting area without excessive propeller dimensions. The airscrews can be arranged to have a longitudinal dihedral; that is, the front screws at an angle to the rear screws, and this, by analogy with the airplane, may be expected to give longitudinal stability. The airscrews can be arranged to have a lateral dihedral; that is the screws on the right side may be placed at an angle to the screws on the left side, thus offering the expectation of lateral stability, again by analogy with the airplane. By providing independent variation of pitch for each screw, it is possible to provide lateral and longitudinal control.

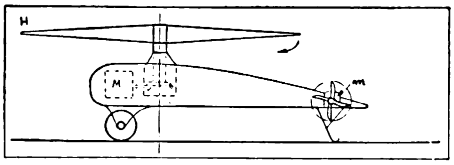
The difficulties of such types in practice are the complications of the mechanical system, excessive weight of the structure, and the fact that such machines will fly in any direction with equal facility. Thus a gust tilting the machine down by the tail may also induce backward motion.

Another variation of the true helicopter is the two-screw machine. Here the mechanical difficulties are somewhat diminished, but there is difficulty in securing longitudinal control in vertical ascent or in hovering.

There have also been helicopters with two screws rotating on the same axis and with one screw mounted above the other. Further simplification is obtained at the expense of stability, (as shown by the test flights of Pescara and others).



***Above:* A helicopter with two lifting screws on a single axis, but operating in opposite directions. *Below:* A single screw helicopter with auxiliary screw and motor at rear to take up torque of rotation**



Still another line of approach (made by Baumhauer, for example) consists in using a single rotating airscrew and in counteracting the torque of rotation by disposing an auxiliary screw at the rear of the machine. Here again mechanical difficulties intervene.

The combination of a fixed wing surface with lifting screws has been investigated exhaustively by Berliner and is now being tried out by Johnson in Wisconsin. The difficulty is that two principles are confused. The resulting machine is likely to be a poor helicopter or direct-lift machine, and a poor airplane in horizontal flight.

Besides the mechanical troubles, and the dubious stability, the helicopter offers tremendous problems in control under all circumstances and particularly in descent with the engine shut off.

Innumerable patents have been taken out which indicate plausible helicopters on paper. The jump from a patentable idea to a practical helicopter is stupendous.

Modern thought on the helicopter seems to incline away from gearing and transmission. Thus, the La Cierva autogiro employs a huge windmill, driven only by the wind of forward motion. It does not pretend to be a direct-lift machine, but provides very slow landing and a short landing run.

The Curtiss helicopter, now in process of construction, avoids gearing by having a single rotating airscrew which is driven by small engines each operating a propeller and mounted on the large lifting blades, with translation attained by inclining the whole craft.

Isacco provides two or more lifting blades with independent engines driving auxiliary propellers, while a propeller placed at the front end of the machine gives propulsive force.

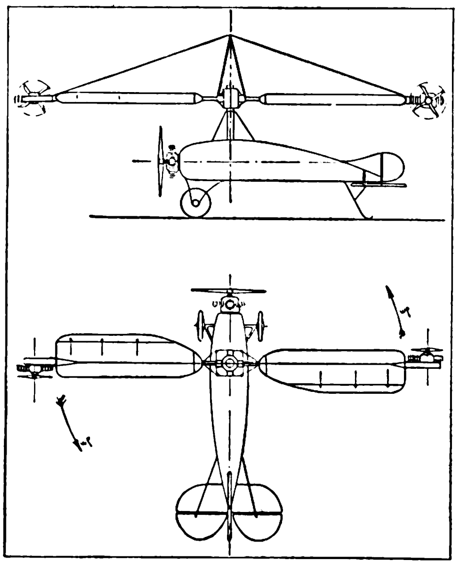
The amount of money, ingenuity, and trouble spent on the helicopter without tangible results is extraordinary. It is one of the mysteries of aeronautics as to whether success will ever be attained.

Black's "Transport Aviation"

IN spite of the rapid growth of air transportation, the number of authoritative texts on the subject remains very small. We therefore welcome the second edition of Black's "Transport Aviation" (published by Simmons-Boardman, New York) which is now a composite work, written by a large number of specialists, including Mr. Black himself, E. L. Jones of the Department of Commerce, Major H. C. Biddlecombe of Curtiss-Wright, John C. Leslie of the Aviation Corporation of the Americas, and other authorities. The subjects dealt with are Aviation Law, Air Routes, Traffic Development, Advertising Safety, Design of Planes, Engines, Airways and Airports, Ground Equipment, Radio Communication, Financial Aspects, et cetera.

It may be of interest to note what the future holds for us, at least in the opinion of the authors:

"The general spread of aviation in the past several years has brought a universal willingness to fly—a condition distinctly



The Isacco helicogyre

differing from that of post-war days. The prejudice against air transport having disappeared, only its high cost is the retarding factor at present. . . . This cost is falling steadily and will continue to fall so far as we can look into the future.

"The railroads will doubtless continue to carry all of the local first-class mail and will be co-ordinated with the air service to act as feeders on the longer hauls.

"It may be set down as a cardinal principle that the railroads or ships or road vehicles have no excuse for carrying mail where it is practical to use aircraft."

The authors also have a prediction to make on the subject of new types of airplanes: "Mail airplanes with facilities for sorting en route, and passenger airplanes with sleeping berths. . . ."

This is a workmanlike, authoritative book, which should be in the library of everyone interested in air transport.

What Businesses Use the Airplane?

AN airplane manufacturing firm, the Ryan Aircraft Corporation, has made a survey of business houses employing the airplane. There are now 135 corporations using planes for their salesmen and executives, for transportation of parts, and so forth. The survey shows that four, six, and eight-place cabin planes, powered with single engines are used almost entirely by such corporations. The oil companies are the largest users, but insurance companies, contractors, express companies, power companies, advertising agencies, roofing manufacturers, automobile firms, tire companies, department stores, and publishing houses are all represented. Altogether 45 different lines of business were discovered as present users. The companies report that a six-place cabin plane costs $0.252 per mile to operate, making allowance for every expense such as depreciation, pilot's pay, insurance, hangar rent, overhauls, gas and oil, and so forth.

Russel L. Putman, a Chicago publisher, in a paper read before the Society of Automotive Engineers, cites three outstanding objections to be overcome before the purchase of planes by business houses becomes more general. These are: lack of confidence as regards safety; high cost; and lack of understanding of the airplane's use. Mr. Putman believes that newspaper comment on aviation does not do much to remove these objections, because it deals mainly with the spectacular, and so he advocates paid advertising. We believe he is quite right, and that systematic advertising by airplane manufacturers is absolutely essential.

A very encouraging piece of news in this regard is the purchase of light *Aristocrats* by the General Tire and Rubber Company of Akron. The planes are painted black-and-orange, piloted by Army fliers on leave, and are to make a year's tour of the country. The tour is designed to test the general applicability of the airplane for commercial purposes. Observations are to be made on the effect of weather on all flying, on take-offs and landings in all kinds of fields, and on the wear and tear of landing tires and landing gear. The tour is to cover 50,000 miles and will take the fleet to all parts of North America. It is understood that in the first six weeks of the tour there has not been an hour's delay due to any mechanical trouble with the planes, although there have been engine and carbureter troubles.

The *Aristocrat*, built by the General Airplanes Company, is a likely sort of plane. It has seating capacity for pilot and two passengers in its closed cabin, and a pay load of 476 pounds. Equipped with the Warner engine of 110 horsepower, it has a cruising speed of well over 90 miles per hour when loaded to its full weight of 2000 pounds. As our photograph shows, the *Aristocrat* has the familiar semi-cantilever wing bracing. The landing gear is of entirely cantilever construction, with two solid streamline members on either side. Certainly a trim and comfortable plane such as this should have an appeal to American business.

The *Aristocrat* monoplane, a three-seater cabin type

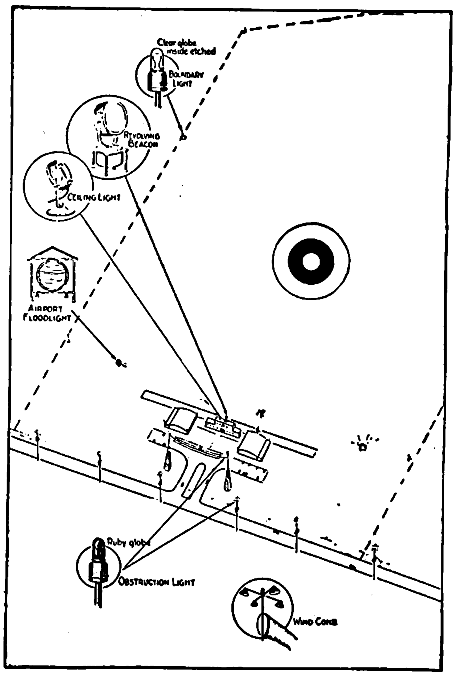
Airport Lighting

THE National Lamp Works of the General Electric Company has issued a pamphlet entitled "Looking Ahead in Airport Lighting" which is of fascinating interest.

We had a notion that a stupendous amount of energy is employed in aviation lighting. Large theaters employ from 50 to 500 kilowatts for lighting only the stage. Electrical advertising signs may use as much as 300 kilowatts. Lighted airports employ only 25 to 40 kilowatts. Evidently airport lighting is quite meager, and its intensity is sure to be increased in the future.

Lighting is, quite rightly, one of the three major requirements for obtaining an airport rating from the Department of Commerce. Our diagram shows a typical airport layout, with the various types of lighting required. The following are the minimum requirements for a class "A" airport:

Airport Beacon. The minimum candlepower must be not less than 100,000 for long range and in no case less than 15,000 candlepower. The beacons are rotating or flashing with flashes of not less than one tenth second duration. Light distribution must be visible all around the horizon and to the zenith or nearly so.



Minimum lighting facilities required for a class "A" airport

Boundary and Obstruction Lights. Either 600-lumen series or 25-watt multiple lamps are employed in clear weather-proof globes mounted on standards 30 inches above the ground, and spaced not more than 300 feet apart to outline boundaries. Green is substituted for white to show the points of best approach, and red globes to show hazardous approaches. The utility of these lights to the incoming aviator is obvious.

Wind Cone and Hangar Lighting. The wind sock, as the wind-direction indicator is called familiarly, must be so lighted as to be visible 1000 feet in all directions if externally floodlighted. The exterior surface of each hangar must be floodlighted to two and one half candles.

Ceiling Light. One of the most useful pieces of airport equipment is the ceiling light, which is projected until a cloud is hit, so that by measurement on the ground of the reflected point, the ceiling or height of the clouds may be determined.

Field Floodlighting. One or more illuminating units are used to provide an even distribution of illumination without shadow areas and of sufficient illumination to make the ground details visible from an altitude of 30 feet. The system must be controlled from a convenient point and be sufficiently flexible to permit landing under all conditions of wind direction without the necessity of landing directly towards the light source.

The care that is evident in the regulations of the Department and in the development work of various airport lighting companies is remarkable.

European Research

THE October *Journal of the Royal Aeronautical Society* contains a number of authoritative papers on the progress of aeronautical research in various European countries.

In France, considerable attention is being paid to the problem of flight on one engine with a twin-engine airplane. One of the factors which militate against this opera-

(*Please turn to page* 88)

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Method of Curing Concrete Supersedes Usual Straw Covering

SODIUM silicate is one of the most versatile chemicals. An adhesive for a thousand different applications, a detergent in dozens of washing operations, a water softener, and in hundreds of other rôles, this ubiquitous mixture of sand and soda plays its part, from preserving eggs to improving paint. Now comes a new application which promises to be visible to every motorist, for sodium silicate seems to offer many advantages as a medium for "curing" concrete highways.

Everyone is familiar with the traditional method of curing a new concrete road by covering it with straw which is periodically moistened. This treatment is designed to prevent too rapid drying of the fresh concrete, in order that the new road may attain its full strength and permanence. Wet straw does the trick nicely, if kept wet, but very often this is not done carefully. The findings of the Maryland Road Commission, working in co-operation with the United States Bureau of Public Roads, reveal an effective curing agent that is not so dependent for its success on the human element.

Silicate of soda, in these experiments, produced concrete as strong as that cured with wet earth; in fact, silicate-cured concrete at the end of six months had a crushing strength of 5364 pounds in comparison with 4855 pounds for concrete cured with wet earth. Also a study of the number and distribution of cracks showed that on this job the section cured with silicate of soda had the least number of cracks.

It has been found that the silicate for concrete curing should have a ratio of 1:3.25 or 1 part sodium oxide (Na_20) to 3.25 parts of silicon oxide ($Si0_2$). This is now available to contractors at a density of 42.25 to 42.75 degrees, Baumé.

Since the gravity of the silicate as applied is 36-37 degrees, Baumé, it is diluted on the job. This is easily done by adding about one gallon of water to four gallons of silicate. Checking with a hydrometer is important to be sure of the specific gravity.

To spread the silicate on the road, it is poured from pails or sprinkling cans, although some contractors use sprayers. A soft brush, mop, or push broom is all that is required for a spreader. When the silicate is spread the contractor's work is done. One application is all that is needed. A second application becomes necessary only if it has rained within six hours after the original treatment. There is no further attention required. Wet earth or straw curing involves extensive water lines, labor for an additional 10 days at least, and then the cost of removal. With silicate curing there is nothing to be removed. The appearance of the road is the same as it is with any other curing.

Humidity Effects Motor Performance

POPULAR beliefs, scorned for a time as superstitions, are often later found to have at least a partial basis in fact. The idea that smoother performance is obtained in wet weather is firmly intrenched in the minds of most automobile drivers.

This impression is doubtless partly the result of psychological factors, and partly a real absence of squeaks caused by the lubrication of the springs by water. However, recent tests at the United States Bureau of Standards indicate that it may result partly from mechanical factors. These tests show that increased atmospheric humidity, or "wetness" reduces the maximum power obtainable and slows up the combustion, the effect of both of which would be to give a smoother flow of power.

The loss of power is proportional to the humidity, and under extreme atmospheric conditions may amount to 10 percent of the total power of the engine.

Although by proper adjustment of the carbureter, equally efficient operation can be obtained irrespective of the humidity, in the absence of such adjustment, less efficient performance normally will be obtained under conditions of high humidity.

Superior Lacquers From Vinyl Resins

LACQUERS that are waterproof and more highly resistant to wear and tear than anything heretofore known are foreshadowed by the development of new synthetic resins which can be used as a base for entirely new surface coatings. Mention is made in these columns (see page 76) of "Glyptal," a new synthetic resin made from glycerine and phthalic anhydride. Now comes another series of synthetic resins promising even wider scope of application, the vinyl resins.

The development of these remarkable compounds was described at a recent meeting of the American Institute of Chemical Engineers by J. G. Davidson. After tracing the remarkable growth in the production of nitrocellulose lacquers and the corresponding decrease in the costs of the aliphatic chemicals and solvents that enter into their formulation, Mr. Davidson demonstrated the properties of some of the most interesting of the newer synthetic resins.

For more than two years his company has been working on the polymerized vinyl compounds, which are of particular interest

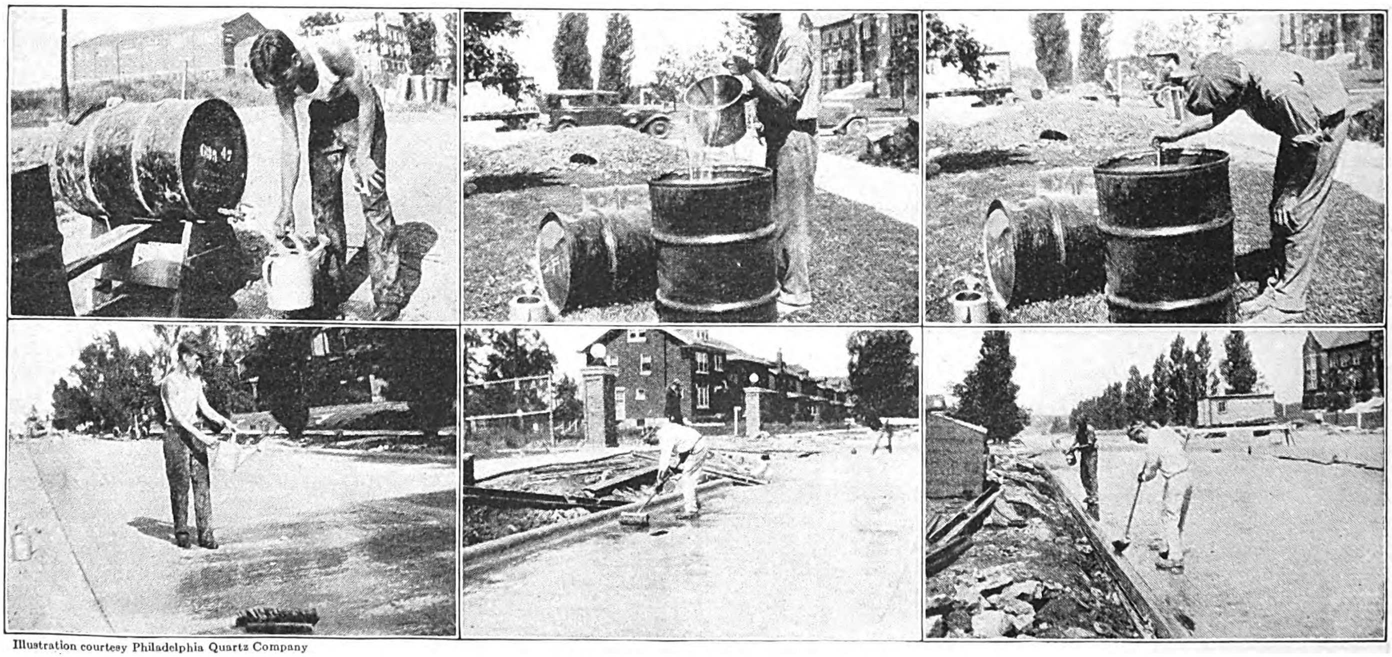


Illustration courtesy Philadelphia Quartz Company

Steps in curing concrete. *Above, left to right*: removing silicate of soda from drum, diluting with water, and mixing the solution. *Below*: Spraying silicate solution on fresh concrete and smoothing it over concrete road in lacquers because they dry in a similar manner to paint and varnishes; that is, by polymerization rather than solely by evaporation, as is the case with lacquer. This means that more film-forming constituents may be left on the surface than with lacquers. Thus while the total solids in a lacquer rarely exceed 25 percent, in varnishes and paints and likewise in vinyl resin lacquers, it is possible to reach 50 to 60 percent of total solids.

Lacquers made with the vinyl resins, according to Mr. Davidson, are waterproof, remarkably resistant to acid or alkali, and can be produced in any colors. The same resins which are to be known by the trade name of Vinylite are thermoplastics and can be molded with or without fillers in any colors, including ivory white. They appear also to have advantages in impregnating fabric, paper, and wood. Their development marks the beginning of a steady evolution through which the lacquer industry will grow to increased size and economic importance, largely as a result of parallel developments in the field of synthetic aliphatic chemistry.

Mineral Wool Made From Lead Slag

A CHICAGO concern has worked out a process for making mineral wool from slag. This mineral wool, which is being put upon the market under the trade name of Therm-O-Proof, is a fluffy and light substance that will not burn or melt at less than 2500 degrees, Fahrenheit, and is being used for insulating material. The only plant manufacturing this wool at present on a commercial scale is at Alton, Illinois, where it is being operated on slag obtained from the lead refinery plant of American Smelting and Refining Company.

Approximately 50 tons of this material is now being turned out daily in Alton, and very soon this output will be increased. It will be marketed in four forms; loose wool, in blanket form, in board and bricks. The principal uses of the material are in building insulation, high and low temperature insulation, sound deadening, and fireproofing.

"Eskimo Pie" Idea Applied to Wolf Poison

NOT all the ingenious discoveries of chemists originate in laboratories. In fact, one triumph of science we recently heard of was achieved by the versatile scientist's familiarity with Eskimo Pie. One of the clients of Arthur R. Maas, consulting chemists of Los Angeles, asked the chemists to prepare a tasteless strychnine for poisoning wolves, foxes, and other predatory animals that kill sheep and cattle. Strychnine is very bitter, and if the "varmints" taste it, they cough up the baits. Also, a quick-acting form was wanted so the furs could be recovered before being damaged.

"We tried mixing with disguising materials, like sugar," said Mr. Maas, "but with no success, as the bitter taste remained. Then, with things that dissolved slowly in saliva—that was too slow. Then we remembered that a chocolate-covered ice cream bar seems to lack taste, and as a layer of wax separates the ice cream from the chocolate, we tried incorporating strychnine with wax. Complete success! The wax protects the poison from saliva, and it is swallowed without being tasted. In the stomach the wax soon dissolves by warmth, and there is a quick kill."

The formula has been highly effective in killing wolves and foxes, and the ranchers now welcome prowling animals because they drop before they do any damage and their skins pay a nice profit.

Bacteria May Supply Chemicals

FERMENTATION methods still play the most important part in solvents production, according to a paper prepared by F. M. Crawford for the Institute of Chemical Engineers. Starting in 1920 with an output from only a few fermenters, the demand from the lacquer industry for n-butyl alcohol has increased by leaps and bounds until in 1929 approximately 150 fermenters, each of 50,000-gallon capacity, are needed to keep up the required rate of production. The original plant capacity at Terre Haute, Indiana, was soon outgrown. A second and a third plant were built at Peoria, Illinois.

During the fermentation, tremendous quantities of gases are given off, consisting of a mixture of approximately 40 percent of hydrogen and 60 percent of carbon dioxide. More than half of the carbohydrate entering into the fermentation process goes into the formation of these materials, which at the Peoria plant are are being converted into synthetic methanol.

Mr. Crawford predicts that bacteria will play an increasing part in the production of commercial chemicals and foresees a time when our exhausted petroleum reserve will be replaced by fermentation processes for the manufacture of the many solvents and chemicals which are now derived from petroleum.

Diphenyl as a Heating Medium

ONE of the most spectacular developments of an erstwhile rare chemical to an everyday commodity for entirely new uses is exemplified by the application of diphenyl as a heating medium. This organic solid changes to a gas at 484 degrees, Fahrenheit, and is therefore ideal for a heating medium between that temperature and 750 degrees, Fahrenheit, just as water, for instance, is an ideal medium for the temperature range covered by steam. The most important application of the new heating medium seems to be in the Govers process for refining lubricating oils.

A. E. Wells, a consulting engineer of Cambridge, Massachusetts, read a preliminary paper on the use this process makes of diphenyl as a heating medium in distillation at a recent meeting of the Institute of Chemical Engineers. Dr. Francis X. Govers, director of research for the Indian Refining Company, answered questions and demonstrated the operation of the process. The problem of producing a special grade of lubricating oil distilling between 485 and 625 degrees, Fahrenheit, called for the use of an indirect heating medium. After considering various low-melting metals, mercury, and sulfur vapors, it was decided to use diphenyl, which has a vapor pressure of 110 pounds at a temperature of 750 degrees, Fahrenheit.

There is apparently no decomposition at this temperature, for Dr. Govers reported that when used continuously in their apparatus for over six months, the make-up amounted to less than ½ percent. Diphenyl produced for this process on a commercial scale for the first time by the Federal Phosphorus Company, of Birmingham, has a melting point of 158 degrees, Fahrenheit, a boiling point of 474 degrees, Fahrenheit, and a specific heat of 0.4. Its thermodynamic properties are being studied at the University of Michigan and elsewhere.

In the Govers process the diphenyl is vaporized in a tubular heater similar to a modern boiler and the vapors pass to a single-effect vacuum evaporator where a mineral oil fraction between 485 and 625 degrees, Fahrenheit, is volatilized and taken off in an overhead condenser. Pressure in the still is about five millimeters. It is reported that with a waste heat boiler the entire process has shown a thermal efficiency of 83 percent.

Spectrum of Chlorine Gas

VALUABLE additions to our knowledge of the spectrum of chlorine, an element whose spectral characteristics have been practically unknown heretofore, and data tending to show that so far as we are now aware, chlorine does not exist in the sun, were made available to physicists and astronomers through a report published in the June 1929 number of the Bureau of Standards *Journal of Research*.

Several years ago Prof. H. Kayser, of the University of Bonn, in reviewing the research work done on the spectrum of chlorine, made the statement that, in spite of all the investigations that had been made up to that time, the spectrum was still practically unknown. The cause for this situation lies in the fact that chlorine is a difficult element to observe spectroscopically. When an electric charge is passed through the gas at reduced pressure in a glass tube, it rapidly enters into chemical combination with the hot metal electrodes and the discharge tube soon becomes useless. This defect has been eliminated in an experimental procedure at the Bureau, whereby a small portable chlorine generator is attached to the discharge tube, thus permitting small amounts of the gas to be admitted to the tube to replace that which has combined with the electrodes.

With such a tube it was possible to produce the spectrum of chlorine for the long periods of time (up to 15 hours) necessary to photograph it in the regions where it had never previously been observed. As a result of this new investigation our knowledge of the spectrum has been extended from the wavelengths visible to the eye in the violet and blue to those in the infra-red, beyond the limit of visibility, but capable of being photographed with specially sensitized plates.

Our modern theories of the structure of the atom enable us to predict the type of spectrum which the atom will radiate when it is losing the energy imparted to it, say, in an electric discharge. These new spectrum lines have been classified into spectral series and it is found that these conform in every detail to the theoretical requirements.

Steel-Coated Paper Money

NO sooner does the government reduce the size of paper currency than the chemist comes along with a plan to make money last longer. By means of a process developed in the laboratory of Dr. Schoop, of Zurich, and reported by *Chemistry and Industry*, banknotes are coated with a particular steel alloy in such a way that metal and paper are firmly combined without damage or alteration to the paper. In addition to such advantages as durability, it is claimed that the metallized notes can not be forged.

Synthetic Lacquer Has Synthetic Name

IT is only five or six years since "Duco" and other pyroxylin lacquers made their appearance in the paint and varnish field and began the conquest that left them supreme in certain important applications. The development of the quick-drying pyroxylin lacquer has been the sensation of the protective coating industry during the past decade. Yet the tempo of science and industry is so fast that already a new pretender for the throne of pyroxylin is marshalling his forces in American chemical laboratories, and some scientists are anticipating a new conquest by synthetic resin lacquers.

Chief among the picturesque resin aspirants to supremacy is Glyptal—a synthetic resin with a synthetic name, formed from the words "glycerin" and "phthalic anhydride," the two substances from which it is made. Developed in the great research laboratories of the General Electric Company, Glyptal is the result of a successful search for an improved synthetic non-conductor of electricity. In its solid form it is a resin somewhat similar to the well-known Bakelite; when dissolved, it produces quick-drying lacquers with surprising qualities which are winning new converts and customers every day.

The first commercial applications are for sealing joints in gas mains, for painting structural iron, motors, oil tanks, metal parts of ships exposed to oil or vapors, fire hydrants, ship hulls, mine machinery, and similar equipment requiring sealing and insulating paint. The General Electric Company is marketing a series of Glyptal lacquers in colors, for use where an oil-resistant, highly protective, durable, and flexible insulating coating is demanded.

These paints possess many desirable qualities, including resistance to acids, mineral oils, weather, and alkalies, as well as adhesion to any surface and protection against rust. The Glyptal lacquers have been found superior to ordinary protective paints, in that they are more easily applied, dry faster to a coating of more pleasing appearance, are more resistant to acids and mineral oils, and are less affected by high temperatures. They withstand temperatures destructive to the commonly used paints, and also have a greater dielectric strength.

These new lacquers are now available in five colors—red, blue, brown, green, and aluminum. They may be applied by brushing, spraying, or dipping, dry dust-free in about 30 minutes, and in approximately ten hours to a hard smooth finish which is not brittle and can be cleaned easily. When using Glyptal lacquers as a finish, no priming or sizing is necessary.

Mold Used to Make Gluconic Acid

THE despised mold, popularly considered only destructive, is now used in the making of a health-giving product by the United States Department of Agriculture. The process of putting molds to work in producing gluconic acid, used in making an expensive calcium salt with highly important medical qualities, was discovered and recently perfected by Horace T. Herrick and Orville E. May, chemists in the Bureau of Chemistry and Soils of the department. By the new method, this salt is reduced in cost from about 15 dollars a pound to 50 cents a pound. "This," says Dr. Henry G. Knight, Chief of the Bureau, "is an example of the manner in which the bureau is using apparently useless organisms to create valuable chemicals.

"The calcium gluconate which is made from the gluconic acid produced in the Color and Farm Wastes Division of the bureau is now regarded as the only calcium salt which can be injected between the muscles, in the treatment of certain ailments of man, without causing abscesses. In common with other calcium salts it can be injected into the blood stream or given through the mouth and, in contrast to the exceedingly disagreeable taste of other calcium salts, it is practically tasteless.

"Until Mr. Herrick and Mr. May discovered the kind of mold that produces gluconic acid, learned to feed this mold the right amount of glucose, learned to keep it in a liquid of the right temperature, perfected large containers which would not corrode from the action of the acid and finished other laborious research, calcium gluconate remained a rare medicine, manufactured by chemical processes and held at exceedingly high prices by certain European manufacturers."

It is believed that calcium gluconate, when fed to high-production hens which lay thin-shelled eggs, may have a marked and unusual effect in thickening the shells. It is considered possible that the textile and tanning industries will also make use of gluconic acid.

Extend Investigation of Rare Gases

IN our June, 1929, issue we described the process of manufacture of the glowing colored tube electric advertising signs, explaining the effects produced by the use of neon, argon, helium, and mercury vapor in the tubes. We are reproducing this month a photograph showing an important step in the manufacture of these popular advertising signs in which the air is completely exhausted from the tubes before the introduction of the rare gases.

The popularity of these advertising signs has opened up a tremendous field for neon gas, which was previously nothing more than a chemical curiosity. Now we are informed that new possibilities for the commercial development of still other rare gases are in prospect as a result of the research work of a French chemist, M. Lepape. He has succeeded in obtaining appreciable quantities of krypton and xenon, both of which are present in the air in minute quantities, by fractionating the residual gases from liquid air. In apparatus of the type used by Claude for the liquefaction of air, the krypton and xenon are entrained in the ebullition of liquid oxygen. In order to reduce loss of these gases through mechanical entrainment, M. Lapape employs fractionation by means of adsorption at the temperature of liquid oxygen. By using coconut charcoal or silica salt with the liquid oxgen in the process of evaporation, the mixture becomes enriched in krypton and xenon, which are subsequently separated by fractionation on the coconut charcoal. By this method M. Lepape has been able to recover from air several liters of krypton and one liter of xenon.

Wanted: Uses For Columbium

AT the recent Chemical Exposition, in New York, columbium was exhibited for the first time. Because of the remarkable properties of this new metal, speculation was rife among chemists as to where application of the newcomer would first be made. The metal exhibited is said to represent all of the metallic columbium in the world. The metal has an atomic weight of 93.5, its specific gravity is 8.3 and its melting point is about 1950 degrees, centigrade.

Columbium is silvery in appearance and may be coated with iridescent, colored oxides by electrolysis. Like tantalum, it is inert to practically all chemical action and is soluble only in a mixture of nitric and hydrofluoric acids. The metal readily absorbs gases by occlusion, is very ductile, and may easily be worked cold. It may

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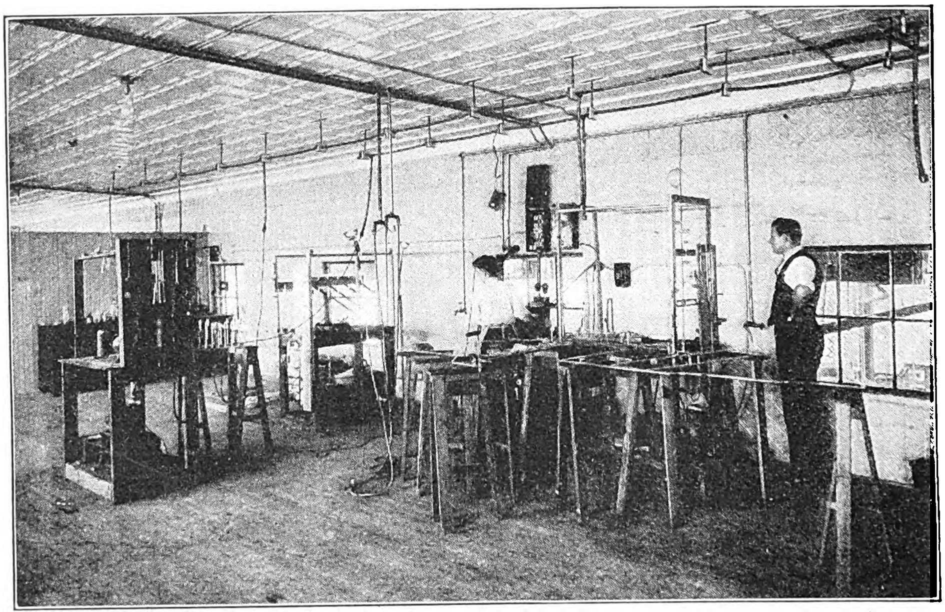


Electrical evacuating apparatus, used in removing air from glass tubes prior to the introduction of luminous gases. A current of 16,000 volts is required

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.

Editor of the Journal of the American Medical Association *and of* Hygeia

The Composition of Cigaret and Cigaret Smoke

DR. EMIL BOGEN has made available the results of his investigation of cigarets sold in the American market. More than 286 brands are purchased by American smokers, varying from pure oriental cigarets made of Turkish and Egyptian tobacco to the pure domestic brands made of Virginia and Carolina tobacco. In addition, there are innumerable blended tobaccos of which the most popular cigarets are typical, as well as denicotinized tobacco cigarets and tobacco-free cigarets. In his investigation, Doctor Bogen found that it was not possible to differentiate regularly between cigarets of the same class, but that experienced smokers when blindfold can tell the difference between cigarets of different classes.

The moisture content and nicotine content of tobacco varies. Domestic brands average 2.50 percent of nicotine, blended tobaccos 1.90, oriental tobaccos 1.44, and denicotinized tobaccos 1.10. There is thus but a small limit of differentiation in nicotine content between denicotinized and oriental tobaccos.

Doctor Bogen recognizes that the chemical composition of the cigaret is not the only factor that may affect the response of the smoker. There is the inhalation of the smoke, the heat, and the deposition of the ingredients in the tissues. In an interesting table, Doctor Bogen contrasts the pains and pleasures of cigaret smoking as represented by the average number of men undergoing blindfold tests.

Pains and Pleasures of Cigaret Smoking

Percentages reported by subjects of blindfold tests.

I. The Pleasures of Smoking	Percent
Sociability	65
Fragrance	60
Relaxation	50
Stimulation	50
Steady nerves	45
Smoothness, mellowness, and soothing	35
Quieting hunger	30
Sight of the smoke	25
Feel in the lips	25
Feel in the hand	10
Taste	5

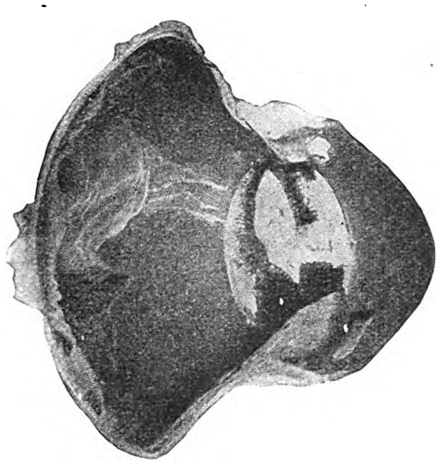
II. The Ill Effects of Smoking	Percent
Shortness of breath	35
Biting and irritation	30
Coughing	30
Burning	15
Nausea	10
Palpitation of heart	5
Hoarseness	5
Salivation	5

A definite relationship was also found between underweight and persistent use of tobacco. Those who use no tobacco were usually overweight and showed a lower incidence of colds and respiratory diseases.

The Lens of the Eye

ALMOST everyone knows that the eyes of animals, insects, and fishes are adapted to the nature of their lives. This applies not only to the retina of the eye, the portion which accurately conveys the vision to the brain, but also to the lens of the eye which acts as a mechanism for focusing the image on the retina.

Dr. John O. McReynolds has made extensive studies of the lens of the eyes of various species, which indicate some of the remarkable conditions that exist. There are some beetles which have thousands of eyes and thousands of lenses. Consider the marvels of the mechanism of the eye of a bird which enables it while flying swiftly to alight with accuracy on a swinging telephone wire or to catch in its beak an insect flying in a diverging course. The eyes of many species are both telescopic and microscopic. The eyes of fish are adapted to the medium in which they live. The owl's eye is interesting, according to Doctor McReynolds, because of the prominent part that the cornea, which is the tissue over the eye, plays in helping the owl to see satisfactorily.



Owl's eye, *Bubo virginianus*. This represents a meridional section of the eye. The enormously protruding cornea is a combination of cylinder and cone and performs an exceedingly important function in the refraction of light

The Malingerer

THE malingerer is usually mentally disturbed. In order to excite sympathy in one in whom he or she, and it is usually she, is interested, he will inflict all sorts of strange injuries on his person. Sometimes in order to avoid hard work or military service, he will claim deafness, inability to see, or even disturbance of the kidneys. During the war there were many such cases. Instances actually occurred in which egg white or similar substances were injected into the bladder so that excretions might reveal the presence of albumin on examination.

Among the strangest of all malingerers are those who inflict injuries on the skin. Every specialist in diseases of the skin has seen numerous cases of this character. Recently, Doctors Stokes and Garner of Philadelphia have described a remarkable case of this kind. A married woman, 40 years of age, developed typical hysterical symptoms, including attacks of rigidity, sleeping spells, and disturbances of vision, and at the same time white spots and scars on the skin. A specialist is able usually to detect the fact that the skin disturbance is self-inflicted.

Usually it is not an eruption on the skin, but an ulcer or an erosion due to the action of some burning or caustic substance. In 34 cases seen by one specialist, 14 were due to the application of carbolic acid or phenol, which had been used to produce burns and scars. Usually the interest of the specialist is aroused at once by the fact that the skin disturbance does not resemble any ordinary skin disease. However, it is possible to injure the skin merely by rubbing it with a wet finger or by applying sand-paper, acids, mustard, tobacco, or more caustic substances.

It is usual for the self-inflicted wound to be in a place that the hand can easily reach. In a left-handed person the scars are on the right side, and in a right-handed person on the left side.

Among symptoms of nervousness which are likely to appear in such people are bitten finger nails, bitten knuckles, and hangnails. Indeed, Doctors Stokes and Garner speak of the nervous restlessness, the slight tremors of the finger muscles, the easily moist or overbright eye, or the "poker" face of the outwardly calm, although inwardly tense, person as typical malingerers. In practically every case it is possible to find a background of motive which may be sexual or associated with a love affair. Jealousy, self-pity, and morbid craving for sympathy are the chief causes of malingering.

In the case of the girl in Escanaba some years ago who deceived physicians for many weeks with an extremely high fever brought about by touching the thermometer to the hot water bottle, it was the desire to attract the attention of some one who was not interested. However, in addition to the jealousy motive, there may be moral, religious, intellectual, or economic reasons for producing the disturbance.

An Exclusive Meat Diet

EXPERIMENTS just completed under the direction of Dr. C. W. Lieb served to confirm the observations made by the Arctic explorer Stefansson when he returned from the far north after having lived for many years on what was practically an exclusive meat diet. At that time observations showed that no definite physical or other changes had occurred in Stefansson.

The people who opposed the eating of meat on prejudicial ground attempted to explain the facts by asserting that he had been able to withstand high protein and fat diet due to the cold air or to his vigorous exercise. As a matter of fact, summer heat comparable to that of our own country was experienced part of the time, and, indeed, winter temperatures in the far north are for the human being much like those of our own climate, because of the furs that are worn and the temperatures that are maintained in Eskimo houses.

For the purpose of the experiment, Stefansson and Andersen, who spent three years with him in the Arctic, consented to go on an exclusive meat diet for a year and to be studied from all angles during the period of the experiment. For a year, therefore, they lived on meat, most of which was cold-storage meat, although for a period of two months they had fresh meat. Calcium was obtained by eating the ends of the ribs and gristle. Very little salt was added to the food. Raw bone marrow was eaten as dessert at times during the year of the experiment. Coffee and black tea and water were the sole beverages and were taken unsweetened.

It is pointed out that both the men were excellent subjects from the psychologic point of view, since they had previously lived on limited diets and had no mental hazards as to the outcome. There was little if any change in their weights and no disturbances of the kidneys. The diets averaged 2600 calories per day. The blood pressure of Stefansson did not change and Andersen's blood pressure fell from 140 millimeters to 120 millimeters. There was no decrease in physical vigor and both men appeared ruddier at the end of the experiment than at the beginning. The teeth did not deteriorate, the bowels remained normal and there was no change in pulse, temperature, or ability to sleep.

It has been argued by some of the opponents of meat in the diet that the eating of meat brings into the bowels vast numbers of dangerous bacteria and therefore is bad for the human body. The investigation revealed the fact that the whole meat diet in both subjects caused a simplification of the germs in the intestinal tract and did not cause the development of putrefactive germs.

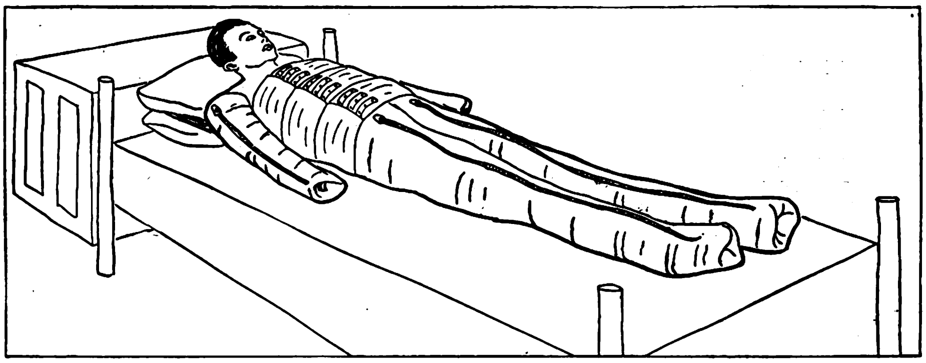
The results of this experiment should not be considered, however, as a recommendation for eating vast quantities of meat or of meat alone by the majority of people. The experiment does break down, however, the arguments of the vegetarians as to the dangers of meat. The fact remains that the best diet for the human being is a well balanced mixture of all of the foods commonly eaten by man, including meat, eggs, fresh vegetables, cooked vegetables, fruits, and cereal products.

An Apparatus for Muscular Relaxation

It has been generally agreed that relaxation of the muscles, whether produced by mental action or by physical process, is conducive to sleep. Dr. Edmund Jacobson has devised a system called "progressive relaxation," in which the patient is taught in a series of lessons to relax muscle after muscle until he finally learns to relax his entire body. It has long been known that gentle massage and a hot bath will produce the same relaxing effect.

It occurred to Dr. Joshua Rosett to develop an apparatus which by alternately compressing and releasing the tissues would produce a similar effect. The device is like a union suit, made of strong inelastic rubberized cloth and is composed of a series of collapsible tubes which encircle the limbs and the body as high as the line of the armpits. By means of an air compressor and exhaust, compressed air enters the garment in such a manner that the tubes are momentarily inflated and deflated one after another in succession, in a direction from the extremities toward the upper part of the chest and shoulders. The degree of pressure is regulated by valves and the speed of the wave is regulated by another apparatus.

This garment has been in use, according to Doctor Rosett, for more than three years and people who try it say that it produces a gentle massage all over the body as if by many fine fingers. The uniform effect has been that of relaxation. Patients with nervous and mental diseases who are excited and do not sleep apparently fall asleep in this device. Experiments are being conducted to determine its usefulness.


An apparatus for the induction of muscular relaxation and sleep

Deaths from Pugilism

Some time ago Dr. H. S. Martland pointed out that several puglists had died and others developed mental disturbances due to the development of a condition called "punch drunk." This condition is the result of small hemorrhages in the brain caused by repeated concussions. Recently pugilism has become more and more popular in Germany. Although boxing was common in ancient Greece and Rome, it did not become popular in Germany until after the World War.

Now the Germans are beginning to observe cases similar to those described by Martland. Kurt Wolff, the German pathologist, lists 25 deaths, in seven of which the fatality resulted from hemorrhage into the brain due to a blow on the side of the head.

The casualties in boxing are usually due to matching inexperienced boxers with better trained and heavier opponents, or to holding matches soon after a full meal or while the boxer is suffering from some disease.

Speech and Intelligence

The mother is invariably interested in the question as to when the child will begin to talk. In the Institute for Juvenile Research in Chicago investigation was made of this particular point. The acquirement of speech is one of the most important functions in human development. Unquestionably speech is learned more rapidly in infancy than in adult life as everyone knows by comparing the ease with which language is acquired in infancy with the difficulty of acquiring a second language later in life. A thousand children were studied as to the age of onset of talking and walking, and this was compared with the mental age, intelligence quotient, nationality, and similar factors.

Doctors Abt, Adler, and Bartelme, who made the study, find that the range in onset of talking extends from 6 to 60 months for both boys and girls. The average age for talking for boys is 19 months and for girls 18 months. Practically all observers agree that girls learn to talk quicker than boys.

In comparing the age of onset of speech with intelligence rating, it is pointed out that the higher the intelligence the earlier the child learns to talk. The average age of speech onset was lowest in the Jewish group and highest in the group with both parents foreign born.

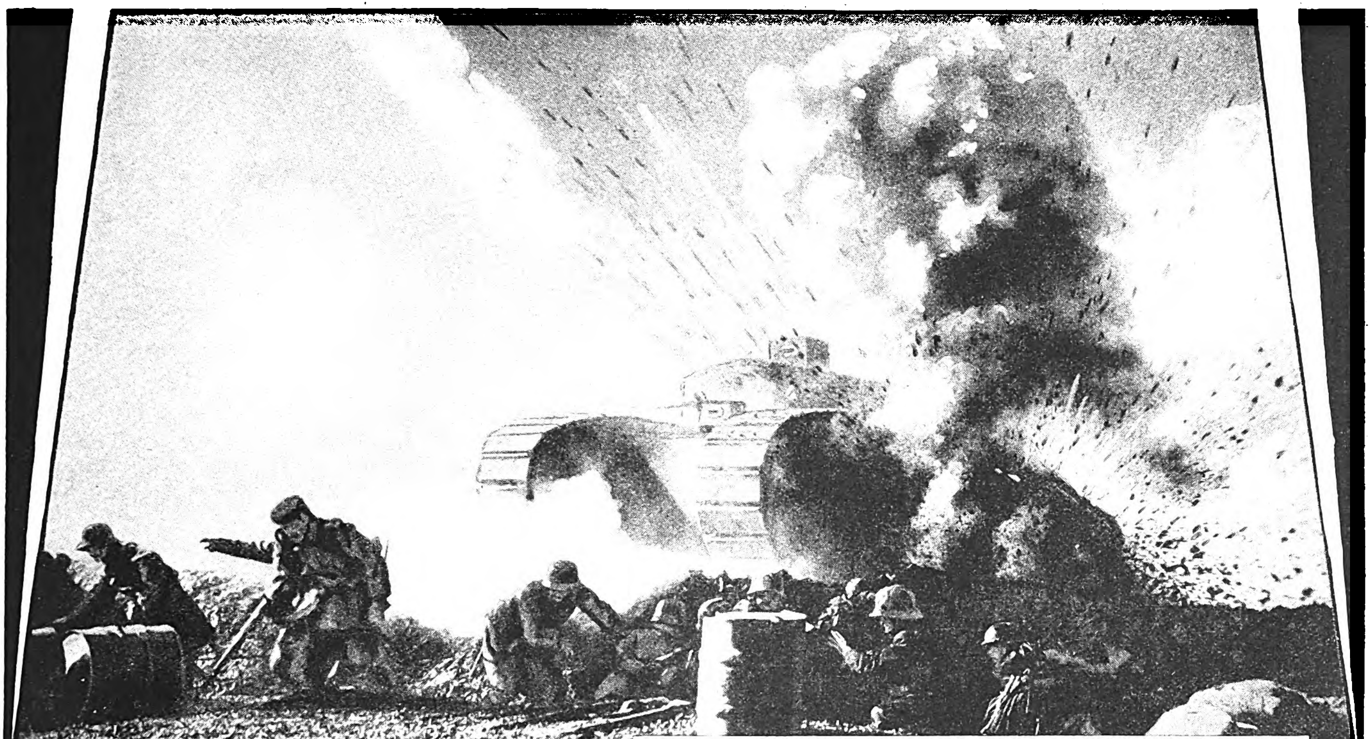
The average of onset of walking for both sexes is 16 months, ranging from 7 to 51 months for boys and 7 to 60 months for girls. There is also a definite relationship between the age at onset of walking and general intelligence.

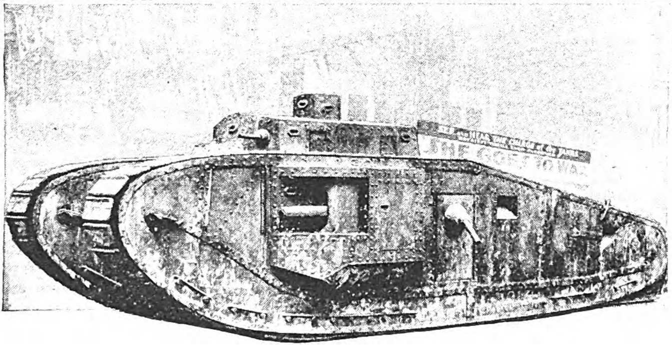
It was noted in addition to this, that children who wet the bed at the age of three years or above learn to talk later than those who have established dry habits prior to that time.

The Hearts of Athletes

During the Olympic Games held in Amsterdam last year special studies were made of the hearts of the athletes by Doctor Herxheimer of Berlin who has for many years been interested in this subject. During the Amsterdam games, the hearts of 246 athletes engaged in various branches of sport were studied with the X ray before and after activity and their sizes were compared with the body weight.

Short-distance runners and athletes participating in a variety of sports had hearts which differed but little from those of the average men. The same is true of long-distance swimmers. On the other hand, marathon runners tax the heart severely, their hearts being the largest of athletes in any branch of sport. Next to the marathon runners were heavy-weight lifters and throwers, the oarsmen, and the long-distance bicycle racers. Boxers also place a heavy tax on the heart, as was shown by the high rates of weight and size of the organ in this type of athlete.





One of the Masonite Presdwood tanks used by Inspiration Pictures, Inc., at the Tec-Art Studios, Hollywood, California.

This tank looks like steel — *but is made of*

PRESDWOOD

If you are interested in any manufactured article, you can probably find ways in which Presdwood will lower your production costs and improve quality. Send for free sample and the Presdwood booklet. Just mail the coupon NOW.

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In great factories, carload after carload of Presdwood goes to the punch press, band saw, or milling machine to be transformed into useful articles. Presdwood makes iceboxes and incubators. It builds beehives and bird houses; is used in the manufacture of clothes hampers, bread boxes, breakfast nooks, kitchen cabinets, campers' tables, radio cabinets, speed boats, table tops, outdoor signs, and scores and scores of other interesting products.

Home mechanics use Presdwood for putting up light shelving, making small toys, or building a radio cabinet. Builders find Presdwood ideal for paneling fine homes and modern buildings. Contractors, employing Presdwood for lining concrete forms, find hand smoothing unnecessary except at construction joints, and thus effect savings of as much as 40 per cent in labor costs.

Manufacturers and builders have a wonderful material in this grainless wood, for it neither cracks nor splits, is highly resistant to moisture, and does not warp when properly handled. The Presdwood booklet explains its uses —tells how various finishes are applied. A copy is waiting for you and will be mailed on receipt of the coupon.

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Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Aviation

Elements of Mechanical Flight is a home study course offered to anyone in the country who desires aeronautical training. The assignments are presented in a non-technical manner so that even a grade school education is sufficient preparation. The course includes fundamental principles of flight, stability and control, the complete design and building of an airplane, flying instruction, and engines for aircraft. *Department of Engineering Extension, Pennsylvania State College, State College, Pennsylvania.—Inquire.*

Engineering

Selected Papers from the Journal of the Institute of Electrical Engineers of Japan are issued in English either in full or in abstract, for the purpose of introducing to the Western public the gist of the papers published in the Journal of the Institute of Electrical Engineers of Japan. *Denki-Gakkwai, No. 3, 1-Chome, Yurakucho, Kojimachi-ku, Tokyo, Japan.—Prices Upon Request.*

Abridged Scientific Publications from the Kodak Research Laboratories (Volume XII) is a compendium of many important scientific papers published during 1928. *Eastman Kodak Company, Rochester, New York.—Gratis.*

Plans For Systems of Sewerage, Sewage and Waste Disposal is a 28-page pamphlet of particular interest to engineers engaged in the design of municipal, institutional, industrial, and private sewage systems. *Division of Sanitation, 23 South Pearl Street, Albany, New York.—Gratis.*

Index of Technical Reprints gives the titles and writers of numerous reprints issued by the Bell laboratories to date. *Bell Telephone Laboratories, Incorporated, 463 West Street, New York.—Gratis.*

Industry

The Oxford Process for the Production of Sugar from Sugar Beets is a report devoted to the development and costs of the Oxford dessication process, with statistics for comparing with the diffusion process. *Oxford University Press, 114 Fifth Avenue, New York.—85 cents.*

The Conservation of Industrial Acreage is a bulletin of the Pennsylvania Railroad showing the need for exercising wisdom and foresight in developing industrial property, and enumerates certain pitfalls to be avoided by owners of industrial property, leaders of business and civic associations, and municipal and state officials. Another recent publication of the company is entitled, What Two Pennsylvania Railroad Men Saw in South America. Their story is very interesting. *Information Service, Pennsylvania Railroad, Philadelphia, Pa.—Gratis.*

Lubrication in the Presence of Water, a special issue of one of the Texas Company's periodicals, discusses from various angles the problems concerning this type of lubrication and the most practical solutions thereof. *The Texas Company, 17 Battery Place, New York.—Gratis.*

Everything for Mine and Industrial Safety, including the Edison safety lamps, is a well-indexed 158-page catalog. *Mine Safety Appliances Company, Homewood Station, Pittsburgh.—Gratis.*

Carbon-Black in 1928, by G. R. Hopkins and H. Backus of the Bureau of Mines, presents complete statistical data and summaries of the carbon-black industry in 1928, when it set new high records for both production and sales, due in part to the steadily increasing demand for rubber automobile tires. The figures show a consumption of nearly two pounds of carbon-black per tire. Most of the carbon-black is produced in Louisiana, Texas, and Wyoming. *United States Government Printing Office, Washington, D. C.—Five cents.*

Natural Gas Pipe Lines in the United States is a map showing the location of natural gas pipelines, and the natural gasoline and carbon-black plants of the country. *Bureau of Mines, Department of Commerce, Washington, D. C.—50 cents.*

Medicine

San Francisco Cancer Survey, by Frederick L. Hoffman, is largely limited to Canada. The compilation is the fifth treatise of a series which began as a statistical survey of cancer on the Pacific Coast. *Prudential Insurance Company, Newark, New Jersey.—Gratis.*

Annual Report of the Medical Department of the United Fruit Company is a well-indexed 378-page book covering the work done during 1928 in controlling malaria on the plantations of the company, and describes improved designs incorporated in new hospitals erected during the year. The book contains many valuable contributions by research specialists of the staff and others, dealing with various tropical diseases and other subjects of medical interest. *Medical Department, United Fruit Company, 17 Battery Place, New York City.—Gratis.*

Biology

Paleontology and the Evolution of Man, by D. M. S. Watson is the view of a conservative paleontologist concerning man's evolution. *Oxford University Press, 114 Fifth Avenue, New York.—70 cents.*

Neanderthal (Mousterian) Man, by Oliver C. Farrington and Henry Field, narrates in easily readable style the present knowledge concerning a race which maintained its existence in Europe for a period estimated at almost 100,000 years, and then became extinct after contributing knowledge of the uses of fire, improved stone implements, the beginnings of family and communal life, and some rudiments of a religious belief. *Field Museum of Natural History, Chicago.—25 cents.*

Miscellaneous

Suggestions to Authors contains pertinent information concerning manuscript preparation and book manufacture, particularly for writers in the technical field. *McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City.—Gratis.*

Revised Encyclopedia of Caged Birds contains advice, suggestions, and information for pleasurable or profitable care of caged birds. Questions are answered concerning bird selection and breeding, treatment and feeding, diseases, types of cages, and methods for training certain types of birds. *Audubon Publishing Company, Louisville, Kentucky.—Paper 75 cents, cloth $1.50.*

World Power Conference, Second Plenary Meeting, Berlin 1930 is the title of a pamphlet which outlines the nature and purpose of the next World Power Conference. *Zweite Weltkraftkonferenz, Berlin NW7, Ingenieurhaus, Germany.—Gratis.*

Beyond the Electron, by J. J. Thomson, presents the author's view as to the complex nature of the electron and its accompanying waves. *The Macmillan Company, 60 Fifth Avenue, New York.—80 cents.*

Photography at Ease is a valuable little handbook designed to help the photographer, whether amateur or professional, to make better pictures. *Burroughs Wellcome and Company, Incorporated. 11 East 41 Street, New York.—Gratis.*

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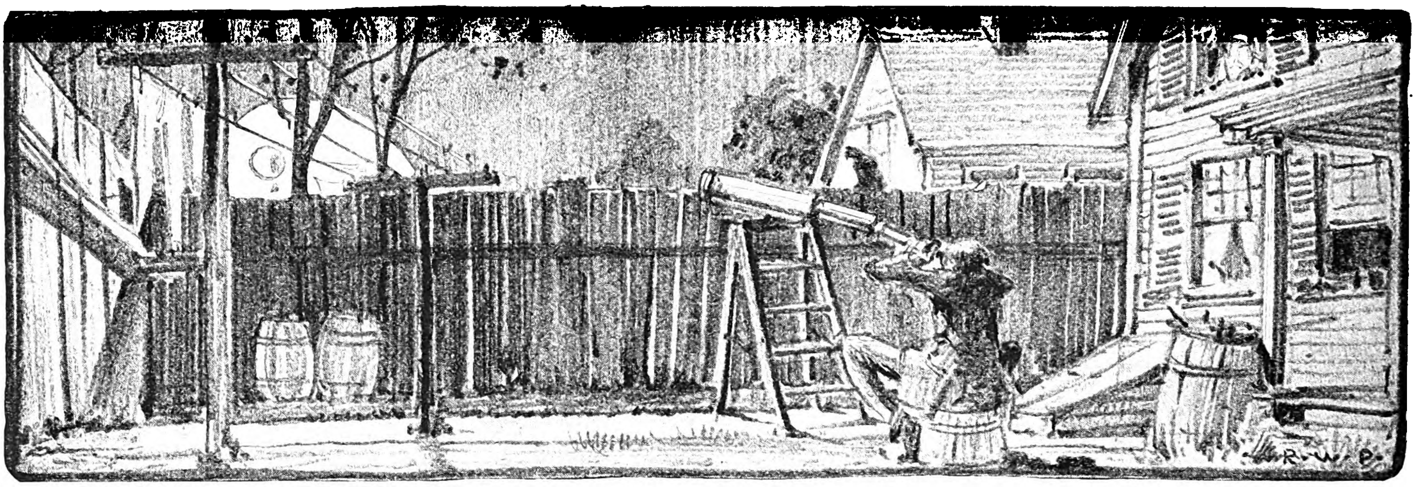


The Amateur Astronomer

THE hobby of the amateur telescope maker received its rebirth at Springfield, Vermont, several years ago, at the hands of a local society of amateurs, "The Telescope Makers of Springfield." We reproduce this month a winter photograph of "Stellafane," the mountaintop clubhouse of that famous society, taken by Oscar S. Marshall, its secretary. Before the mountain which "Stellafane" surmounts was officially renamed Mount Porter the neighboring farmers sometimes called it Breezy Mountain. It is so breezy in winter that the builders of "Stellafane" anchored each of the house's four corners to the Granite State by means of a steel cable let into the rock, so that the building would stay in the state during the Vermont winters. Amateurs who have visited "Stellafane" may behold it now shrouded in white, with the dead grasstops waving above the snowbanks, in the photograph.

ALL three of the other photographs this month are of lads who have taken up telescope making, the hobby which appeals to young and old. The first is Winston Juengst, Box 43, Croton Falls, N. Y., aged 16, who says he has scratches and a turned-up edge on his mirror, but such a good paraboloid nevertheless that the telescope "supplies a real thrill." Juengst is studying astronomy with seriousness. He plans an eight-inch telescope next, but this appears to be contingent on parental permission, as it seems he has also gone in for interior decoration, having redecorated the kitchen, where he made the first mirror, in red of a shade suspiciously resembling that of optical rouge.

Richard W. Aldrich, 626 East Washington Street, Hoopeston, Illinois, aged 17, sends a picture of a four-inch mirror which "took a long time to make but finally came out all right." The total cost was not over seven dollars, he says, the eyepiece being from a "Kopton" optical set. He gets a magnification of 104 diameters.

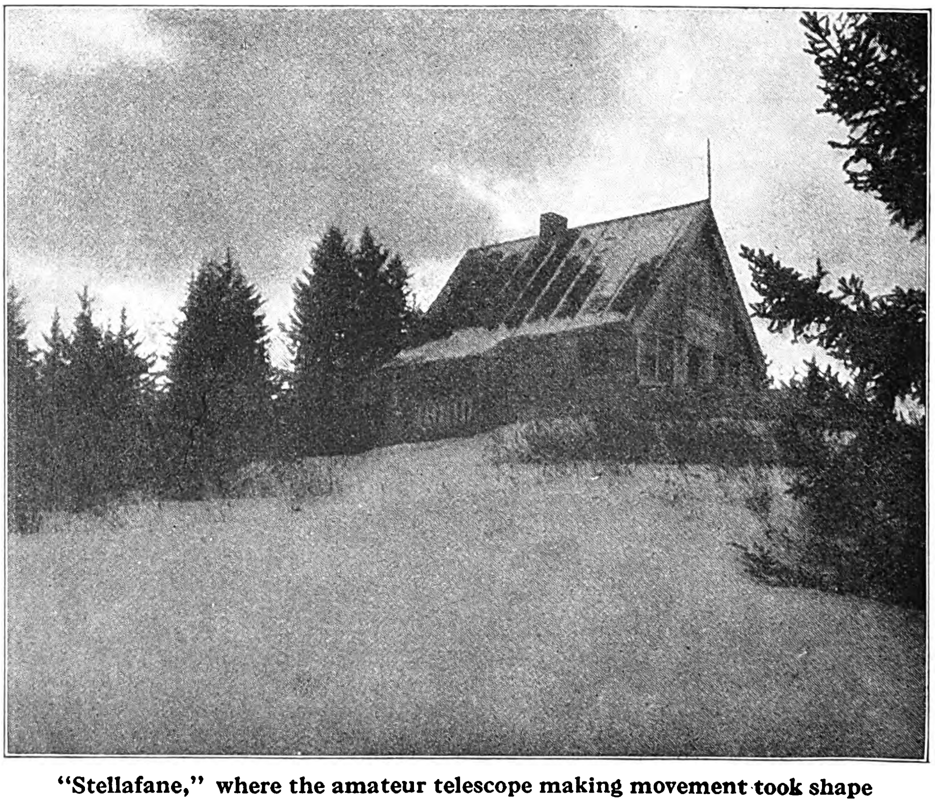
Reed Knox, Jr., of University Terrace, Deland, Florida, says he "sends us a picture of his telescope so far." It is his third attempt. He dropped No. 1 on a concrete floor and No. 2 refused to polish out, but each time he gains impetus. As he is still no more than 12 years old he has time to beat the 200-inch record about to be hung up. When he grows up he says he expects to be a professional astronomer. Probably Knox is our youngest amateur. Who claims to be our oldest?

LAST month we promised to publish an abstract of an article by Professor A. E. Douglass of the University of Arizona, entitled "Atmosphere, Telescope and Observer." This appeared in *Popular Astronomy* for June, 1897. Our abstract was sent to Professor Douglass with the idea that he might wish to alter it in the light of later experience, but he found nothing in it to alter. After all, however, the matters involved are basic and not a bit different in 1929 than in 1897, and therefore we make them available to our readers. Professor Douglass writes:

"Every astronomer knows that good seeing is not a matter of clouds and that the definition does not become superb merely because the atmosphere has become clear and perfectly transparent; on the contrary a certain amount of haze sometimes improves the seeing.

"Every possessor of a fair-sized telescope, has at hand a means whereby he may study the more obscure atmospheric conditions which accompany good and bad seeing and, at least in some cases, determine whether bad seeing is due to local conditions which may be evaded by moving a few miles, or to general conditions which may require a large change in latitude to correct. The means consists simply in placing the eye directly in the focus of the objective and watching the streams of air pass by overhead.

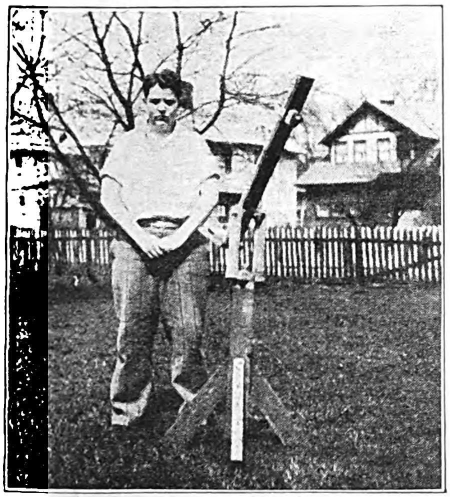
"The currents cast, as it were, their shadows on the objective and as all the light is concentrated in the focus, the eye can, without changing position, see all the irregularities in illumination which take



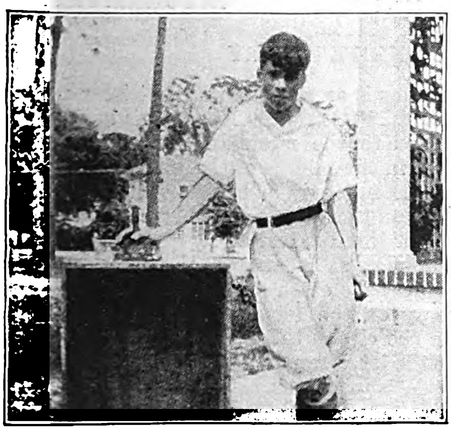
"Stellafane," where the amateur telescope making movement took shape

Winston **Juengst**

place over that area, that is, in the cylinder which extends from the lens to the limits of our atmosphere in the direction of the star. In the case of a planet of sensible diameter this volume is a truncated cone with its smaller end at the objective, instead of a cylinder. These differences of illumination are not real shadows but are condensations or rarefactions of light caused by the refractive power of the air. When, therefore, the objective brings all the light to a focus, the light from certain portions of the waves comes together inside the principal focus, and from other portions outside, so that an eyepiece may be placed behind these foci



Richard W. Aldrich



Reed Knox, Jr.

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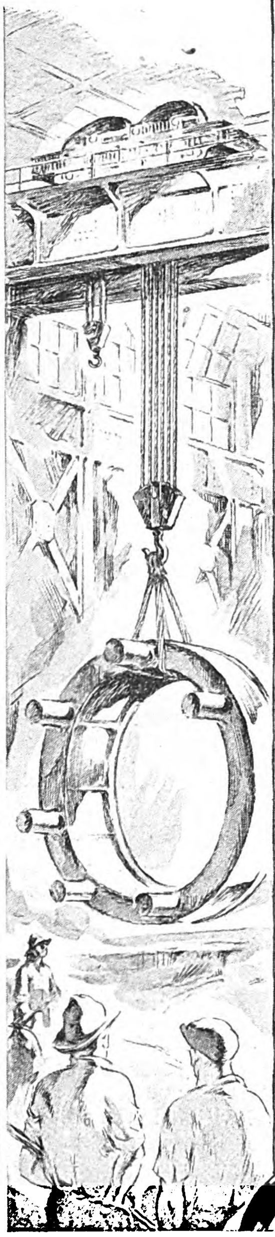

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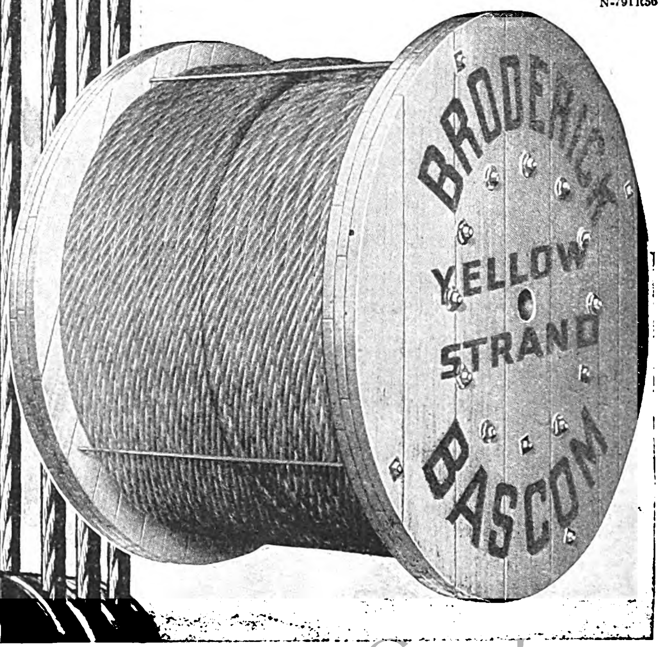

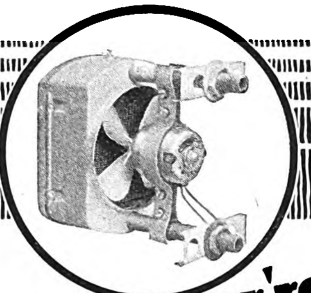

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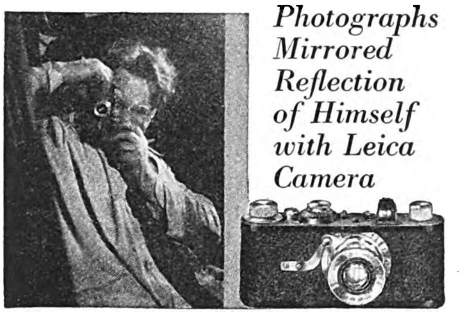

NICHOLAS HAZ, F.R.P.S.

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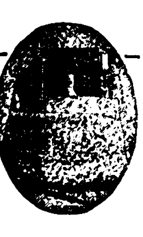


at proper distances and the waves seen through it.

"The currents of course are usually observed at night but they may be seen in the daytime by using a small diaphragm at the focus to exclude the greater part of the light of the sky. By day they are extremely handsome.

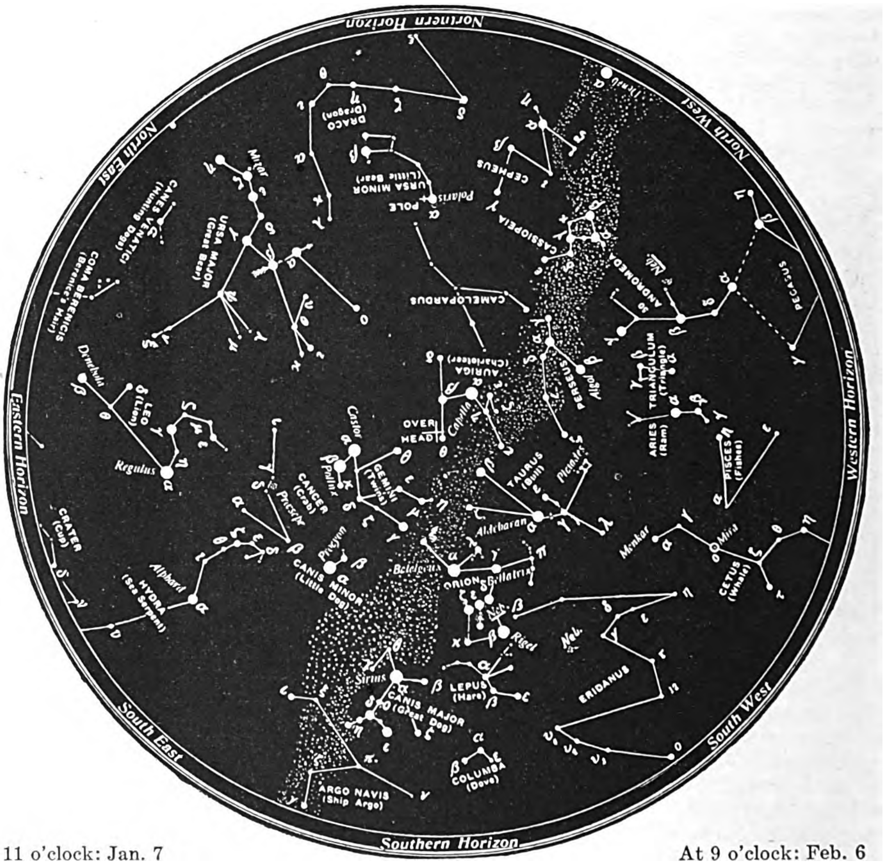
"In order to understand the subject better, let me cite a few familiar cases of the same or similar phenomena. The most ordinary instance is met with in sunlight upon shallow water. There, beneath each rising wave, the light is condensed, while beneath each trough the light is enfeebled. At a certain depth, depending on the character of the waves, the contrast between the crest and the trough is most marked. Upon going deeper the difference decreases, leaving finally only light and dark patches. I conceive the waves in the air to be very similar in their action, although having a different origin and with an extremely slight refractive power. These so-called waves are lines of irregular refraction in the air due to non-uniform density. The irregularities in density are due, I am convinced, to irregularities of temperature.

"Bearing in mind the foregoing facts in regard to the constant presence of air waves which are only a few inches apart and have a measurable refractive power, it is no difficult matter to deduce the conditions under which certain apertures become preferable."

Professor Douglass' discussion will be concluded in next month's number, when he will point out some limitations of the larger sizes.—*A. G. I., Tel. Ed.*

The Heavens in January

By PROF. HENRY NORRIS RUSSELL, Ph.D.


Northern Horizon
North East
North West
Eastern Horizon
Western Horizon
South East
South West
Southern Horizon
DRACO (Dragon)
URSA MINOR (Little Bear)
POLE
Polaris
CEPHEUS
CASSIOPEIA
CANES VENATICI (Hunting Dogs)
URSA MAJOR (Great Bear)
Mizar
COMA BERENICES (Berenice's Hair)
CAMELOPARDUS
ANDROMEDA
PEGASUS
AURIGA (Charioteer)
Capella
PERSEUS
Algol
TRIANGULUM (Triangle)
ARIES (Ram)
PISCES (Fishes)
Denebola
LEO (Lion)
Regulus
OVER HEAD
Castor
Pollux
GEMINI (Twins)
CANCER (Crab)
Praesepe
TAURUS (Bull)
Pleiades
Aldebaran
Menkar
Mira
CETUS (Whale)
CRATER (Cup)
HYDRA (Sea Serpent)
Alphard
Procyon
CANIS MINOR (Little Dog)
Betelgeuse
ORION
Bellatrix
Neb.
Rigel
LEPUS (Hare)
ERIDANUS
Sirius
CANIS MAJOR (Great Dog)
COLUMBA (Dove)
ARGO NAVIS (Ship Argo)

At 11 o'clock: Jan. 7
At 10½ o'clock: Jan. 14
At 10 o'clock: Jan. 22.
At 9½ o'clock: January 29
At 9 o'clock: Feb. 6
At 8½ o'clock: Feb. 14.
At 8 o'clock: Feb. 21.

NIGHT SKY: JANUARY AND FEBRUARY

MERCURY is an evening star when the year begins and may be seen low in the twilight, especially about the 6th when he is farthest from the sun (19° 15'). He then draws in rapidly and passes through conjunction on the near side of the sun on the 22nd. Venus is still a morning star but is so near the sun that she is substantially invisible. Mars is a morning star, rising less than an hour before the sun, and is hard to see. Jupiter is well visible in the evening sky and is due south between 8 and 9 P.M. during most of the month. Saturn is a morning star but can be seen only late in the month, and then with difficulty. Uranus is an evening star in Pisces setting about 11 P.M., while Neptune is in Leo and comes to the meridian between 2 and 3 A.M. in the middle of the month.

The moon is in her first quarter at 10 P.M. on the 7th; full at 5 P.M. on the 14th; in her last quarter at 11 A.M. on the 21st; and new at 2 P.M. on the 29th. She is nearest the earth on the 15th, and farthest away on the 1st and again on the 28th. As she circles the sky she passes Mercury on the 1st, Uranus on the 7th, Jupiter on the 11th, Neptune on the 17th, Saturn on the 26th, Mars and Mercury on the 28th and Venus on the 29th.

Chemistry in Industry

(*Continued from page 76*)

be spot-welded, rolled, drawn, hammered, and formed with ordinary tools. The value of the new metal is about half that of gold.

Chemical Jingles

THE following chemical rhymes by Thomas Stephenson, reprinted from a recent issue of *Industrial and Engineering Chemistry* will amuse anyone who has experimented in chemistry enough to remember that:

1. Silver nitrate, $AgNO_3$, is extremely corrosive and blackens the skin.
2. Calcium carbonate, $CaCO_3$, neutralizes sulfuric acid, H_2SO_4 with the liberation of carbon dioxide gas, CO_2.
3. Potassium cyanide, KCn, is a violent poison.
4. Copper sulfate, $CuSO_4$ comes in bright blue crystals.
5. Ammonium iodide is very explosive.
6. HgCl is calomel. $HgCl_2$ is bichloride of mercury.

Sam put $AgNO_3$
  In his ma's perfumery,
Thinking he would make a hit
  If he strengthened it a bit.
Now each morning little Sammy
  Goes to greet his Coal Black Mammy.

Johnny, feeling life a bore,
  Drank some H_2SO_4;
So his father, an M.D.,
  Gave him $CaCO_3$.
Johnny's neutralized, it's true,
  But he's full of CO_2.

Maudie was delighted when
  She found a lump of KCn.
"Daddy's fond of sweets," said she,
  As she dropped it in his tea.
Father drank it; that is how
  Maud's mamma's a widow now.

Tommy, eager to explore,
  Found some $CuSO_4$.
"Nice rock candy," Tommy cried
  As he jammed a lump inside.
Doctor pumped him out, it's true,
  But Tommy still feels rather blue.

Bobbie, in his careless glee,
  Mixed some I with NH_3.
When the stuff was dry and thick,
  Bobbie hit it with a brick.
Robert's now in heaven, they say;
  At least he seemed to go that way.

Auntie Jane gave Baby Sue
  A dose of $HgCl_2$.
Baby's with the angels now,
  And Auntie Jane is wond'ring how
A single atom of Cl
  Can make such change in calomel.

We Pay For Ashes

AN enterprising coal dealer in New York has been soliciting business with a personal letter that says, among other things: "No joke about it. . . . We're hauling the best kind of coal. . . . It's so low in carbon content that very little ash remains after burning."

Of course, there *is* a joke about it, and it's on the coal dealer. What he meant to say was that his coal is low in mineral

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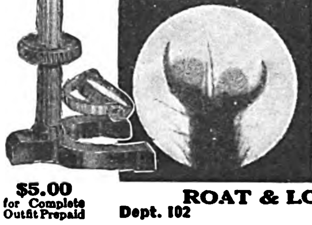

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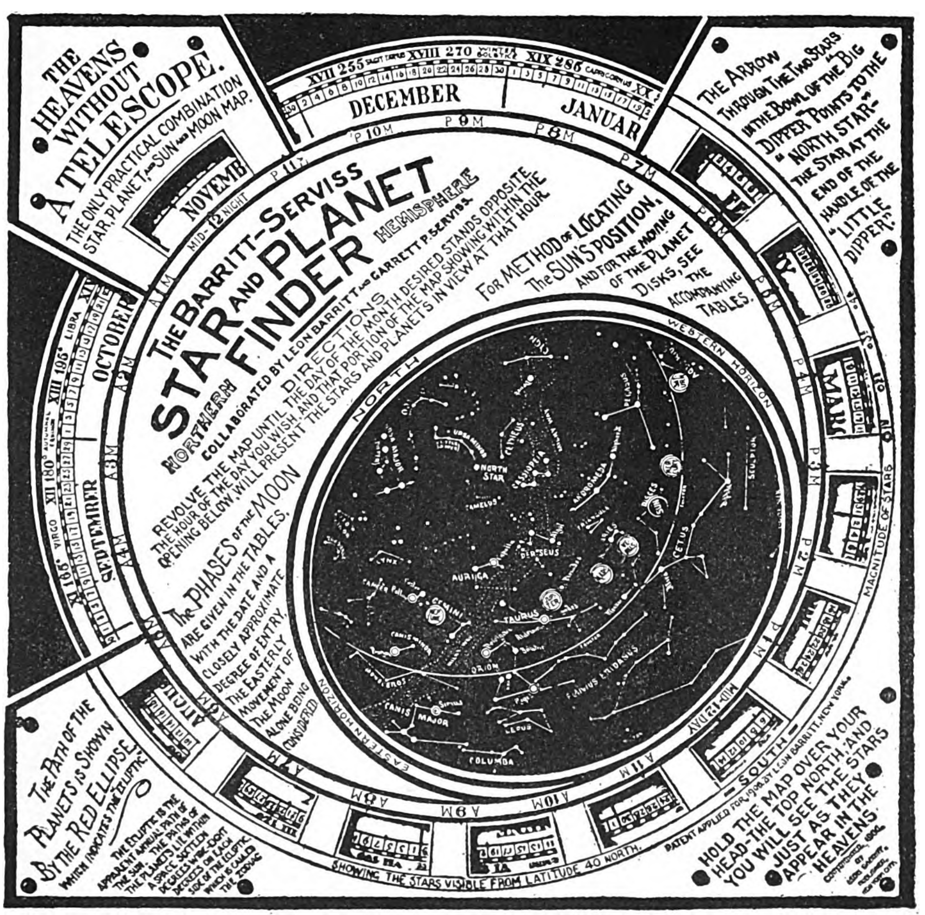
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FOR METHOD OF LOCATING THE SUN'S POSITION, AND FOR THE MOVING OF THE PLANET DISKS, SEE THE ACCOMPANYING TABLES.
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content. But the general subject of ash in coal is no joke, economically, for millions of dollars are paid in freight to haul the ash which is part of America's coal.

The handling of the worthless ash through the various steps in the distribution and utilization of coal is a large item in the cost of energy delivered at the power plant, says the United States Bureau of Mines in a recently issued bulletin. For example, 1 percent of excess ash in a 50-ton car of coal amounts to 1000 pounds of worthless material per car and entails a loss in transportation cost of one dollar per car where the freight rate is two dollars per ton. If we assume an average freight rate of two dollars and forty cents per ton on the annual production of bituminous coal in the United States during 1927, the transportation loss amounts to a total of 12,426,000 dollars for each 1 percent of unnecessary ash. Consideration of this one item alone shows the economic importance of dirt in coal.

The froth-flotation process, used extensively in the concentration of ores, has been applied within recent years to the separation of coal from ash-forming materials. Briefly, the process involves the agitation of raw coal, 1/10-inch in size or finer, with four to ten times its weight of water and a small quantity of reagent (0.5 to five pounds per ton of dry coal). The reagent with air forms a froth supporting the coal, which floats at the surface and may be removed, while the ash forming materials are largely rejected and remain in the bulk of the water and may be removed separately.

Many reagents may be used including certain oils, soluble organic substances, alcohols, and soaps. The process appears to be particularly applicable to coal that is originally fine or that is crushed to fine size as a part of normal preparation treatment, as for coking.

New Uses for Stellite

STELLITE, a cobalt-chromium-tungsten alloy, has been known as a cutting-tool alloy for many years. Now, due to the development of the Stelliting process, it is finding wide use in a comparatively new field, namely, resistance to wear or abrasion and to combined abrasion and corrosion, says W. A. Wissler, in a recent issue of *Chemical and Metallurgical Engineering*.

The demand for faster production and longer life for all machine parts subject to abrasion has resulted in the development of the hard-facing process, which consists in welding a surface of a wear-resisting alloy to an iron or steel base. This process produces a composite article having a surface of highly specialized alloy capable of resisting abrasion, combined with a steel or iron base that has ample strength and toughness to support the wear-resisting surface.

Such a composite part has great economic advantages as it will wear much longer than a solid steel or iron part and is much stronger and cheaper than if it were made entirely of the wear-resisting alloy. The process also permits the rebuilding of worn parts, thus extending their life indefinitely.

Stellite is being extensively used in many of the large industries wherever severe abrasion is encountered. Included are agricultural machinery, rock drilling and digging equipment, and dies for metal-forming operations. The paint industry uses this alloy on grinding and pulverizing machinery. Cement and cement clinker are both ground and conveyed with the help of Stellite. The active surfaces of colloid mills are being hard-faced with this alloy, as is also grinding and crushing equipment of all kinds.

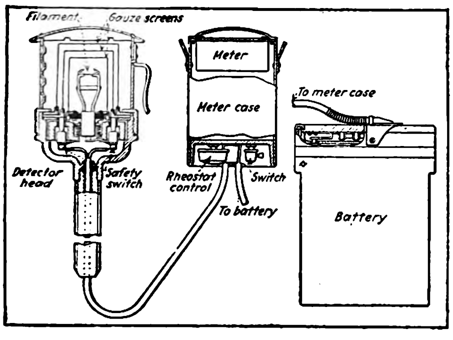
Electric Tester Shows Presence of Inflammable Gas

A NEW electrical tester used for determining the presence and amount of inflammable gases, was described in this department in our June 1929 issue. More detailed information is now available, showing how the detector operates. The device makes use of a heated metallic filament connected in one arm of a Wheatstone bridge circuit. Its use is based upon the fact that the burning of a combustible gas on the surface of a heated filament causes an increase in the temperature of the filament and consequently an increase in its resistance. If, when the bridge is in balance, the filament is exposed to a combustible gas-air mixture, the resultant combustion throws the bridge circuit out of balance, and current flows through the galvanometer, causing a deflection of the needle. The magnitude of this deflection is dependent upon the concentration of the combustible component.

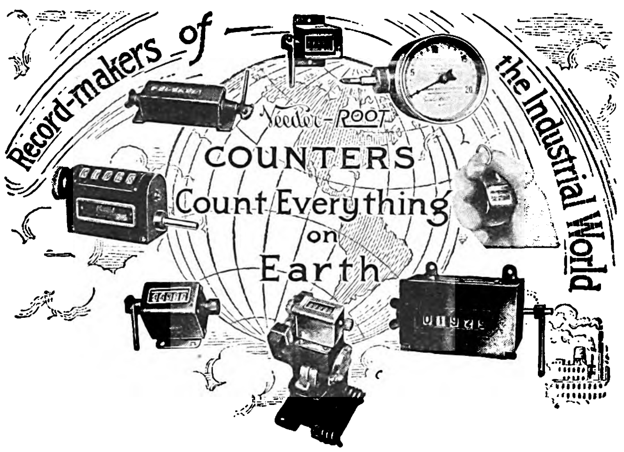
The illustration shows the apparatus partly in section. The detector head consists of a cylindrical metal case or bonnet, in which are three concentric, cylindrical gauze screens of a type similar to those used in flame safety lamps. These afford protection against ignition of an external gas-air mixture.

In operation, for instance in the detection of methane in mines, the operator first turns the switch to heat the filament. Then after a few minutes, when the filament has reached a temperature equilibrium, he connects the meter in the circuit. This is done while the detector head is in a vertical position in pure air. The rheostat knob is adjusted until the meter reads zero, after which the detector may be inserted into the atmosphere to be tested.

The atmosphere will penetrate the gauze screens and come in contact with the hot filament, whereupon, if any methane be present, the meter needle will immediately move and come to rest at a point indicating the percentage. If the gas mixture is of explosive proportions, the needle will move rapidly back and forth across the upper part of the scale, this oscillation indicating



Interior mechanism of electrical tester for determining the presence of dangerous gases in the atmosphere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recurring explosions within the inner screen which cause periodic cooling and heating of the filament.

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Phenol Prevents Mold on Leather

IT is a common experience to find mold on the surface of leather goods that have been stored away, particularly if the storage place is warm and damp. This tendency has caused no little trouble to shoe manufacturers because the growth occurs on sole leather during the process of manufacture.

In efforts to prevent this nuisance, the United States Bureau of Standards chemists have discovered that if the leather is soaked in a 0.2 percent solution of phenol, no mold forms. This simple expedient suggests that phenol or some phenol salt might be used to advantage in dressings for use on leather which is apt to mold in storage or in use, because of high humidity due to climatic or service conditions.

Learning to Use Our Wings

(*Continued from page* 73)

tion is the resistance of the dead propeller. Generally speaking, the propeller runs as a windmill and turns the engine over. The resistance is then much greater than when the propeller is completely stopped, because the power to turn over the propeller and the engine is obtained from the stream of air.

If the propeller is free to revolve and is disconnected from the engine, the resistance is smaller than that of the completely stopped propeller and much smaller therefore than the resistance of the propeller when turning the engine. There are two solutions available: to lock the propeller so that it cannot turn, or to fit it with a "free-wheel" mechanism. The latter and more effective solution is being tested experimentally. It constitutes a pretty mechanical problem.

European constructors are now following American practice in the matter of wheel brakes. One aspect of wheel brakes, which we have often discussed, is the possibility of turning over if the brakes are applied violently and the wheel center is not far enough forward of the center of gravity of the airplane. If on the other hand, the wheel is put well ahead of the center of gravity there is some difficulty in raising the tail at take-off. French designers are now meeting the difficulty by arranging an automatic brake release operative when the tail of the airplane rises. We hope to present shortly a description of this interesting device.

The main objectives of French effort are now safety in flight, the development of

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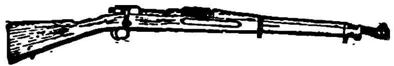

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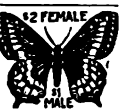

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commercial aviation, and improvement in metal construction. These objectives are akin to those of American aviation.

It is always troublesome and expensive to protect steel aircraft members against corrosion by the use of paints, varnishes, and and similar preparations. The British have apparently solved the problem by the electro-deposition of zinc and cadmium on steamline wires, tie rods, et cetera. They are also using stainless steel in their structures, with much success.

In American practice, the guiding of aircraft by radio has been accomplished by the projection of a radio beam, deviation from the path of which is indicated by a visual or audible signal to the pilot. The British have been more interested in giving an airplane its exact bearings. The system employed consists in having two or more direction-finding stations on the ground, which on demand from an aircraft take a bearing on the aircraft. These stations are usually grouped under a common control where the bearings obtained are correlated and the position of the aircraft determined and transmitted to the pilot. This system offers the objection that it requires the aircraft to be equipped with both a transmitter and a receiver and needs a certain amount of formal signal organization.

Now as a result of considerable research, a system has been developed which requires only a receiver on the aircraft and enables the plane to determine its position wherever it may be, provided only that it is within the range of the transmitter. The system employs on the ground what is termed a rotating beacon. This is a transmitter consisting of a simple loop. This loop is rotated at a constant speed of one revolution per minute. It transmits a characteristic signal when in the north and in the east positions.

If the aircraft pilot receives the north signal from the beacon and notes the time which elapses between the transmission of this characteristic signal and the receipt of the minimum signal, the bearing of the aircraft from the beacon is immediately obtained by multiplying the time in seconds by six. An installation consisting of two such beacons enables the plane to determine its position without having to transmit. The system is simple and requires no preconcerted signal organization.

Such a system might have considerable advantages over the American plan.

Beryllium for Aircraft

At the meeting of the Society of Automotive Engineers held during the Cleveland Air Races, the possible use of beryllium for aircraft construction was discussed. This is a most extraordinary metal. Its density is only that of magnesium or about two thirds that of aluminum, yet in strength and elasticity it is equal to steel. A 60 percent beryllium-aluminum alloy may have a tensile strength of 60,000 pounds per square inch and beryllium, if used for aircraft construction, has extraordinary possibilities of weight saving. One competent authority estimates that a Ford tri-motor plane could be lightened over a thousand pounds by the use of this new metal. Its main drawback is cost, which is now about 60 dollars a ton. If this can be reduced, particularly by sale of the by-products of beryllium ore, this material may become immediately useful to aircraft designers.

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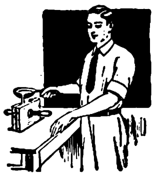

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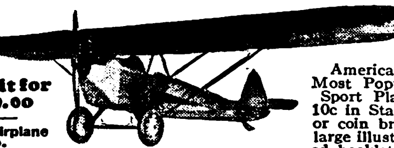

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By Katharine Bement Davis, Ph.D.
Formerly Gen'l Sec'y Bureau of Social Hygiene

IN an editorial which brought us a large number of inquiries when published in the February 1928 number, we foreshadowed the publication of this scientific book on sex. We stated then that, until the practical research to be summarized in it had been made, humanity actually knew more about the sex life of the other animals than it understood about its own; also that old and well-established beliefs about the prevalence of certain forms of sexual indulgence had now been found to be erroneous and very decidedly so —that is, that sex indulgence had been found to be much more general than most of us had previously believed. Almost to a certainty this book, now available, will upset a number of fondly cherished beliefs and may temporarily shake some readers' faith in the human race. Nevertheless it is a thoroughly scientific record of scientific work in sociology, performed by a noted scientific authority. The discoveries recorded were based on actual data secretly obtained, not on anyone's personal opinion. The book should be read seriously and its findings regarded in a scientific light. It contains no recommendations or preachments, being a citation of fact. 418 pages. $3.70 postpaid

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On Board the Emma

By Alexandre Dumas

A NEWLY discovered, previously unpublished work by the famous author of "The Three Musketeers." All appreciative readers of Dumas will welcome this publication which fills in hereto unchronicled years; the second part relating his campaign with Garibaldi's "Thousand" in Sicily.
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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

"Eskimo Pie" Patent Held Invalid

DESPITE the fact that "Eskimo Pie" had achieved almost phenomenal success commercially, having a marked effect upon the ice cream and confectionery industries, it has been judged unworthy of protection under the existing patent. This decision, rendered by the Circuit Court of Appeals for the Third Circuit, upheld the ruling of the lower court that there was no invention in coating a block of ice cream with chocolate.

The holder of the patent, Eskimo Pie Corporation, had brought suit for infringement against John Levous and Purity Ice Cream Company in the District Court for the District of New Jersey. The defendants admitted that if the patent were valid it was infringed, leaving the court to decide upon the question of validity.

In holding invalid the patent granted to C. K. Nelson (Number 1404539) in 1922, for a chocolate covered rectangular block of ice cream, the court gave credence to earlier references which described the manufacture of "ice cream cannon balls." These confections were round balls of ice cream covered with chocolate in the manner that candies are coated. The appellant contended that the Eskimo Pie coating is a "sustaining and form-retaining casing," unlike the coating used for the "cannon balls" and candies. In the opinion of both courts, this claim was not substantiated and there is no invention in merely changing the shape or form of an article without changing its function, except in a design patent.

In a doubtful case of this kind, the fact that a patented article has gone into general use has great weight, but in this instance it was held that commercial success is an unsafe criterion even of utility and much less of patentability. It was pointed out that such success may be due to extensive and judicious advertising, activity in putting the goods upon the market, large commissions to dealers or the attractive manner and form in which the goods are put up and exposed to the eyes of the purchasers. Moreover, the court decided, when an article is sold under a trademark, commercial success may be due to a large extent to an attractive name used as a catch word.

New York courts are apparently more charitable than New Jersey courts, for in the somewhat analogous case concerning the process for making ice cream lollypops, the genius of the inventor is recognized. In the latter case, the District Court for the Southern District of New York ruled that the Burt ice cream lollypop (Patent Number 1470524) was valid and infringed. The Popsicle Corporation et al had brought suit for infringement against Isadore Weiss, doing business as Goody Frozen Products Company.

Various patents were citied in an attempt to show that the Burt patent was lacking in patentable novelty. One of these was a patent to Goldberg (60136) in which a stick was inserted into candy while the candy was in a warm, soft, sticky condition; upon cooling, the stick became rigidly fixed to the candy. However, the Court upheld the Burt patent, stating, "It is one thing to insert a stick in a warm, soft, sticky substance that by cooling will adhere thereto, and quite another to effect a strong union between a stick and frozen substance." Other prior patents had disclosed a handle of metal and a flexible looped cord frozen into a block of ice cream, but they were held not to anticipate the use of a wooden stick.

Motion to Dismiss With Prejudice Denied

IN the suit of A. C. Gilbert Company *versus* United Electrical Manufacturing Company, in the District Court for the Western District of Michigan, the court denied a motion for dismissal of the bill with prejudice on the grounds that the case must be settled on its merits. Both firms are manufacturers of electrically operated devices, which are used for the same purposes and are sold by plaintiff and defendant in competition. The plaintiff filed a bill of complaint and then sent circulars to the trade and to the defendant's customers, asserting that the defendant's devices were infringements on patents of the Gilbert company.

Later the plaintiff filed suit against one of the defendant's customers in another jurisdiction, and desired for convenience to try the matter at the latter place. With this end in view, the plaintiff filed a motion to dismiss without prejudice the original suit. The motion was opposed by the defendant on the ground that in view of the publication of charges asserting infringement, a prejudice was left in the minds of defendant's customers without opportunity on his part to disprove the charges.

In its decision, the court held that the publicity given the matter must have had a detrimental effect on the business of the defendant. In the opinion of the court, "this effect is of such nature as would not be removed if the bill of complaint herein be voluntarily dismissed. . . . Such damage to defendant's reputation and business standing can only be removed by a judgment of the court deciding the controversy on the merits." The court held also that the defendant cannot use the conduct of the plaintiff as a ground for dismissal of the bill with prejudice while relying on such conduct as a ground for opposing the dismissal of such bill without prejudice.

White Light from Electrified Gases

SINCE George Claude produced light with the first practical electrified gas-filled tube, utilizing neon gas, engineers have been seeking to perfect an optically clear white light of the same type as the red light produced with neon. The principal difficulty has been to produce a gas yielding a white light, having sufficiently long life to be commercially practical. Engineers of Claude Neon Lights, Incorporated, have developed what seems to be the desired white light, possessing the characteristic brilliance of electrified gaseous light without imparting glare or eye strain.

It is contended by the advocates of luminous tubes that the ordinary electric incandescent lamp incurs a waste of more than 75 percent of the electric current, because of the heat that must be generated before the filament provides illumination. In the gaseous tube type of electric light, advantage is taken of the fact that the inert gases of the atmosphere are conductors of electricity, and consequently an electric current can be passed through a gas-filled glass tube without the use of wire filaments. The action of electricity on the gas creates the luminous glow which has become so familiar in advertising displays. This glow can be controlled in density and color.

The new white light is said to render greater visibility with less actual candlepower than is required when using incandescent lamps, with considerable saving in electric current consumption. Because it is a comparatively cold light, it is said to be adaptable to under-water illumination and various cold weather conditions. The new white tubes possess brilliance and intensity comparable with tubes of red, blue, green, yellow, and other colors.

Just the Inventor

AN engineer, explaining the operation of a certain machine in a factory, was very much annoyed by the frequent interruptions of a certain man. Exasperated, the engineer refused to continue and walked away.

"Who is this fellow who pretends to know more than I do about this machine?" he demanded, when he met his employer.

"Oh, he is the man who invented it," was the reply.

Patents in Czechoslovakia

NUMEROUS aeronautical patents have been issued recently in Czechoslovakia, including one (Number 26383) which enables an airplane, in the event it alights on steep ground, to be protected against tilting over. Another (Number 25798) makes it possible to secure the simultaneous release of an airman and parachute by merely pulling a lever, which frees the parachute so that when the airman jumps the 'chute is pulled away from the plane, opening automatically. Patent Number 25809 facilitates the opening of the parachute at the moment when the flyer jumps from the airplane.

According to a report compiled by Dr. Kunzl, Departmental Chief of the Patent Office of Czechoslovakia, the applications for patents received during 1928 numbered

8461 or 698 more than in 1927. The number of new patents granted in 1928 was 3450. Every year sees an increased interest in the protection afforded by patents. Many of the applications come from the United States, which ranks next to Germany in the number of foreign applications received. Electrical machinery and equipment, chemical processes, and various kinds of apparatus are the most popular fields for invention, according to the report of Dr. Kunzl.

As in other parts of central Europe there has been a marked increase in popular interest concerning new technical developments during the past few years, although the world-famous Czech handicrafts are still flourishing, providing a livelihood for thousands of impoverished families. An association known as the Detva is active in keeping alive the peasant customs and folklore of a people who can look back upon a thousand years of history and tradition, and the Red Cross has provided funds for Czech children in the schools to be taught how to make toys, ornamental beads and small wooden figures which find a ready market in Europe and America. The Red Cross hopes to enlarge this work to teach the children to make embroidered bags, laces, and ornamental lamp shades, for which there is a constant demand. In some of the mountainous districts where most of the adults eke out a living as weavers and glass makers, the children have been able to provide themselves with excellent schools largely through the money they have earned by pursuing their native handicrafts.

British Inventor Perfects Message Recorder

LOUIS BLATTNER, noted for his invention of the magnetic steel wire system of recording "talking pictures," which is said to produce records that are virtually everlasting, has perfected a telephonic recording machine which is said to automatically record and file telephone conversations or communications. The record is available as soon as the conversation ends. It is pointed out that telephonic messages can be received and recorded late at night without disturbing friends, or at places of business outside of working hours. The patents are held by the London Blattner organization and the Telegraphic Patent Syndicate of Berlin, which joined forces recently under British control.

Fire Extinguisher Patent Not Infringed

ACCORDING to a ruling issued in the case of Foamite-Childs Corporation versus Pyrene Manufacturing Company, the Laurent patent now owned by the plaintiff has not been infringed by the defendant's apparatus used for the same purpose, which is not constructed with a mixing chamber within the device. The case was an appeal from the District Court for the District of Delaware, in which the plaintiff had brought suit against the defendant charging infringement of United States letters patent 858188 issued to Mr. A. G. Laurent of Russia, on June 25, 1907. As the bill was filed in 1924, only a few weeks before the patent expired, the plaintiff did not seek an injunction.

Although the plaintiff in his suit for infringement of the patent claimed otherwise, the court held that the claims in suit were limited to chemically operated foam entinguishers which, although perhaps not having mechanically complete mixing chambers, nevertheless are constructed with a chamber sufficiently complete to enable the apparatus to operate as described in the patent. In reaching this conclusion, in was held that although the claims not in issue include, in terms, a "mixing chamber," and the claims in issue do not include such terms but state that the substance is mixed, the claims in issue must be limited to include a "mixing chamber" to avoid the prior art. Judge Buffington dissented to this view.

It was also stated that where claims do not specifically call for a "mixing chamber," they may be interpreted to do so when the specification states that a mixing chamber is essential. In his dissenting opinion, Judge Buffington pointed out that the distinguishing feature of both extinguishers is the fire-blanketing foam, that the plaintiff was the only maker in America of such apparatus until 1922, and that the defendant began making and selling foam extinguishers in 1922, two years prior to the expiration of the Laurent patent. The Pyrene company had been previously selling soda and acid extinguishers in competition with the foam-producing apparatus. The proof offered in the suit showed that the older type of extinguishing equipment has been completely superseded by the foam extinguisher. In stating his reasons for believing that the patent should be held valid and infringed, the dissenting judge cited the fact that the Laurent invention is embodied in a generic claim as follows:

"A fire-extinguishing apparatus, comprising a receptacle containing separated gas-producing fire-extinguishing substances and a foam-producing substance which causes the substances to produce a gas-filled foam simultaneously with the evolution of gases."

In centering the case around the mixing chamber necessary for the production of fire-extinguishing foam, the Court of Appeals sustained the decision of the district judge, who had dismissed the bill of complaint on the ground that the Laurent patent was not infringed because the claims in suit must be limited to chemically operated foam extinguishers. Such extinguishers, although perhaps not having mechanically complete mixing chambers, nevertheless are constructed with a chamber sufficiently complete to enable the apparatus to operate as described in the patent. The defendant's apparatus was not so constructed, according to the Court, and consequently there was no infringement. The dismissal of the bill was affirmed.

Sanitary Robot Vends "Hot Dogs"

PATENT 1716266 has been granted to Alexander Flamm of Bridgeport, Connecticut, for a vending machine which cooks and seasons frankfurters, places

Patents Recently Issued

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Pertaining to Aeronautics

LONGERON FOR AEROPLANES—Formed from four metal tubes connected by means of rigid struts and wire diagonals with adjustable tension, the lines of action of stress all passing through the central axis which serves to support the strut. Patent 1731157. Gianni Caproni.

AIRSHIP CONSTRUCTION—Wherein the wings are disposed in somewhat compact form adjacent the propellers thus obviating the additional weight created by outspreading wings, and aiding in lifting the ship which may be automatically righted without aid of the motor power. Patent 1731348. Marshall R. Myers.

AIRCRAFT LANDING—Wherein mechanism, including a hooking device, at the top of the aeroplane is caught by a cable suspended between two captive balloons and the aeroplane subsequently lowered to the ground without being subjected to damaging shocks. Patent 1731091. Harr C. Belleville.

AEROPLANE—Constructed with means under the pilot's control for dropping the engine and gas tank in case of necessity, and releasing parachutes connected with the fuselage so that the plane and its occupants may be brought in comparative safety to the ground. Patent 1733030. Morris D. Rosenblum.

Pertaining to Apparel

ARCH SUPPORT—Embodying a metallic plate interposed between the inner and outer sole of a shoe for holding the inner sole in such form as to embrace the arch and support the metatarsal bones of the foot. Patent 1731106. William D. Moore.

COLLAR PIN—For holding soft or semi-soft collars, wherein the front bar of the pin has a necktie receiving recess which will prevent the necktie from being pushed outwardly, as is the case with a straight pin. Patent 1731163. Stanley L. Gedney.

STRAW HAT CONSTRUCTION—In which a mechanical or non-adhesive means is employed for securing down the pointed projections of straw braids in flat contact with the next adjacent convolution, whereby a lighter and more flexible hat is produced. Patent 1733075. Philip Rosenberg and Albert Jaeger.

Chemical Processes

METHOD OF WATERPROOFING FABRICS—Wherein cloth is given a coating of pyroxylin, which is a solution of nitrocellulose, solvent, plasticizer and gums, on one side, subjected to a finishing action, and treated with a second pyroxylin coating, which leaves it flexible. Patent 1732121. Kenneth B. Church.

ALKALI-METAL COMPOUND OF A SUB-OXIDE OF TITANIUM AND DERIVATIVES THEREFROM—Sodium orthotrititanite—a new alkali metal compound of sodium and titanium in which titanium exists as a sub-oxide $Ti_3 O_5$. One of its forms is dense bluish colored powder unsoluble in but hydrolyzed by water. The formula being $2Na_2 OTi_3 O_5$. Patent 1731364. Foord von Bichowsky.

Process for Recovering Borax from Brine—More particularly the brine of Searles Lake, California, whereby it is possible to obtain carbonates of soda in the form of large crystals, easily separated from the mother liquor, and quickly washed clear of adhesive brine. Patent 1733537. Henry D. Hellmers.

Designs

Design for a Paper Napkin or the Like—Patent 79610. Edwin B. Schoonmaker.

Design for a Fabric—Patent 79599. William H. Mayer.

Design for a Hub Cap—Patent 79653. George L. Hall.

Design for a Combined Lamp, Ash Tray, and Lighter—Patent 79656. Charles W. Hopes.

Design for a Radiator-Cap Ornament—Patent 79550. George A. Briggs.

Design for a Radiator Cap—Patent 79718. Fred A. Holloman.

Electrical Devices

Electric-Light Fixture — In two parts, one of which may be secured to the stud at the outlet, the other providing some freedom of movement between the body of the fixture and the part secured to the stud. Patent 1732087. Richard Hammerly.

Of Interest to Farmers

Hog Greaser—Which is simple in construction, yet rugged and durable in use, may be readily charged with grease, and in which a positive feeding of grease against the bodies of the hogs is assured. Patent 1731181. William E. Shimp.

Agricultural Machine — A cultivator or harrow expecially adapted for use with an attachment, to Ford tractors, for cultivating the soil beneath low branches and close to the trunks or main stems in orange groves or orchards. Patent 1731925. Levi C. Hester.

Fruit-Gathering Device—Consisting of a pair of cutters and a receptacle, the cutters being so constructed as to be operated by one hand, and automatically sharpening themselves, the receptacle may be readily emptied, particularly adapted for gathering cherries. Patent 1732252. Amasa O. Blue.

Of General Interest

Ventilating Awning—A Venetian blind which may be raised and lowered to desired positions, and the slats manually operated and adjusted to various angular positions for any degree of ventilation. Patent 1729928. Charles L. Dabney.

Concrete Wall Construction—In which special slabs two inches in thickness are secured in vertical relation edge to edge and locked into reinforced concrete columns poured in place, easier to erect, and cheaper than solid concrete, for certain purposes. Patent 1729293. Charles E. McCartney.

Holder for Graphic Instruments—Adapted for holding a fountain pen or other closely analogous instrument conveniently disposed in an angular position, the holder will accommodate and yieldingly or tensionally hold pens of different sizes. Patent 1730287. Ernest Oldenbusch.

Book Cover—Particularly adapted for account books, to protect them from the usual wear and tear, the cover is provided with means whereby a metal plate may be applied to serve as a hard writing pad. Patent 1730244. Rudolf Reinisch.

Universal Plug Valve—So called because it can be made to replace any type valve, and will prevent leakage or escape of fluid, gas, liquid, etc., no packing being necessary and no extra space necessary in operation. Patent 1730305. George Stancu, Jr.

the "weenie" in a toasted roll which is automatically slit, and transfers the sandwich to a sanitary wrapper which mechanically closes around the contents. The chief claim for the device is that it keeps the food free from dust. The machine is controlled by electricity, and is operated by the insertion of a coin.

Origin of Our Patent and Copyright Laws

Delving into Colonial and early American history, according to Karl Fenning in a recent issue of the *Journal of the Patent Office Society*, one finds that there was no debate or controversy concerning the patents and copyrights clause of the Constitution. According to Mr. Fenning, the patent statutes and the copyright laws of the United States are based on a section of the Constitution which does not employ either of the words "patent" or "copyright" but reads as follows:

"The Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

General Charles C. Pinkney of South Carolina played a leading part in having the Constitutional Convention authorize protection for both authors and inventors. As early as 1784, South Carolina enacted a statute for protecting inventions. Prior to this time, according to Mr. Fenning, there had been several states with copyright laws but none that had made provision for patenting inventions. After providing for copyright protection of books, the South Carolina Act said:

"The inventors of useful machines shall have a like exclusive privilege of making or vending their machines for the like term of 14 years, under the same privileges and restrictions hereby granted to, and imposed on, the authors of books."

Of course, it is pointed out by Mr. Fenning, "copyright and invention patent protection was extended to the colonies by the English laws, and the meaning of the words 'patent' and 'copyright' were more or less fixed. The laws of five of the States, namely, Connecticut, Georgia, New York, and North and South Carolina, had definite requirements for publication of copyrighted books in sufficient numbers and at a cheap enough price to satisfy the public demands.

"Those requirements were, of course, impressed upon the patent clause of the South Carolina statute, and apparently became a requirement to manufacture the patented device and to sell it at a reasonable price. Some of the state laws provided that if these requirements for publication and sale were not carried out a tribunal might grant a license to someone else to publish.

"It is significant, therefore, that in framing the Constitution in its final form, the words patent and copyright were not used, possibly lest the power be limited to the particular forms of conditional exclusive rights which were at that time known as copyrights and patents. The words finally chosen for the Constitution seem to allow no limitations on the 'exclusive' right such as requirements for working or compulsory licenses. It seems clear that it would be unconstitutional for Congress to endeavor to provide for either type of limitations in either patents or copyrights."

Joint for Corrugated Boxes—Especially designed as a corner connection for a box of the foldable type, to be employed in lieu of connecting the meeting edges with a strip of tape which is the common practice. Patent 1731111. Morris C. Romer.

Glass Protector for Windows and Doors—In the form of a metal strip with reinforcing pad, which may be quickly applied to the surface of plate glass windows for protecting the glass in cases of severe wind storms. Patent 1731114. Martin E. Sparrow.

Rod-Supporting Means—For awnings and canopies, a union consisting of rod end receiving sockets for connecting together the sections of an unusually long rod and rigidly supporting and preventing sagging of the same. Patent 1731113. Fred W. Siegel.

Recording Device for Cameras — Which will operate in conjunction with the shutter for photographically registering on a portion of each film or plate certain information, such as time of exposure, and "stop" used, which will appear when the film is developed. Patent 1731198. Frank J. Kawatch.

Reflecting Device for Motion-Picture Projectors—Whereby an adjustable auxiliary reflector, added to the main reflector, will enable the operator to simply and efficiently control the distribution uniformity and intensity of the light with accuracy as it is projected on the film. Patent 1731104. William Mayer.

Ring Setting—Having a mounting with swiveled connection which permits the setting to be reversed to expose different stones, the setting also being hinged between the stones or ornaments so that it may be opened to expose a picture or other enclosure. The inventor has been granted two patents, 1731092 and 1731190. Charles Birnbaum.

Toothbrush—Having brush head sections which may be converted from a convex surface to a concave surface, or vice versa, the brush head being held by a latching means. Patent 1731751. William M. Neissl.

Nursing Bottle—So constructed that air will enter at the bottom instead of at the top thus causing an easy flow through the nipple, leakage being prevented through a valve. Patent 1732126. Joseph P. Gardiner.

Collapsible Barrel—Wherein a plurality of hingedly connected sections may be readily disconnected, permitting storage in a limited space, the barrel may be readily assembled or dismantled without the use of special tools. Patent 1732128. Harley A. W. Howcott.

Humidifier—Constructed to utilize the waste heat from the smoke pipe of a heating plant to warm and vaporize a spray of water for producing the proper moisture into the air of a home or other building. Patent 1732055. Wiliam P. Lee.

Internal Control for Dumb-Waiter Doors—Which will prevent the occupants of apartments opening and leaving open the door, which becomes a source of great danger, the door opening only on signal from the janitor that the elevator is at the apartment floor. Patent 1731349. Holger Petersen.

Guard for Gutters—In the form of a screen for roof gutters, or eaves troughs, for preventing leaves and rubbish from entering the gutter and clogging the drain pipes, and so preventing the same from overflowing. Patent 1732058. Martin M. Martini.

Type Clamping Attachment for Chases—In the form of a bar attached at its opposite ends to one side of the chase, and elements threaded through said bar for clampingly engaging the type, and relieving the chase side of warping strains. Patent 1732074. Andrew B. Weiler.

High-Light Stop for Cameras—A light stop plate having grouped light openings assembled in polygonal formation with opposite corners of a diagonal of the figure disposed in the longitudinal median line of the plate. Patent 1732051. Carl G. Johnson.

Shower-Bath Spray—Wherein hot and cold water are delivered simultaneously, through separate pipes, so that the water strikes the body in the form of a hot stream encircled by a stream of cold water, giving a very exhilarating shower. Patent 1733054. Edgar J. Crill.

Envelope Opener—In which, through the co-operation of two blades, the extreme edge of an envelope is cut away and separated from the body so as to cause the envelope to be opened along an entire edge. Patent 1731413. Richard Glasser.

Corrugated Roofing and Building Sheet—Comprising a duplex corrugated sheet formed by uniting two separate preformed sheet elements, the outer one being of asbestos cement and the inner of compressed cork-board sections, the two being cemented together by a jointing cement. Patent 1732368. Louis Lane.

Educational Device—Comprising an alphabet display means, having the consonant letters and the vowel letters colorably distinguished from each other, to aid in or otherwise facilitate the teaching of correct spelling and increase the average individual vocabulary. Patent 1732980. Althea S. Mooney.

Container—Having a restricted tubular member with closure, in open communication with the container, through which material may be removed from the container while preventing too great a surface of the contents being exposed to the atmosphere. Patent 1733889. John Laughlin.

Insect Trap—Or catching device, which has conically shaped members open at opposite ends, which will aid in guiding an insect into a chamber, divert it away from the original passage it entered and prevent its escape. Patent 1733818. Carl J. Nordstrom.

Crutch—Having a resilient tip or bottom, the resilient features consisting of a spring, a rubber ball and a cylindrical sleeve for holding both the ball and spring in conjunction with one another. Patent 1733430. John L. Shahan.

Heating and Lighting

Damper Control—In which a manually operated wheel revolved through a complete revolution will move the damper through a small angular degree to give a minute draft control, and will maintain the damper in any desired position. Patent 1733832. Charles H. Sparklin.

Hardware and Tools

Pipe Cutter—Having means for advancing the cutter, for cutting pipe or other cylindrical objects, during the act of turning the stock upon such objects, thus, in effect, bringing continuous cutting pressure to bear. Patent 1732160. Richard T. Frye.

Cable Clamp—Including a cable-receiving body member having bifurcated portions which are adapted to receive a clamping member which is adapted for threaded engagement to control the tension applied to cables received therethrough. Patent 1732033. Edwin B. Snead.

Nut Lock—Which may be applied to any standard bolt, thereby dispensing with specially constructed bolts, means being provided and actuated by the rearward rotation of the nut for firmly locking the same against such rotation. Patent 1731337. Sebastian Giovannini.

Pipe Wrench—Which has a positive and instantaneous grip, great freedom of release, and is adapted to be instantaneously reversed without taking it off the pipe, a locking notch preventing any accidental loosening from the pipe. Patent 17456. (Reissue.) Oscar Johnson.

Cable Fastening—A strong and durable fastening device which will securely anchor a cable to a post and permit the former to be subjected to a maximum strain without becoming detached, yet in case of breakage of any one of the elements they may be quickly replaced. The inventor has been granted two patents, 1732053 and 1732054. Omar K. Landis.

Adjustable Ratchet Wrench—Adjustable to suit a variety of objects such as nuts, wrench sockets, square or other bars, is adaptable to all the standard sizes of sockets so that it may be regarded as a universal handle. Patent 1733012. William F. Henderson.

Machines and Mechanical Devices

Grinding Machine—Particularly adapted for boring or reboring the cylinders of engines, which can be secured to the cylinder, by the same bolts which secure the cylinder head, and attached in place of a cylinder head. Patent 1729288. Frank S. Harrell.

Alarm Mechanism for Clocks—Which first renders operative a relatively mild alarm and signal light to gently awaken the sleeper, and subsequently sets into operation an alarm bell, the device may be conveniently associated with many conventional alarm clocks. Patent 1730276. August J. Kollman.

Tire - Patch - Cutting Apparatus—A belt-knife splitting machine, which facilitates the making of tire patches from old and used tires, and forms the patches uniformly, accurately and quickly, and insures patches of perfect shape for tires or other articles. Patent 1731132. Adolph R. and Charles Hendry.

Pump Plunger—Adapted for pumps employed in mines for removing water and other liquids, wherein the main part of the plunger is formed of vitreous material and the metal parts formed of acid resisting metal. Patent 1731147. Fred W. Moyer and Frank J. Reninger.

Derrick Cap—Which will adjust itself to the pull of the guy cables without causing any binding between the cap and gudgeon pin, will permit the mast to swing in any direction, and may be repaired without dismantling. Patent 1731121. Edward P. Bathurst.

Drill Stem—For use with well equipment, will stand a maximum of vibration, comprises telescoped tubes and a threaded head at each end, each having connecting means with the drill stringer and the drill bit. Patent 1731171. Jesse P. Miller.

Cableway—An overhead travelling system that is capable of carrying loads and depositing them at any point within a prescribed three dimensional space, particularly adapted for use in the construction of dams and bridges. Patent 1729964. Verne L. Peugh.

Display Case—Having mechanism whereby lead pencils or other articles are attractively displayed and readily accessible for purposes of sale, or other authorized purposes, yet reasonably safe against removal by an unauthorized person. Patent 1732173. Sverre R. Svendsgaard.

Cutting Mechanism—The inventor has been granted two patents, for fabric cutting mechanism, one for cutting strips on the bias of predetermined length and width, and for protecting the cutter, the other having a cutter arranged for cutting a piece of fabric at any desired angle, within a certain range, into strips of various lengths and widths. Patents 1732148 and 1732149. William R. Barrett.

Hoisting and Transporting Device—A structure which is adapted to be set up over a hole communicating with a basement for hoisting cans of ashes or refuse from the basement and for transporting the loaded can to a disposal point. Patent 1732153. Delma C. Crichton.

Filling Mechanism—Adapted to dispose measured amounts of liquid, such as syrup, in bottles, the capacity of the measuring means may be varied to the slightest fraction of an ounce and the desired quantity disposed in each bottle, irrespective of the temperature effect upon the liquid. The inventor has been granted two patents, 1731464 and 1731465. James Kantor.

Method of Coating Pipes—Whereby the outside is conveniently covered with a waterproofing composition, such as bitumen or asphaltum, applied hot, and which cools to form a complete coating to protect the pipe from injurious contact with the earth. Patent 1733006. Hugh M. Cook and Lorlys R. Rogers.

Sod Cutter—A machine adapted to be drawn over sodded ground, having means for cutting the sides of the sod and beneath the same to a desired depth, and a knife for severing the sods in given lengths. Patent 1732972. Michael J. Kniffing.

Printing-Press Attachment—For stock feeding tables, whereby automatic suction shoes are prevented from bearing weight on the uppermost sheet and pressing it down upon the next sheet, designed for "Miehle" presses but may be slightly changed to fit other presses. Patent 1732653. Boliver Margwarth.

Electric Sand Sprayer—A spraying machine conveniently manipulated by hand, in which sand is discharged into a conduit wherein a forced draft thoroughly separates the sand, a tapered nozzle discharging the sand in a fine spray. Patent 1732655. Kurt A. Peters.

Medical and Surgical Devices

Renewable Dental Slab—In the form of a renewable surface which may be removed and discarded and a fresh surface exposed for the next mixing operation, thus saving time in cleaning the customary glass slab. Patent 1729292. John J. McCarthy.

Back Washer—Which embodies means for containing a detergent or soapy solution which will reach the back or other parts being washed, may also be readily converted into a medical appliance for a bandage, or poultice holder. Patent 1730299. Adam A. Sanders.

Prime Movers and Their Accessories

Rotary Engine—Having an intermittent coupling between the rotors and drive shaft which admits of the operation of the motor in either a clockwise or counter clockwise direction by employing ignition devices at two points. Patent 1732995. Traugott Tschudi.

Choke Control for Carburetors—Adapted to engage the usual actuating rod for the choke valve permitting ready actuation, but which will cause the rod to travel slowly after release as the valve is opened by the usual spring. Patent 1732969. Stuart G. Garrett.

Piston Ring—For internal combustion engines, having spring means retained in tubular members within the piston adapted to exert a steady outward pressure thereby fitting a wide range of cylinder diameters and automatically compensating for wear. Patent 1732978. Thomas O. McLendon and James H. Irving.

Pertaining to Recreation

Fishing Rod—Of the extensible type, comprising a hollow cylindrical handle and a tapered body portion capable of adjustment, and having means for firmly clamping the parts at any desired length, when retracted may be conveniently carried. Patent 1731173. William E. Pope.

Merry-Go-Round—So constructed that children can exert a push or pull to turn the revolvable portion of the structure, the arrangement being such that a number of children can stand on a platform and operate the device. Patent 1733005. Herbert D. Clayton.

Pertaining to Vehicles

Moisture Trap for Automobile Crank Cases—For trapping the accumulated waters of condensation which settle at the lowest point in the crank case, whereby the water may be drained off to prevent stoppage by freezing. Patent 1729978. Edward T. Barron.

Top for Automobile Rumble Seats—In the form of an attachment, characterized by its simplicity, ready adaptability, removability and collapsibility, to permit it to be stored in a relatively small space when not in use. Patent 1729919. Otto Altenbach.

Vehicle Bumper—Having a light reflecting element by which light rays from the headlights of an approaching vehicle will illuminate the bumper, thus enabling approaching vehicles to safely clear each other, notwithstanding glare from the headlights. Patent 1729274. Stephen P. Millar.

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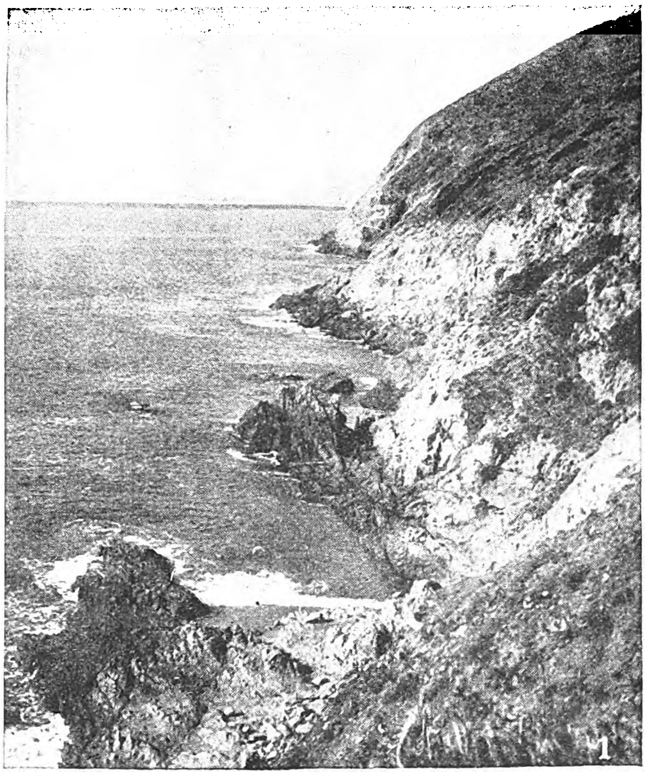
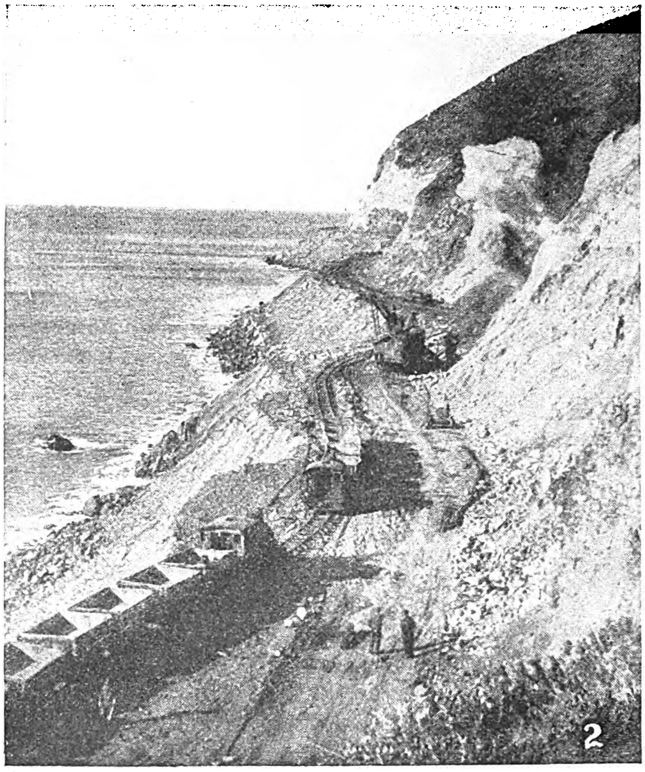
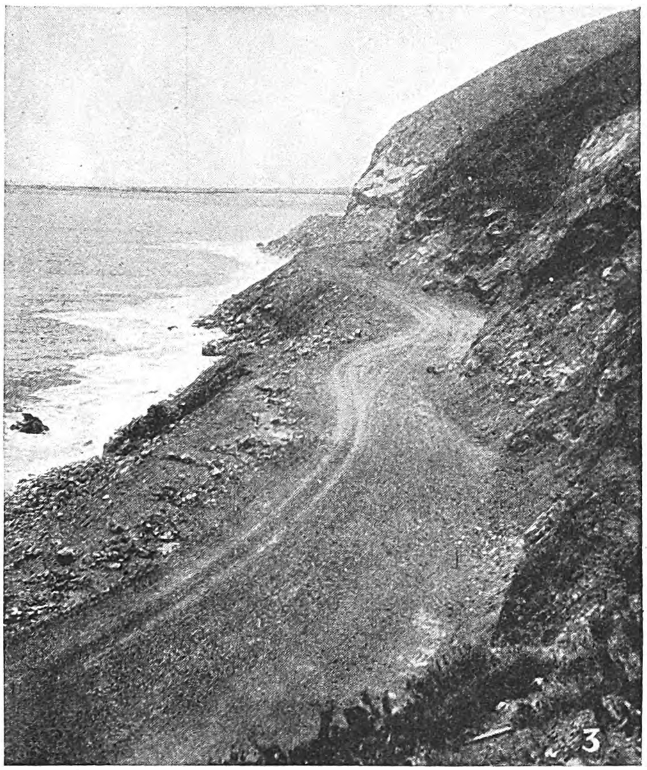
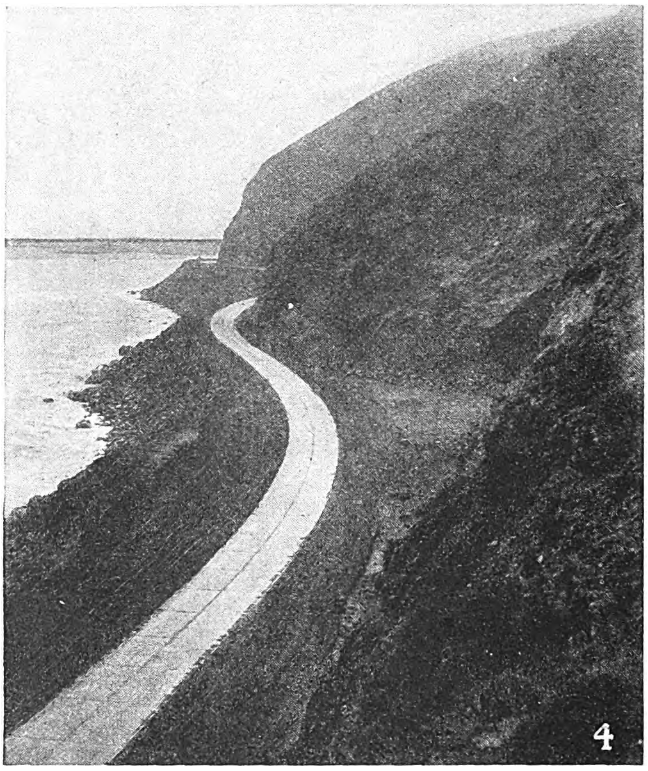




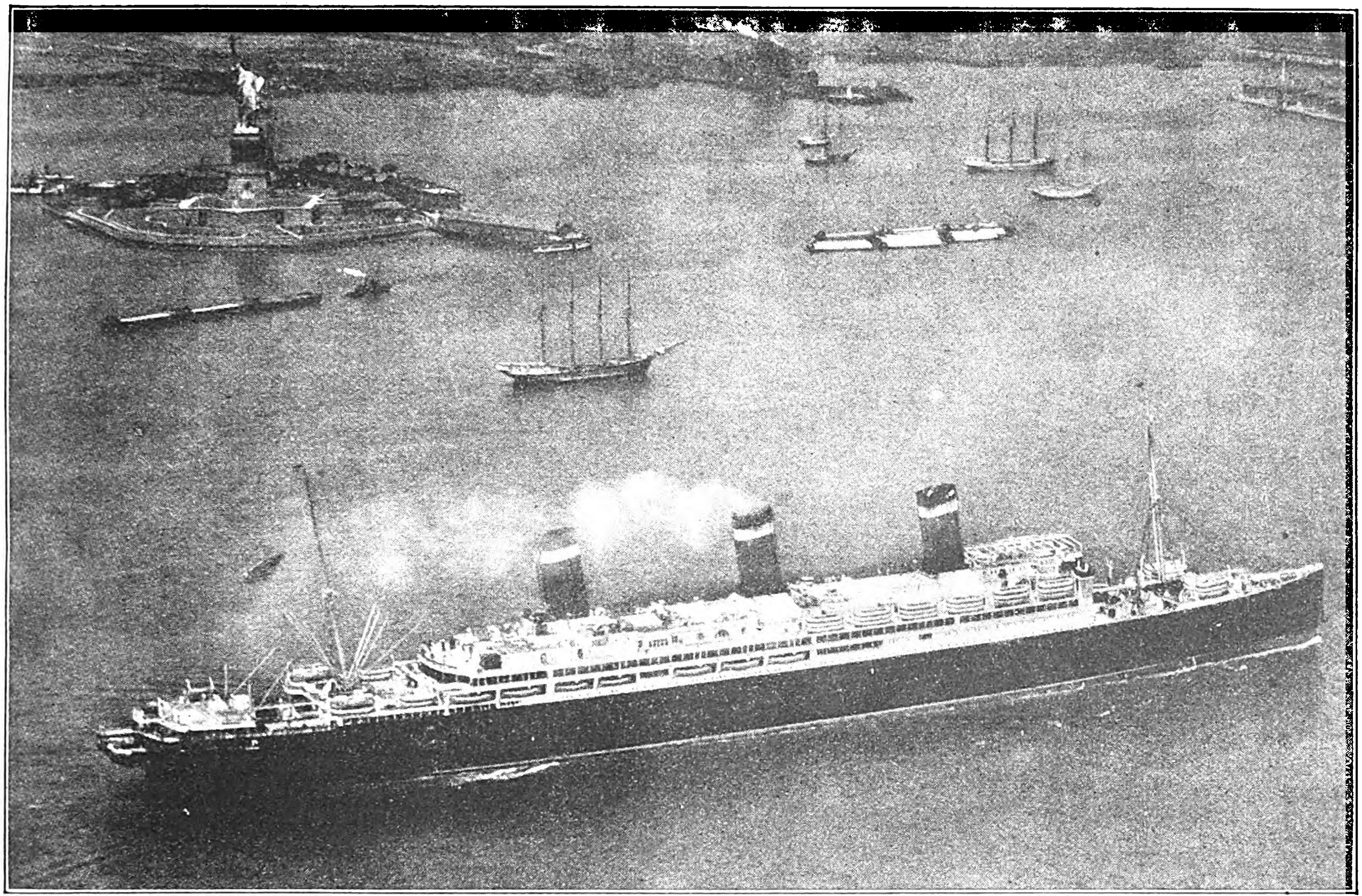




Courtesy *California Highways and Public Works*

Growth of the Highway

ON this particular section of the Santa Monica-Oxnard, California, highway, which was formally opened to traffic in 1929, many difficulties were encountered and overcome. A glance at illustration Number 1 will show why it was necessary for surveyors and workmen to be suspended from above like Alpinists, prior to the beginning of work and during the early stages of construction. Since there were no shipping points between Santa Monica and Oxnard, a long expensive haul was required. Water for construction purposes had to be obtained from a city over 12 miles away, through a specially built pipe line. Seawalls could not be built to keep back the waves; therefore huge rectangular blocks of concrete were lowered into the ocean and then filled with concrete. Illustrations 2 and 3 show construction stages, and Number 4, the completed highway. Construction of the seven most difficult miles at this point cost 1,000,000 dollars.



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THE "LEVIATHAN," AMERICA'S FINEST, PASSES THE STATUE OF LIBERTY, INWARD BOUND

American Ships and American Prosperity*

A Discussion of the Weak Link in Our Transportation System and the Need of Public Support for a Greater Merchant Marine

By E. M. HERR

Vice-chairman of the Board, Westinghouse Electric and Manufacturing Company

THERE was a time, not so many decades ago, when American clipper ships carried a large proportion of the world's commerce. Then came a decline which lasted until after the World War. Now our foreign commerce leads the world and we need more ships for the same reason that one department store does not employ another store's trucks to deliver its goods.

New ocean mail routes will greatly stimulate shipbuilding, for the construction of 29 ships, two of them super-liners, is to be specified in the contracts. But this will be only a start.

Mr. Herr's accompanying article puts us to shame for our apathy in respect to our merchant marine. It is hoped, therefore, that his discussion will aid in renewing that old feeling of pride Americans possessed when our flag floated above some of the finest and fleetest ships in the world. —*The Editor.*

AS A DIRECT result of the sound economic policies which have been pursued by both American industry and the American government, the people of the United States have enjoyed unprecedented prosperity during the past few years.

The extensive use of power in industry, the development of the system of mass production for a large number of manufactured articles, and the rapid practical application of the discoveries of science and research, have greatly increased our national productivity and our national wealth. This added wealth, contrary to what has often happened in the past, has not been largely absorbed by a small group, but practically all who have had a hand in its creation have shared in it, so that wages have risen, the purchasing power of the majority of our people has widely extended, and the standard of living in this country has reached the highest level ever known. Finally, there is every reason to believe that those disastrous financial crises, which have periodically wiped out a large proportion of the savings accumulated in prosperous times, have been eliminated by the Federal Reserve Banking System.

Never before, in fact, has so much been accomplished for the good of so many people in such a short time.

But, although the American peoples as a nation are prosperous and content, there is a minority who are actually being injured by the very processes that are benefiting their fellows. Although society as a whole gains whenever a new type of labor-saving machine is placed in operation, or research discovers a better way of performing some operation, certain individuals invariably suffer loss by being thrown out of work. Experience shows that unemployment due to this cause is

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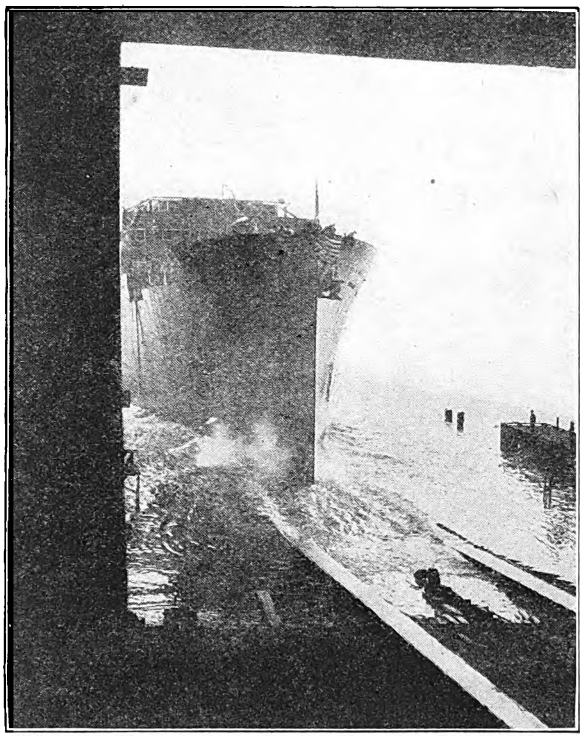


Courtesy Grace Lines

LAUNCHING THE "SANTA CLARA"

usually temporary, since the wealth created by the new improvement always creates a demand for labor elsewhere; but this does not ameliorate the immediate distress of the unemployed, and on more than one occasion during the past five years, our industrial progress has taken place so rapidly that thousands of families were in want for long periods of time.

To this group, which our general prosperity has failed to touch, must also be added the American farmer. Whereas the agricultural industry has made progress during the past 50 years and the average farmer of today is much better off than was his grandfather, the status of the industrial worker has improved so much more during this same period that the farmer's economic position is relatively lower than it was formerly. Hence there is justification for the discontent that pervades many of our rural districts.

IT is typical of the spirit that now dominates American affairs that these weak spots in our otherwise highly satisfactory state should command widespread attention. We can confidentially believe that, insofar as it can, our national government will work out practical plans for farm relief, arrange work on public undertakings so as to reduce unemployment in times of depression, and carry out other constructive measures. But while vast good can thus be accomplished, it must be recognized that government is a remover of obstacles rather than a creator of economic opportunities, and that only economic remedies can permanently cure economic ills—and then but slowly.

What we chiefly need is an ever widening market for our goods. If we could constantly increase the demand for both our manufactured and our agricultural products by even a few percent per annum, much of the slack in our production system would be taken up, unemployment would be kept down to a minimum, and a much needed stimulus would be given to agriculture. In other words, one of the most effective things that we can do at this time to widen the scope of our prosperity is to build up our foreign trade.

We have never, as a people, been "foreign-trade minded," like the British, for example. Although the value of our foreign commerce in 1927 was in the neighborhood of nine billion dollars, it represented only about 10 percent of our total business, and this small proportion has been maintained very closely for many years. We have in this field almost unlimited opportunities for commercial expansion but as a nation we have not taken advantage of them. The time has now arrived, however, when we must embrace all opportunities to increase our overseas markets.

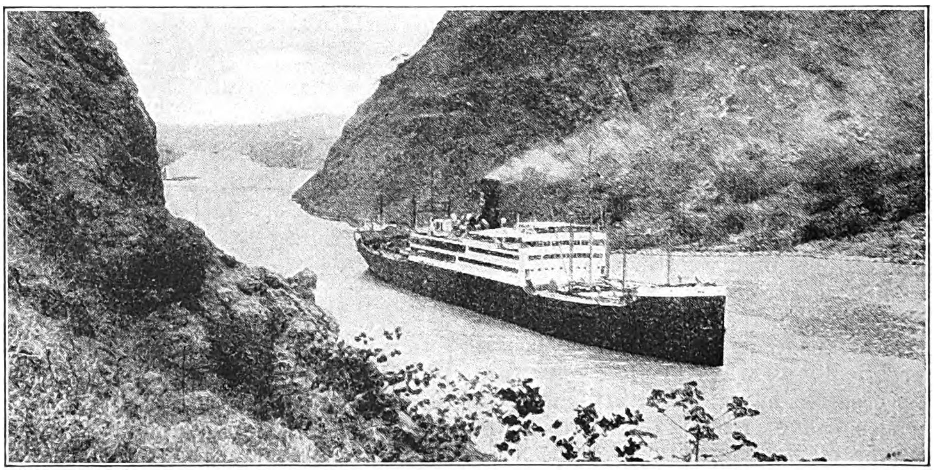
MUCH of the task of extending our foreign trade will, of course, devolve upon commercial, industrial, financial, and political specialists, but there is one phase of it which is the concern of the American people as a whole. If we want to maintain and extend our prosperity by developing foreign trade, we must strengthen a serious weakness that now exists in our transportation system.

Transportation and production are inseparable. If there is a free flow of goods from the producers to the consumers, the greater the quantity of useful articles the producers can turn out, the better off everyone concerned will be. But interfere with this flow anywhere and everyone will suffer loss; stop it, and civilization will disintegrate.

Fortunately for us, our transportation system as a whole is splendidly developed. Our railroad system is larger and more efficient than any other in the world. We own 78 percent of all the automobiles in existence and spend billions of dollars every year for new cars and trucks and for road improvement. Our aviation system is at present in its infancy, but, in view of the present public interest in this subject, no one can doubt that we shall in time be supreme in this field also.

EVEN in what might be called the minor branches of transportation, our position is satisfactory. We have an adequate fleet of lake-going, coastwise, river, and harbor craft, which is being increased as needed by vessels of the most modern types; we have added nearly 100,000 buses to our already extensive urban and interurban railway system; and although electric traction has had to mark time for several years because of the extremely rapid development of the automobile, it is now entering into a new era of active progress and promises to be one of the most important factors in solving the serious problems created by traffic congestion in our cities.

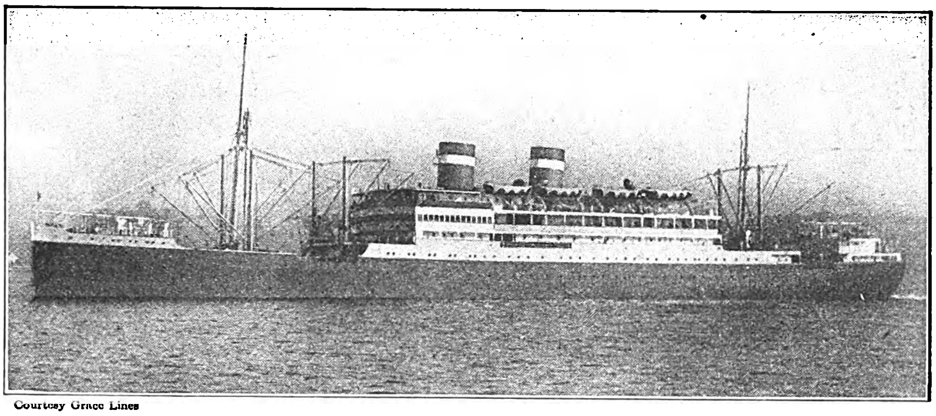
In striking contrast to all this is our international transportation system. While on paper our sea-going merchant fleet totals 11,000,000 tons and is second only to Great Britain's, 50 percent is probably useless and perhaps 50 percent of the remainder is obsolete or nearly so. As to new ships, without which the efficiency of our fleet cannot be maintained, only 3 percent of the ocean-going ships built since 1923 belong to us; and during 1928 we did not spend a single cent on ships for foreign trade. The percentage of our imports and exports carried in our own ships



Courtesy Dollar Line

THE "PRESIDENT POLK" PASSING THROUGH CULEBRA CUT, PANAMA CANAL has been slowly but surely declining since the high point of 1920, so that we are obviously in danger of slipping back into our old-time position of almost complete dependence on foreign ships for handling our sea-borne commerce.

We should, indeed, be ungracious if we were to criticize the shipping service that foreign nations have rendered us in normal times; nevertheless, blood is thicker than water, and a ship is always bound to its mother country by strong political and economic ties. On more than one occasion we have been left in the lurch, with our products, many of them perishable, piled upon our wharves because ships of foreign register, on which we were depending for transport, were suddenly drawn elsewhere for some reason that was no concern of ours.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Motorliner "Santa Maria," One of a Large American-owned Fleet

A CLOSELY parallel situation would exist in our domestic transportation system if the great majority of our freight locomotives and trucks were under foreign ownership and control and were liable at any time to be withdrawn from our service and sent to Canada or Mexico. Obviously, under such circumstances, it would be impossible to develop that fine adjustment that now exists between our production and our transportation; and our internal commerce would be but a fraction of what it is at present. And yet, if we were thoroughly accustomed to this method of handling our traffic, we would perhaps find it difficult to realize what we were losing by not taking it under our own control. We would undoubtedly, from time to time, consider the question of substituting our own rolling stock for that supplied by foreign capital, but the cost of the operation would stagger the average man, and, because of the numerous invisible factors involved, he would probably be quite unable to understand how so great an investment would benefit him personally.

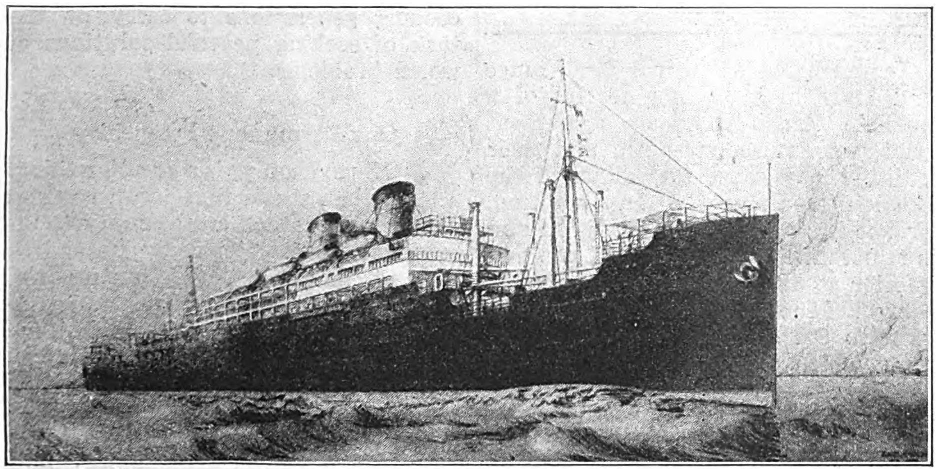
For similar reasons, the American people have been slow to appreciate the value of a merchant marine of their own. As long as less than 10 percent of our business is seaborne, it does not matter very much who handles it; but if we wish to develop a large volume of foreign trade, we must have an adequate number of the right kind of ships under our own immediate control and serving primarily our own national interests, for without them we shall not be able to insure that reliability of transportation service which is essential for the success of such an undertaking.

Another highly beneficial result of the building up of an American merchant marine would be the revitalizing of shipbuilding in this country. Prior to the war, there were 23 shipyards in the United States building sea-going vessels; today there are but 12, and several of these are barely maintaining their existence on the odds and ends of repair work. Great Britain, on the other hand, has 57 yards, and Germany has 18.

If an adequate amount of business could be given to our shipyards, a goodly share of our surplus labor would be immediately absorbed; a demand would be created for large amounts of steel, machinery, and other of the innumerable supplies needed for ships; the producers of these materials would give employment to other workers; and thus an ever-widening circle of prosperity would be started. Moreover, we would save from extinction an industry that is absolutely vital to our national safety. We cannot afford to let our shipbuilding machinery decay and our technically trained shipbuilding staffs disintegrate. If we become unable to build ships to meet our needs in emergencies, we shall lose our grip on sea power, and then our seaboard, our island possessions, our commerce, and our prosperity would be at the mercy of any maritime nation that chose to attack us.

The situation is more promising today than it has been for a long time. Within the past year, Congress has passed certain legislation in the interest of our shipping and shipbuilding, and there is every reason to believe that work on a number of new sea-going vessels to fly our flag will be started in the near future. But without that widespread popular interest and support which created our railroad and our automotive transportation systems and which at present is playing so important a part in developing American commercial aviation, we shall have no merchant marine.

THIS whole subject is a matter that concerns all of our people—merchants, manufacturers, public utility operators, professional men, farmers, and workers—for even a moderate increase in our overseas commerce and our shipbuilding activities will result in a marked increase in the demand for labor, materials of every description, power, internal transportation, and all other varieties of service, and this will benefit everybody. Our industrial and political leaders can, in fact, do few things more useful than to create public understanding of the value, to every American individually, of foreign commerce and an adequate merchant marine.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Turbo-electric Liner "Santa Clara," as She Will Appear When Completed

¶ *In constructing the new vehicular tunnel under the Detroit River from Detroit to Windsor, Canada, new engineering methods were used and problems were overcome. The interesting story of this work will be published in these pages at an early date.*

OUR POINT OF VIEW

California Sees the Light

QUALIFIED scientists, engineers, architects, builders, and real estate men of California have for many months been laboring over a uniform building code due to appear in the coming spring. This code will take frank and, it is stated, full recognition of existing earthquake risks in that state as determined—or as nearly as existing knowledge permits determination—by the science of seismology.

Such a code is past due. The lesson of the San Francisco earthquake has been wearing off. San Francisco itself not long ago reduced its own specifications for earthquake resistance in its building code.

As Henry D. Dewell, a consulting engineer, reports to the Seismological Society of America, an earthquake catastrophe first arouses a lethargic public, building regulations are made more stringent, codes are revised to match the advice of technical advisers; and then the cycle of events pursues its course: people become forgetful, familiarity with what science alone seems to realize is only a temporary let-up in earthquakes begets contempt, and building codes are allowed to lapse. Then comes another disastrous earthquake.

The time of *least* danger of earthquakes is directly after an earthquake—just when building codes are stiffened.

The time of *greatest* danger comes years later when earth stresses, temporarily relieved by the earthquake, have again accumulated—just when building codes are being weakened.

There must be some way to bridge this characteristic blind spot in human nature and provide stronger buildings at the proper time instead of at the wrong time. This is what science and engineering are now doing in California. It is, of course, only common sense, but common sense is a quality not too often noted in connection with public matters of this kind. Therefore the action deserves praise from all scientific people.

The Naval Conference

THE recent rebuff our Secretary of State, Mr. Stimson, received from the Soviet Government indicates the great difficulty one state has in understanding the reaction its policy will meet abroad; certainly Mr. Stimson's action was inspired by innocent motives but it raised Russia's resentment and encountered the thinly veiled hostility of Japan. The three directly interested parties were Russia, China, and Japan; China appealed to the powers when she became unable to sustain her position by force; Russia believing her cause was just and knowing her soldiers could maintain her position refused to leave the decision to outsiders; Japan disliked the idea of a concert of powers interfering in Manchuria lest a precedent be established that could be used in some future Manchurian problem in which she might be involved.

Television and the Cathode Ray

ALTHOUGH television, seeing at a distance, is a subject that incites the mind to fanciful flights into the future, the practical development of the art has been exceedingly slow and, so far, unproductive of satisfactory results. In 1889, Paul Nipkow, a German experimenter, devised an "electric telescope" and in his patent application he laid the foundation for all future disk-type television transmitters and receivers. Since that time progress has consisted almost solely of refinements and developments based upon Nipkow's original apparatus. Now, however, comes the hope that in the near future cumbersome scanning disks and drums, capricious neon tubes, and difficult-to-synchronize motors may be eliminated from the television reception field and replaced by the comparatively simple cathode-ray tube in which no moving parts are employed. A description of the cathode-ray television system appears in the SCIENTIFIC AMERICAN Digest of this issue, and it is our sincere hope that other experimenters will take up the work of Dr. Zworykin and thus bring successful practical television nearer to the average person's home.

In much the same manner, France and Italy have become fearful of a possible Anglo-American agreement relative to cruiser strength, and their attitude may cause the failure of the London conference. In addition, France has a real naval tradition and is reluctant to accept a naval position inferior to Japan; France regards the control of the water route to Algeria as vital to the effective strength of her army which contains a large African contingent; and while France will support Italy against a supposed Anglo-American combination, she will bitterly oppose an equality with Italy for with colonial possessions only exceeded by Britain, she considers her needs are much greater than Italy's. Finally, France must retain her submarine strength as a counterpoise to Britain's superior surface fleet.

So the complexities of the situation the London conference will face are becoming more and more evident; on the other hand President Hoover and Premier MacDonald have skillfully avoided many pitfalls in handling the preliminary measures; they are supported by an overwhelming public opinion in favor of reducing armaments and it only remains for conciliatory statesmanship to find the solution.

The country approves the President's action in surrounding our civilian members of the conference with experienced naval advisers, and the previous records of Rear Admirals Jones, Pratt, Moffett, Pringle, Yarnell, and Hepburn insure that the civilian members will be furnished the necessary technical assistance. Our President is too sagacious to ignore the necessity of expert advice. We feel sure that the presence of these Flag Officers in London assures the safeguarding of American interests, and we fondly hope the collective wisdom of the assembled delegates will find a solution that will further world peace.

Now is the time to limit armaments, for much of the hatred of the World War has evaporated while the memory of the suffering it caused is still fresh. No thoughtful person believes that eternal peace can be established in the present era; but some causes of war can be removed entirely, others may be neutralized, and war perhaps deferred until civilization is better able again to withstand the shock of arms. If the conference only succeeded in postponing one small war for a decade, it would deserve well of the world, and any success it may have will encourage succeeding generations to carry on the task of seeking peaceful solutions of world problems.

Our Permanent Prosperity

MOB psychology is a peculiar thing. When stocks first began to drop in the recent stock crash, many thousands of people frenziedly unloaded, like so many sheep following the leader, and almost caused an industrial collapse from which it would have taken months to recover. The stampede forced stocks to a very low point despite the fact that business was basically sound.

President Hoover understands mob psychology and so took immediate steps to circumvent its destructive influence. He knew that if the man in the street could not see figures in black and white, this man would cry "hard times" and would curtail his expenditures; the cry would be taken up by others; and the mob's pessimistic belief would become actuality. Mr. Hoover therefore called upon all state governors for facts as to their states' projected work for 1930. The responses were most favorable; it was found that state construction on highways and public works for this year will run into hundreds of millions of dollars.

As early after the stampede as the first week in December, C. W. Nash, of the Nash Motor Car Company, stated that his company had found no cause for worry; their sales had been maintained on a par with, and in some cases showed an increase over, preceding years. Henry Ford, shortly after having reduced prices on all models of Ford cars, announced a general increase in the wages of all employees. Recently the United States Shipping Board certified a program of ship construction for our merchant marine which calls for the building of 29 vessels based upon ocean mail subsidies. Several of these will be begun almost immediately, thus assuring much business for our shipyards, employment of many men, and the use of much steel—and steel production is referred to as "the barometer of business conditions!" The *Engineering News-Record* recently published a survey showing that the cost of construction for 1930 will total around ten billion dollars.

Many other facts and figures could be quoted to show that 1930 will be a busy and prosperous year—we could cite the increase in bank deposits recently, and in stamp sales, the latter also called a business barometer—but the case is already proved. Yet the same old mob psychology, still pessimistic in tone, tends to hang on. There is thus the necessity for constructive optimism on all sides, plenty of hard work, and the free circulation of money so that business and industry may boom and a stabilized prosperity be ours permanently.

To such criticisms of our financial structure as that voiced, with puerile acerbity, by the Soviet press relative to the market crash: "So this is what can happen in a capitalistic country!" let us point to our 1930 program and say, "*This* is what *will* happen." Then let us forget criticisms and critics along with pessimism and other unpleasant things.

Swan Song

IN January, 1927, we published an editorial which stated that the average annual increase in the number of installations of electric household refrigerators from 1920 to 1925 was 100 percent, that the year's increase in 1925 alone was 350 percent, and ventured a prediction as follows:

"Imaginary conversation in 1977—*Grandpa*: 'When I was a young man, they actually brought ice into peoples' houses to keep their food cool.'

"Laughter.

" 'Grandpa, wasn't that in the days of the candle?' "

We thus gave a conservatively long time for the supplanting of the old ice refrigerator by the modern electric one. Since 1927, however, increasing use of the latter has been so marked as to indicate that the imaginary conversation may be possible in much less time than the predicted 50 years. And yet there are die-hards who either are myopic and thus cannot see the handwriting on the wall or are so deeply concerned financially that they are fighting the change with the frenzy of despair. We have no sympathy with the former because they are of the type that drag the wheels of progress but for the latter our feeling is somewhat similar to that we had for the buggy makers when the automobile made its appearance. We are simply sorry that, in time, they will have to turn to other things.

In this latter class we would place a certain association of ice manufacturers which, after we had published the article "Ice By Wire" in our October, 1929, issue, informed us that the article was fundamentally, essentially, and technically wrong, and demanded that we retract. Unfortunately for them they posited a weakness on our part which we do not possess. The article was not hastily prepared; on the other hand, it was presented only after careful consideration and study of the situation and then under the guidance of refrigeration experts. What, then, is there to retract? Nothing.

We can pass over this association's criticism that our title "Ice By Wire" was incorrect for obviously it was not to be taken literally. Likewise, we cannot retract our statement that, as a refrigerant, sulfur dioxide has very little danger either as a poison to human beings or as a corrosive agent for the pipes or interior of the refrigerator. It is admitted that the electric refrigerator is not actually electric but the term "electric" is as descriptive here as when used with such appliances as electric vacuum cleaners, electric dish washers, et cetera. We reiterate that there is less spoilage of food in electric refrigerators due to the lower temperature and to the lack of moisture.

We were of the opinion that ice manufacturers, faced by the competition of the electric refrigerator, have expanded into new fields and actively promoted their business. For that reason, we were rather surprised at the association's statements that "From the standpoint of economy, efficiency, and service, the ice industry has nothing to fear from mechanical refrigeration competition," and that "—the small ice machine"—with which name they choose to heap indignity upon the apparatus under discussion—"would not have reached its present degree of use had it not been backed by the enormous financial power of——; coupled with the fact that dangers and disadvantages of small ice machines have been studiously hidden from the public." And yet they did not enumerate these vital facts that have been *studiously hidden from the public.*

The association's argument reminds us of the little boy on a gloomy road at night, whistling to cover his fear, and of Hamlet's rebuke to one who thus practiced dissimulation: "The lady protests too much, methinks."

An Industrial Antarctic?

TO those of us who studied geography long before the World War, the problem of relearning the map of Europe after its remolding was indeed a difficult one. It is possible, or rather probable, that in a few years it will be necessary—if, of course, we wish to keep up with the times—for us to familiarize ourselves with the map of an entirely new continent: the Antarctic.

Already with several notable and well-known achievements to his credit, Commander Richard E. Byrd is now exploring by air and mapping in photographic detail this last great unknown and puzzling part of the world. In the SCIENTIFIC AMERICAN Digest of this issue we publish a map of his recent flight to the South Pole and give an idea of some of the facts that may be learned by him in the Antarctic. Besides the valuable data mentioned in that item, however, perhaps he will bring back other information that may lead to commercial exploitation of natural resources which some have predicted may be discovered there.

Who knows but that in the years to come there will be numbers of year 'round base camps, similar to Byrd's Little America, scattered over the Antarctic and peopled by hundreds or thousands of workmen who extract from the mountains there such natural wealth as gold, diamonds, oil, coal, or iron? Airplanes or airships might transport the more valuable of these from the interior to shipping points and methods might be found to ship the more bulky. The question, of course, is: Does the Antarctic contain any minerals of value or is it simply a barren, rocky land? Byrd will doubtless give us some information on that point and others will help our enlightenment. We may yet see the Antarctic a thriving industrial continent.

How Old Is the Earth?

How Geologists, Physicists, Geophysicists, and Other Scientists Are Pooling Their Knowledge for a Combined Attack on This Ever-fascinating Problem

By ALFRED C. LANE, Ph.D., Sc.D.

Chairman of the Committee of the Division of Geology and Geography on Estimation of Geologic Time by Atomic Disintegration, National Research Council

LOOK with a pocket lens at the luminous numbers of the dial of a wrist watch after you have been sitting two or three minutes in the dark. The figures do not shine with a quiet, steady glow but quiver with light. If the lens defines sharply you will find that the light comes from showers of sparks, like bursting rockets; or, it may be, more like that of fireflies on an August night. Each flash is made by an exploding atom.

We know now that the atoms of the chemical elements are not the "indivisible" units they were thought to be when that name was given to them, but according to one conception they are complex aggregates of positive protons and negative electrons. The outside electrons of an atom are pictured as whirling around the central nucleus with a velocity so great that they may be thought of as being practically "all over their orbit" at once. In the heavier atoms the number of outside electrons becomes very large, up to 92, and for some of the atoms the arrangements are too complex to be stable, so that once in a while they explode. Sometimes the explosion merely gives off an electron — sometimes it gives off what amounts to an atom of the light gas helium.

WHEN an atom explodes, the particle goes off with tremendous energy. We can imagine how great the energy is, from the fact that the particles have been going around their orbits many millions of times each second. When such a particle is set loose, like a stone from a sling, and strikes the white powder of an impure zinc sulfide, it causes a flash. Thus each of the flashes seen in the luminous paint on the watch dial represents such a collision.

Now if we were watching a pop-corn machine and counted how many kernels popped in a minute we could tell, provided the rate of popping was uniform, how long the machine had been running. Even so, with our popping atoms the physicist generally tells us that, so far as he can find out, the number of atoms of a spontaneously disintegrating element that explode per second depends only on the number that are present; and that this number is uniform, regardless of temperature and pressure, and regardless of other substances present. The experiments upon which this statement is based have ranged throughout the whole variety of conditions that might be present near the surface of the earth.

There are a number of these popping elements. Radium is the one in which this property was first recognized. While the rate of disintegration of radium is relatively rapid, incidentally causing it always to be warmer than its surroundings, the radium is half gone—its atoms half exploded—after some 1580 years. This is not, however, so fast that, like some of the other elements, radium vanishes under the chemist's fingers.

ANGEL TERRACE, YELLOWSTONE

By measurement of rate of decay of radium in these deposits it was possible to date the time since the recession of glaciers

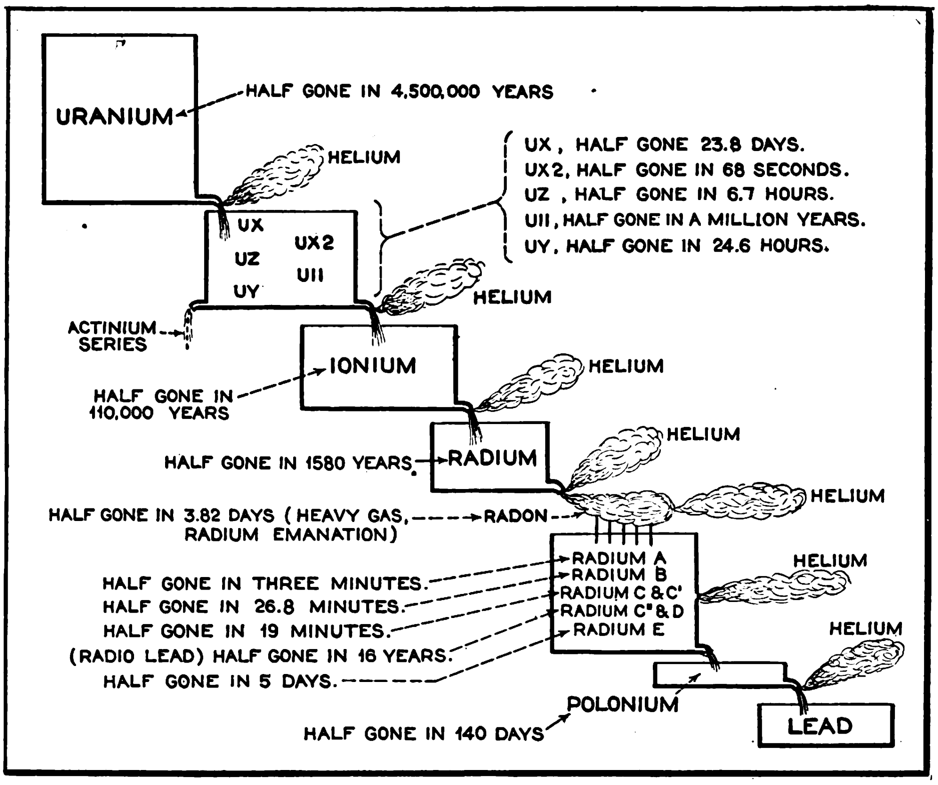
By measuring the rate of decay of the radium contained in certain deposits, Schlundt of Missouri and Moore of Purdue estimated the time since the ice extended down to the geysers of the Yellowstone Park during the Great Ice Age. It was done in this manner: The water of the geysers contains radium, and the deposits of tufa laid down by the geysers are also radioactive. The older these radio deposits are, the less active they become. The older deposits of Terrace Mountain have a radioactivity of only 1 percent of the more recent ones and are overlain by boulder clay deposits of the glaciers. If, then, we assume that the original activity took place at the same rate as now, we can estimate the age of these deposits by the degree to which they have lost their original radioactivity. If radium loses half its volume during the first 1580 years, and half its remaining volume during the next equal period, and so on, it will be reduced to 1 percent of its original radioactivity in about 10,500 years.

However, the most suitable element for computing the great lapses of time since the earth's crust began to be practically at its present temperature and pressure is not radium but uranium. Incidentally, there is a very small amount of closely similar elements called "isotopes," that are grouped together under the name of uranium and distinguished as U I, U II, U X, U Y, and U Z, and so on. Ordinary uranium is mainly U I.

URANIUM is the source of radium, but its atoms are so much less explosive than those of radium that it would take 4,500,000,000 years for it to be half gone. In a milligram of uranium, which is about the quantity that would cover a circle as big as the letter *O* with a layer as thin as a piece of paper, there will be about 2,540,000,000,000,000,000 atoms. From this quantity of uranium we might see something like 11 flashes per second. From a mineral containing only ½ of 1 percent of uranium I have counted flashes at the rate of four a minute. As there are 31,556,926 seconds in a year, it is easy to see that if 11 atoms disintegrated per second per milligram, the uranium would be gone in 8,000,000,000 years. However, since the number of atoms which burst depends upon the total number present, the rate constantly diminishes. But we can easily allow for this factor.

If, then, we know how much uranium there was in the rock when it was formed, we can tell by the amount left how long a time has elapsed since that event. We can ascertain the amount originally present by measuring the residue left, for each atom of uranium ultimately leaves a residue of lead. I say ultimately because there is a complication. The disintegration of uranium is not quite as simple a process as the popping of corn, although in both cases, to be sure, gas and energy are set free. In the uranium explosion the result is an atom of another element which is much less stable than uranium and explodes in its own turn. In it the number of explosions per number of atoms present is much greater, and the time when the atoms are half gone is proportionately shorter.

This new atom derived from the explosion of an atom of uranium in turn changes into another, and this into another, until we have a whole staircase of descent in the course of which eight atoms of helium are given off. At the bottom of the staircase is lead. Ionium, radium, radium emanation, and polonium are among the elements formed in this process. In all there are about 17 of them.


URANIUM
HALF GONE IN 4,500,000 YEARS
HELIUM
UX, HALF GONE 23.8 DAYS.
UX2, HALF GONE IN 68 SECONDS.
UZ, HALF GONE IN 6.7 HOURS.
UII, HALF GONE IN A MILLION YEARS.
UY, HALF GONE IN 24.6 HOURS.
UX
UZ
UY
UX2
UII
HELIUM
ACTINIUM SERIES
IONIUM
HALF GONE IN 110,000 YEARS
HELIUM
HELIUM
HALF GONE IN 1580 YEARS
RADIUM
HALF GONE IN 3.82 DAYS (HEAVY GAS, RADIUM EMANATION)
RADON
HELIUM
RADIUM A
RADIUM B
RADIUM C & C'
RADIUM C" & D
RADIUM E
HELIUM
HALF GONE IN THREE MINUTES.
HALF GONE IN 26.8 MINUTES.
HALF GONE IN 19 MINUTES.
(RADIO LEAD) HALF GONE IN 16 YEARS.
HALF GONE IN 5 DAYS.
HELIUM
POLONIUM
HALF GONE IN 140 DAYS
LEAD

ATOMIC DISINTEGRATION SERIES SIMPLY ILLUSTRATED

In this diagram the atomic disintegration series is illustrated by water running down through a series of tanks. It shows what happens while radium is being transmuted into lead in nature

WE may compare the process, as shown, to the flow of water from a great tank of uranium, through a series of smaller tanks with outlet pipes of various sizes. The larger the outlet pipe in a tank the less water will remain in it at the end of a given period of time. The lowest reservoir is lead—"radio-lead"—differing from ordinary lead in no obvious respect. But its atomic weight is 206, whereas for ordinary lead this atomic weight is 207.18.

Thus any mineral or rock which contains uranium has always some lead as well as radium in it and, while the ratio of uranium to radium approaches a fixed value, the older the mineral the greater will be the proportion of lead present. If we multiply by the fraction 238/206 we will get the original amount of uranium present—provided we can assume that all the lead came from the uranium; otherwise we should get a greater figure for the age of the earth than the true one. In this way Professor Henry Norris Russell of Princeton figured that the solid crust of the earth could not have been solid for over 10,000,000,000 years. This quite accords with the astronomic estimates that the earth as daughter of the sun can not be over 1,500,000,000 to 5,000,000,000 years old, as given by Jeans and Jeffreys of Cambridge; and by Holmes of Durham University who gives three ways of estimating it.

However, part of the lead may be original, part derived from actinium or from thorium, for there is another family of radioactive elements whose grandparent is thorium, and thorium decays about a third as fast as uranium. If we could tell just how much of the lead was derived from uranium, how much from thorium, and how much was of other origin, we could then check up on our estimates. Aston of Cambridge has shown a way of determining this, although it is not yet very precise.

To make sure that the lead is derived from uranium its atomic weight must be determined. Even then we have to be reasonably sure that there was not originally uranium lead present. For certain crystals it is not likely that there was more than a trace of original lead of any sort, and Davis of Reno and Hall and Richards of Harvard showed that for the oldest rocks of the Black Hills of Dakota—older than any well defined fossils there—the radio lead is nearly one quarter of the uranium left. This means an age of 1,667,000,000 years. Assuming that the uranium disintegrated in the past at the same rate as at present, Ellsworth of Ottawa has shown in the same way that the oldest rocks in Canada are over a thousand million years old.

Miss Gleditsch of Oslo, Norway, who has worked with Madame Curie, and Ellsworth; also Riss and Kirsch of Vienna; Holmes; and writers cited by these scientists—all have shown similar great ages for the oldest rocks in various parts of the Old World, and it is in some such way that Sir Edgeworth David, Professor of Geology at the University of Sydney, Australia, estimated the ages of the rocks to which he has recently called public attention.

As we have stated, uranium contains more than one element and the presumption is that these different elements would disintegrate at different rates. Therefore those which did so most rapidly would the soonest disappear. This leads us to infer that the present rate of disintegration is less than in the past. Probably some allowance is to be made on this score, but reason will be given for the belief that this will not shorten the time by more than a small fraction of the total, and that the ages of rocks and minerals will be relatively the same.

RADIOACTIVITY and the radium discovered by Madame Curie were first studied in the products of a mineral known as pitchblende, from Bohemia. In this mineral the ratio of radio lead to uranium is but 0.028. This would imply an age of something like 200,000,000 years—not much over one tenth of the age of the consolidation of the crust. A number of tests of minerals from various places—minerals which were formed during that great series of crustal disturbances that ended the Carboniferous Period and formed the Appalachians; also crumpling the coal beds from Alabama to Rhode Island and from Wales through Belgium to Russia—point to similar ages. On the other hand, R. C. Wells, of the United States Geological Survey and M. F. Conner have recently shown by the lead-uranium ratio that the close of the Cambrian Period or "age of trilobites" was something like twice as far removed in the past.

That these estimates of great geologic times are justified is indicated by the results obtained from other methods of computing the earth's age. If, for example, we liken the estimation of geologic age by comparing the amount of uranium and lead to the estimation of the time that a pop-corn machine has been running, by determining the proportion of popped and unpopped corn, we may also liken estimates of the age of the rocks by the amount of helium gas which has been generated as described, to an estimate which should correctly measure the steam given off by the explosion of popped corn. Of course, helium gas thus generated is likely to diffuse away and give us estimates which are too low. Yet even these estimates give ages of several hundred million years. Dean Moore (Purdue), and Bennett are using this method.

A STILL more interesting method which is employed might be likened to seeing how battered up the pop-corn machine was, or counting the dents in the machine made by the flying corn. When an atom of a radioactive element explodes it sends the helium particle flying with a velocity which may carry it several inches. In solid substances, however, it has a much shorter range. The more frequent the explosions, the more violent they are, and the greater the range of the helium "bullets."

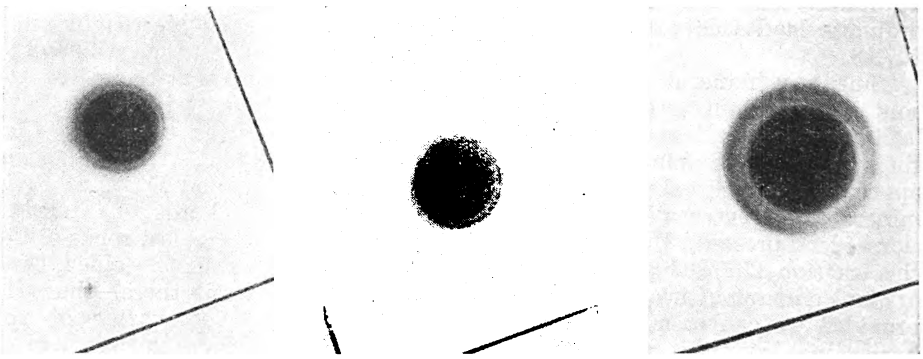
Now these helium "bullets" can do a good deal of smashing up and discoloring of molecules, especially toward the end of their flight when they have lost a good deal of their velocity, even as a rifle bullet with a high velocity may make a clean small hole in a window pane but at a low velocity may shatter it. The result is that a minute particle of a radioactive mineral embedded in mica, for example, is likely to be surrounded with a halo. Careful investigation may disclose not merely one darker ring but several, each corresponding to one particular element of the series shown, which in its explosion sends off helium bullets with its own particular velocity.

A photograph of these rings in the fragments of a very old Canadian rock, from a paper by Dr. Kerr-Lawson of the University of Toronto, is reproduced. The diameter of these rings matches very well the diameters which would be formed at the present date, and this is one reason for believing that a more rapid decay of uranium in times past is not likely to be very important in our calculations; for if it were it would show more in the diameter of the rings. Joly, of the University of Dublin, one of the greatest of the observers in this field, does believe there is a slight difference, in that the older rings are larger. But if so the amount is only some thousandths of a millimeter, and another explanation has been suggested even for this.

As yet no definite ages have been obtained by means of the ring method just described, since we do not know exactly how much radioactive material there may be in the minute specks which produce the halos. However, estimates even for the small fraction of all geologic time that has elapsed since the Devonian Period, give us a possibility of hundreds of millions of years.

The radioactive elements give us the most trustworthy estimates of ages, because, so far as we know, the rate of change seems to be the least variable of all the common methods of estimation. Most of the other forty-odd methods give us much shorter estimates of the duration of the geological periods. Here, however, we know that the rate of change is variable, and in many of them it is very imperfectly known.

Take, for example, the method by which the age of the ocean, stated as some 90,000,000 years, was estimated by the time needed to accumulate the salt in it at the present rate at which the rivers are bringing salt into the ocean. We doubtless know within a few percent the amount of salt in the ocean and the amount of water that yearly goes into it, but the analyses of the water are very uncertain both in their accuracy and especially, as Collins of Washington shows, in that they do not represent fairly the amount of water which goes off in floods. This is a very large proportion of the total run-off. The analyses have not been weighted in proportion to the amount of run-off they represent, and the estimates of the average percentage of salt in the river water may be two or three times too great. Moreover, the continents are now, as the Yale geologist Schuchert tells us, much larger than they generally have been in the past. Again, in the Ice Age which ended (or apparently ended) only a few thousand years ago, a lot of unleached rock was exposed to leaching. Finally, man, with his many activities and his salt mines, adds salt to some of the rivers and, in fact, may be traced by the extra salt he introduces into the water.



After D. E. Kerr-Lawson

DISCOLORATION HALOS ON MICA, PRODUCED BY FLYING ATOMS

Such halos are microscopic and, as seen on paper or on a thin sheet of mica, are really cross-sections of spheres or concentric shells produced by the helium atoms shot out at differing (hence the different rings) speeds. They are often called "pleochroic" halos, also

Thus, it may be assumed safely that the accumulation of salt in the ocean is now going on more rapidly than it was in the past. The 90,000,000 years just mentioned would be surely a minimum, except for the fact that we do not know how much salt there may have been in the ocean in the beginning.

THIS brings up another kind of uncertainty. In our estimates of geologic time we start at the present, and the farther back we go the more unlike present conditions the conditions then must have been. This applies to all the "hour-glass" methods; that is, those that depend on actions that go in only one direction. These are "one-way streets." We can tell the age of a horse by the amount that his teeth are worn down; we try to tell the age of a mountain range by the way the folds of the strata have been eroded away; we can estimate the time taken for Niagara to cut a seven-mile gorge at the rate of five feet per year. But each of these actions represents but a comparatively short fragment of geologic time—too short a fragment for accuracy.

Those of the earlier estimates of geologic time which were arrived at by considering the cooling of the earth and sun, have ceased to be thought worthy because most of them assume a cooling from some particular uniform temperature. But probably these temperatures never were uniform. Modern astronomy leads us to think that the temperatures may have been much higher at the earth's center than those outside near the circumference, or than those assumed by Lord Kelvin. The higher the temperature, the longer would be the duration of cooling. Moreover, these methods have ceased to be of value because the radioactive disintegration which we have mentioned furnishes a source of heat which indefinitely prolongs the cooling process. In fact, if there were as much radioactive material throughout the whole earth as in the surface granites the earth would heat up and would be likely to melt and explode.

This brings us to a most interesting and recent method of estimating the age of the earth. It is not probable that the earth is as radioactive all through as at the surface, for meteorites, which are believed to correspond in composition with the interior of the earth, are not nearly as radioactive as granites, which correspond to the outer rocks of the continents. Yet it is quite possible that an excess of heat is produced within the earth, above that which is constantly leaking through the crust. This heat accumulates and weakens the crust until there is a rather sudden yielding, then the excess heat comes out in a comparatively short time in a volcanic outburst and in the upheaval of mountain ranges. This would be something like the intermittent escape of steam from the lid of a tea kettle; or more like the discharge of the heat which slowly accumulates at the bottom of a geyser tube and discharges, say, once an hour.

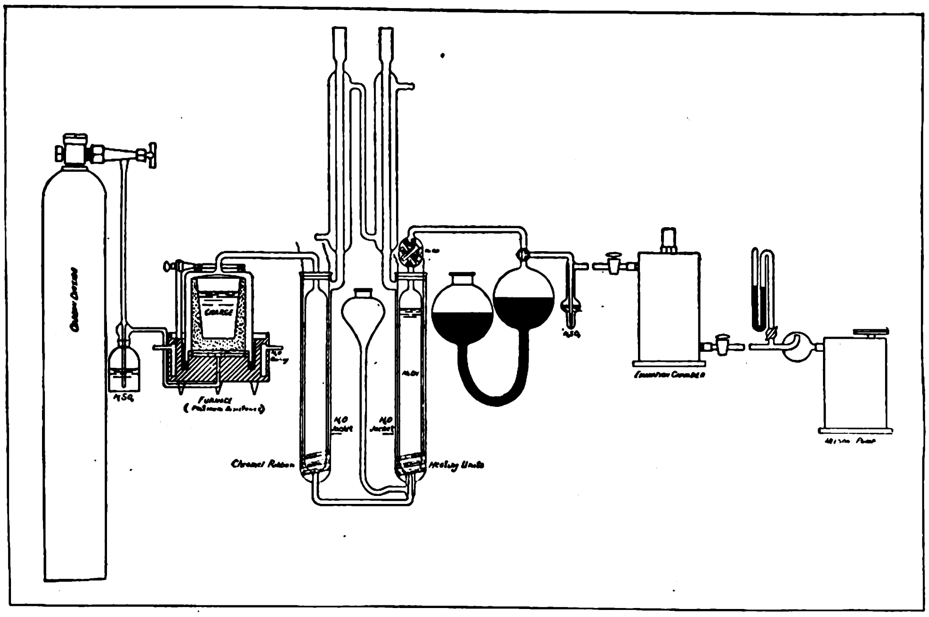
Professors Holmes of Durham and Joly of Dublin have estimated that such paroxysms occur about every 20,000,000 years.

THE question then arises; how many such paroxysms can the geologists recognize? Holmes believes he can identify 20 in the better known part of the geologic rocks. We have here a method of measuring geologic time by cycles, due to a combination of a progressive action with paroxysms nearly at regular intervals. But we do not know how regular the intervals are.

It would be ideal if we could associate geologic time, as we do the ordinary time of history, with regular astronomic cycles. For a short and recent duration this has, indeed, been done. Professor Ellsworth Huntington of Yale, lying on his stomach all one summer, measured the rings of the big trees of California. These rings are larger in rainy years. Thus he has carried back their annual record of climate to the famine which took place in the days of Elijah. Professor De Geer of Stockholm and his students, Antevs, and others, have similarly studied the banded, that is "varved," clays with an alternation of coarser clay deposited in spring, summer, and fall and very fine clay settling under the ice in winter, and has thus carried back the tale more than 12,000 years to the time when Sweden was mantled in ice.

It would be an interesting thing if we could recognize in the strata of the earth, varves due to the effect of changes in climate that take place in longer astronomic cycles than a year. At present when it is summer in the northern hemisphere the earth is farthest from the sun; it is nearest when it is sumer in the southern hemisphere. Some 13,000 years from now the reverse will be true. Gilbert and Kroll have studied the possible climatic effects, and more recently the Englishman Stamp thought he found in the Miocene Epoch strata of Burma a change in the character of beds which was due to this 26,000 year cycle. Thus he computed over 2,170,000 years for the time taken to form a series of beds that represent but a fraction of a later period of geologic time.

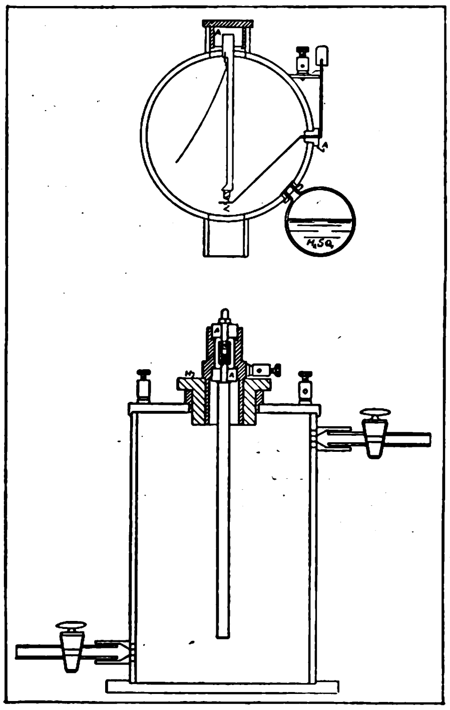
Again, at present the earth's orbit is nearly circular, so that from the September equinox to that of March is only three days shorter than from the March equinox to the September equinox. But there are times when the difference is more than a month, and the earth's orbit is much more elliptical. It is conceivable that one may detect the effect on climates and on the strata laid down when these changes take place in a much longer cycle. It is also conceivable that the whole solar system, traveling through space, might periodically pass so near to some star that the event would record itself in the story of the rocks.



Courtesy *American Journal of Science*, after Piggot

DIAGRAM OF APPARATUS FOR DETERMINING THE RADIUM CONTENT OF ROCKS

Rocks are heated in furnace, carbon dioxide picks up the radium emanations, the gases pass through the scrubbing towers and are dried and collected over mercury. A detachable gold-leaf electroscope (shown in the diagram below) on top of emanation chamber determines the ionization of the air, hence the degree of radioactivity of the particular rock samples chosen



THE ELECTROSCOPE

At bottom is the emanation chamber, vacuum-tight, with insulated brass rod in center, and above it the detachable electroscope head. Within this is a continuation of the brass rod; also the gold leaf. The little lever at right is for charging the electroscope by temporary contact with the rod

HOWEVER, with a possible exception of the 26,000 year period—our so called "precessional period"—no such cycle has been identified, though Luyten, the Harvard astronomer, has been studying the distances and the motions of the nearest neighbors of the sun.

The continuity of life and the balance of the earth's climate between the two exterminating extremes in temperature is one of the marvels of the geologic story that suggests a guiding intelligence. The identification of longer cycles, either astronomic in nature or produced by the periodic accumulation and discharge of heat due to radioactivity, is a task for the coming generation of geologists and astronomers. But it is certain that we have millions of years—hundreds of millions of years—in which to study.

Rats

The Rat Is Such a Common, Familiar Animal That His Psychology Has Almost Been Overlooked. But Even a Rat Is Interesting

By CALVIN P. STONE, Ph.D.
Professor of Animal Psychology, Stanford University

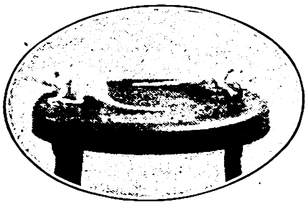
BIOLOGICALLY if not esthetically speaking the common rat is an admirable creature. Its ability to live in all parts of the world and for the most part against the will of man certainly entitles it to a high rank among the more efficient chemical engines of nature.

But hardiness and adaptability possessed by a pestiverous animal like the rat seldom win favor in the layman's thinking. While admitting the rat's efficiency for keeping in touch with his store of edible foods, at the same time he harbors an unqualified intention of lambasting him with a club whenever it is possible so to do.

In biological laboratories, however, rats have found complete asylum from those who would annihilate them when in the wild state. Strange to say it was by virtue of those same qualities that made of them the efficient pests of man, that they have now become the ideal subjects for many psychological and biological experiments. To increase the range of their usefulness scientists have found it to their own advantage to learn more of the psychological as well as the physiological make-up of rats. These psychological investigations have revealed facts that are most entertaining as well as useful.

ONE puts no great strain upon the imagination when he says that rats have coats of many colors but that they are totally unaware of it. By selective breeding tints, shades, and hues that are seldom or never encountered in the rat's native habitat have been produced. Of these the black and orange or straw yellow are probably the most striking and attractive. Esthetically speaking many people prefer the albino or the hooded strains, of which those with white bodies and black, brown, or yellow heads and similarly pigmented stripes along the back are the most common varieties. The pure albino, being the gentlest of all strains so far isolated, is for that reason a favorite in experimental laboratories. According to results of special investigations, rats are insensitive to what in ordinary terms is known as color. They can, however, discriminate with fair acuity small differences in shades and tints.

By native endowment the rat is fitted for a diversified education in a relatively complex and changing environment. Not only does he come into possession of a large repertoire of instinctive responses before or soon after the suckling period has ended, but in the course of a lifetime he forms and retains hundreds of habits and skills which enable him to cope with the individual characteristics of the native habitat. Some idea of the quality of the native equipment may be had by considering certain special phenomena of reproduction.

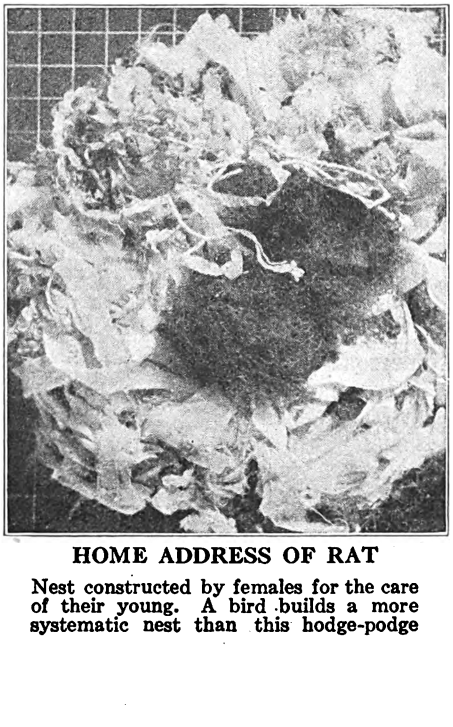


STRAW-COLORED RATS

By the common method of artificial selection rats of several colors have been bred

A farmer whose cribs and barns have become rat infested has ample reason to believe that the rat is psychologically and physiologically equipped for prodigious fecundity. Nevertheless the range of error in a conjecture of this character is unbelievable. Given ten virgin females and a couple of males, selected from a first-rate stock of well-nourished rats, an animal breeder, properly equipped and schooled in the moderns methods of husbandry, might reasonably expect to have 1500 healthy offspring on hand one year from date.

Within a year and a half this number could certainly be doubled, so strong are the reproductive instincts and so efficient the well-fed mother's care of young. Monthly increments and totals of animals on hand throughout the first year are shown in the chart. After all, however, adverse climatic conditions, unbalanced rations, food shortage, disease, and natural enemies probably are still man's greatest allies in withstanding the ravages of wild rats.



HOME ADDRESS OF RAT

Nest constructed by females for the care of their young. A bird builds a more systematic nest than this hodge-podge

Under favorable nutritional conditions the amorous life of both sexes awakens at the end of the second month of life. This, in terms of relative life span, corresponds roughly to the age of early childhood in man. The male is not a lazy drone in affairs of the heart, for his incessant philandering keeps him active from early adolescence to late senility. With the female, receptivity usually ceases before two thirds of her life course is run. Males are polygamous and females polyandrous. Incest is never a sex barrier. All provisions for the infants' care and nutrition are made by the female until the offspring are able to shift for themselves; thereafter family ties are speedily broken and forever lost.

WHEN not in captivity domesticated rats perform a wider range of activities in connection with the birth and care of their young than is usually found in the maternity wards of rat laboratories. This may be attributed primarily to lack of appropriate stimuli in the laboratory situations, rather than to a deficiency in the innate endowments of the mother, for when the latter is given a variety of nesting materials, allowed some latitude in the selection of nesting site, and permitted to avoid certain hardships and distracting stimuli of the surroundings her repertoire of maternal responses greatly expands.

A variable amount of nesting behavior is characteristic of all young adult rats of both sexes living in the wild state. Nesting contributes to the heat regulation of the body by conserving radiated energy when the temperature drops below the more comfortable ranges. To illustrate, an adult male which had always lived in a well-heated laboratory with no occasion for nest building was observed to build a nest for himself when his cage was temporarily put into a refrigerator for a period of approximately two hours.

Comparative studies of virgins and prospective mothers show that there is a great wave of nesting activity associated with or attendant upon the birth of their young. At this time nesting is more vigorous and persistent than at any other time of the animal's life. Even in the summer time when room temperatures are higher than those required for comfort of either the newborn or the mother it may be seen in all its characteristic vigor.

The nests are loosely constructed from whatever portable objects the animal may find. Upon analysis it is usually found, however, that the materials are poor conductors of heat. A sample nest mass constructed by a female from strips of various kinds of cloth, twine, hemp rope, and hair under laboratory conditions is shown in one of the illustrations. The supply permitting, a female carries new materials to the nest site daily and heaps them upon the total mass without attempting to place the individual pieces in any particular order or arrangement. Later she burrows into the mass and with fore-paws and mouth rearranges the materials about her until there is a fairly well formed pocket for herself and young. With only a limited supply of materials available an open top nest is usually constructed and maintained.

UNDER laboratory conditions many rats drag the food dishes to the nest site and push them upon the mound. On several occasions when the halves of condensed-milk cans were being used for food receptacles this tendency of the female presented some rather mysterious phenomena that we came to understand only after a bit of surveillance of the females' activities. Milk cans were found inverted over the mouths of the nests and young rats from five to ten days of age were closely packed into them like sausages of certain well known brands.

Our curiosity upon making this discovery raised the question as to whether the mothers were capable of this dexterous manipulation of young and, if so, what useful purpose it might serve either mother or young. Observation completely unveiled the mystery. The mother simply carried the can to the nest and rolled it upon the mass of shavings and paper of which the nest was built. If the open mouth of the can came to rest over the rim of the nest, the young, which crowd together like young pigs at a trough, crawled into the cans until all available space was occupied.

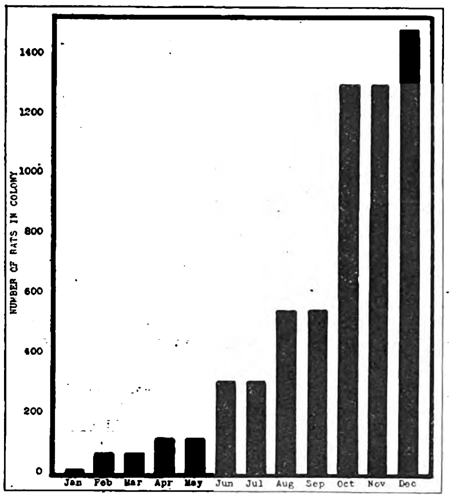
Another phenomenon strikingly absurd to the casual onlooker is seen among female rats whose nesting materials are very limited in amount. At times during the day, but more often at night, the female leaves the nest site and engages in search for more materials to enlarge or repair it here and there. On these occasions she sallies forth to all parts of the cage in search of bits of shavings, paper, or other portable materials.

Even when there is nothing more to be had, the search is continued for many minutes. It is then that the female, having gone to the farther wall of the cage, turns partially around and notices her tail lying on the floor before her. Picking it up in her mouth she starts for the nest, turning around and around until she reaches her destination, where it is deposited and shoved into place with her fore paws before starting on another forage for materials. Such stereotyped activities have been seen to be repeated over and over again in a single evening.

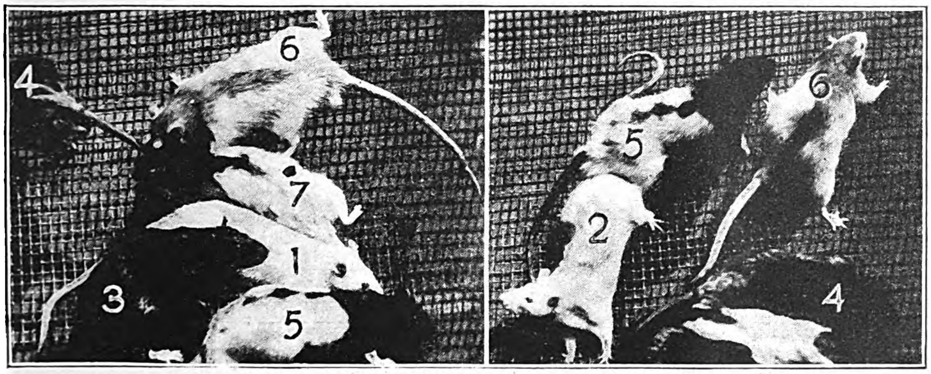
MANY actions of this type strongly suggest the presence of a strong inner driving factor back of the repertoire of maternal responses which finds expression in an abortive manner even though objects normally provoking these responses are absent and only poor equivalents are to be had.

In test situations female rats with new-born young show a remarkable range of ability to adapt their maternal behavior to sudden exigencies of the environment for which they have had no previous training or experience. When given the opportunity to choose between excelsior and pulverised dirt for the next site, the former is usually chosen. Likewise wood shavings are usually preferred to fine dirt. On the other hand dirt is usually selected when the only alternatives are fine sand or sawdust. Generally speaking, materials which admit of making the most stable nests are chosen.

If permitted to elect an illuminated or a semi-dark nest site, the latter is usually chosen. Among wild rats, hardly any exception to this rule is found. Both wild and albinos will frequently, although not invariably, move the nest and young back to the dark site daily if they are moved out into the light by the experimenter. You may recall that one seldom finds a wild rat's nest lodged in a well lighted place, as is the case with many of the well known ground birds. They hide their nests and young just as they themselves tend to hide from people and from animals which prey upon them.



OPTIMUM RAT PROGENY
Result from ideal breeding test, starting with ten selected females and two males



A RAINBOW OF VARIEGATED RATS BRED TO ORDER
Number 1 is an albino; 2 is straw yellow; 3 black; 4 brown or agouti; 5 black hooded; 6 yellow hooded; and 7 agouti hooded. Apparently the rats themselves are color blind

Under experimental conditions mothers will usually move their nests and young from strong currents of wind directed upon them, if cage facilities permit of such maneuvers. When air currents are daily directed upon the nests in their new locations, females will usually move nests and young to a quiet zone in relatively short order. Similarly, mothers repeatedly move their nests and young from a source of heat that is much too hot for bodily comfort.

EXPERIMENTS of the foregoing nature are of special value because they indicate the scope and quality of those inborn potentialities of rats, by virtue of which they are able to adapt themselves to very complex life situations. Facts of this nature, seldom coming to the attention of casual observers, help one to understand why the rat is able to perpetuate its kind the world over, even against a perennial host of adverse conditions which temporarily though never permanently hold it in check.

Bases for appreciating the marvelous adaptability of the rat also are to be had by considering it from the standpoint of its educability. Through experiments of this character we can plumb the rat's psychological makeup even better than by a consideration of its instinctive equipment.

The Radio and the Spectroscope

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

THE average citizen has probably never had much to do with the spectroscope, but he is likely to have a fairly good acquaintance with an instrument which is really of very similar nature; namely, a radio receiving set. Different as the two devices may appear, both are designed to separate from a multitude of radiations traversing the ether and falling upon the apparatus those of any desired wavelength, and to record their intensity and behavior.

The radio enthusiast demands two things above all of his receiver: it must pick up sufficient energy from the feeble waves which come from distant or low-power stations to give a clearly intelligible record, and it must be as free as possible from interference between stations operating on nearly the same wavelength. These two qualities, distance-reception and selectivity, are familiar in tens of thousands of households, and exactly the same things are what the astrophysicist desires in his spectroscopic outfit.

"DISTANCE" for him means the capacity to observe faint stars or nebulae. For stars this is primarily a financial question. The bigger the telescope which collects the star's light and feeds it into the slit of the spectroscope, the fainter will be the stars that can be reached with a practicable exposure time; so the great reflectors have this field practically to themselves. To get faint nebulae is a different matter. They are *patches*, not points, of light and a large telescope, although it collects more light, spreads it out into a large image most of which falls outside the spectroscope slit. Success here has come partly by ingenious design, concentrating the photographed spectrum on a small area, and partly by patience in making very long exposures.

Resolving power, as the spectroscopist calls the capacity to separate radiations of neighboring wavelength, is quite another story. To secure it one must design one's instrument so that the number of successive light waves which at any given instant are actually traversing the working part of the instrument is large. That is, if we use a prism it must be of considerable thickness at the base; if a diffraction grating, this must be big enough to have a large number of lines. Practically speaking, then, high resolving power demands a large spectroscope.

When enough light is available, as in solar work or in the laboratory, spectroscopes are often made very large, and spread out the spectrum so widely that the red and the violet are many feet and even yards apart. With the stars, of course, this is impracticable, and a compromise must be struck between the intensity and resolution of the spectrum. A great telescope may have half a dozen auxiliary spectroscopes. The faintest stars will be observed with a small instrument giving a spectrum perhaps a quarter of an inch long, showing a dozen or two of the strongest lines; the brightest with one which yields spectra more than a foot long, on which thousands of lines can be distinguished.

In actual selective power even a small spectroscope surpasses the wildest dreams of the radio enthusiast. It is a poor instrument that will not clearly separate the yellow sodium lines which differ in wavelength by about one part in a thousand. If radio sets could be made as good they would not be seriously troubled by interference between two stations working on wavelengths in the broadcast band different by half a meter, and the tasks of the radio commission would be much less perplexing than they are now. A really powerful spectroscope will do a hundred times better than this, and may be likened to a radio device which would permit of the inclusion of all the present American broadcasting waves within a single kilocycle. (Certain complications obvious to the radio expert which arise from modulation of the waves in broadcasting would make any such result unattainable in practice, however perfect the receiving and sending sets.)

WITHOUT this high resolving power there would have been no hope of observing more than 20,000 separate lines in the solar spectrum, each carrying its own message concerning its origin. Some of the 57 elements which have been identified in the sun are revealed only by faint lines which, with an instrument of low resolving power, are so "fuzzed" out as to be lost altogether. Others are detected by lines which lie so close to stronger neighbors that only a high resolving power will separate them. Even so, there remain many blends of lines which lie too close together for our best spectroscopes to separate. In stellar spectra, where less power can be employed, such blends are often the rule rather than the exception. It is no wonder therefore that observers never cease to desire instruments of still greater resolving power.

We know, however, that nature will sometime set a limit to such an advance. Could we make receiving instruments ten times as powerful in this respect as the best set we have now for working on the sun we would not gain proportionally. For there comes a time when we must consider what the sending instruments are doing.

These "instruments" in the sun or the stars are the innumerable atoms which compose the heated gases of the upper atmosphere and absorb from the

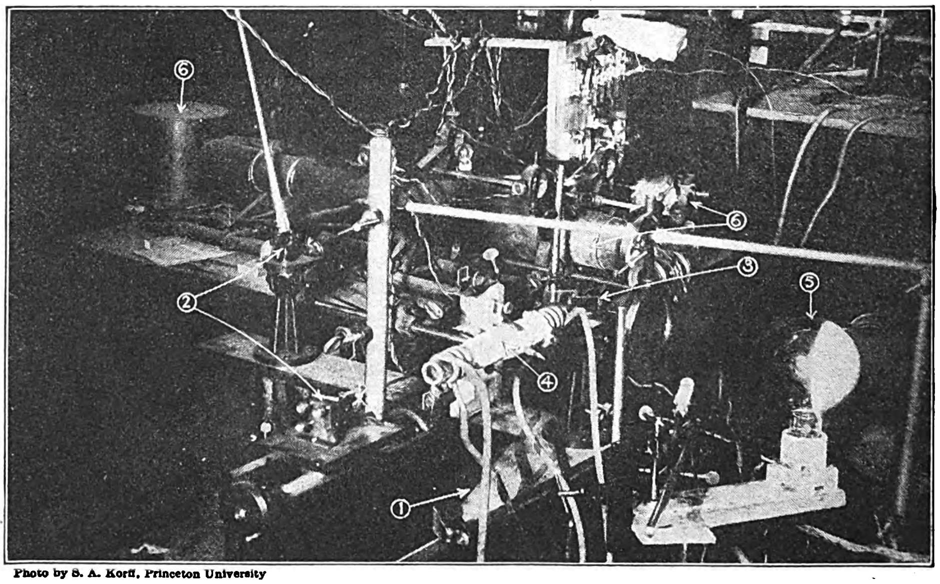


Photo by S. A. Korff, Princeton University

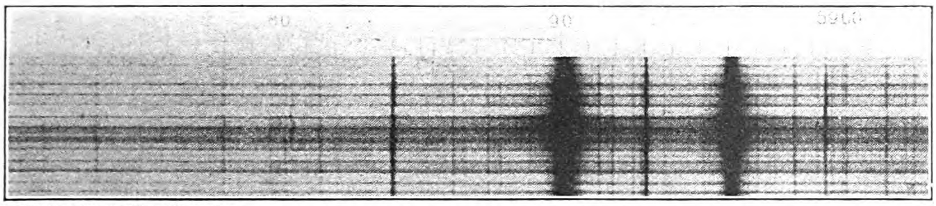
APPARATUS FOR STUDYING WIDTHS OF LINES

1, Base of Michelson interferometer; *2*, its end mirrors; *3*, its center mirrors; *4*, tube containing sodium or other vapor to be studied in absorption, with central heating coil and water cooling to protect end windows; *5*, source of light, a 1000-watt bulb; *6*, spectroscope for observing or photographing lines. Apparatus employed by Prof. J. Q. Stewart at Princeton radiation of the hotter layers below the upper atmosphere those wavelengths which correspond to the observed dark lines. The waves which they absorb are of just the same nature as radio waves, but an atom is by no means like the oscillating electric circuits of a radio receiver.

INDEED, no physicist dares today to say very much about the processes which happen when an atom absorbs light waves or gives them out. There is good reason, however, to believe that in the net effect an atom behaves very much like a tiny receiving and sending set of the simplest imaginable sort. We may picture such a set as a simple electron free to oscillate under the varying electrical forces of the light waves, but "tuned" in such a way that it responds naturally to radiation of one particular wavelength. The behavior of such an ideal "oscillator" is much like the more familiar one of an ordinary radio receiving set. We all know that, when a set is correctly tuned to the wavelength of a powerful station, the response comes in loud and strong. Our set is absorbing a large amount of energy (relatively speaking) from the incident waves. But if we put our set a little out of tune with the station we do not lose the response wholly. It fades away gradually as we turn the dial and sometimes remains strong enough to interfere seriously with weaker signals of somewhat different wavelength; that is, our set still absorbs some energy from waves for which it is a little out of tune, although less and less as we go farther out.

The better designed our set is, the narrower will be the band of interference on each side of the wavelength of the powerful station. But perfect tuning is impossible. Even the ideal oscillator, consisting of but a single electron, must have its own region, although very narrow, in which it responds to and absorbs radiations to which it is not exactly tuned. Atoms in a star's atmosphere therefore, even if they behave as well as the idealized systems just described, should not give an absolutely sharp absorption line. Exactly at the right wavelength for which they are tuned they will absorb very strongly and give a very dark line, but a little to each side they will still be absorbing—although ever more weakly—and the observed line will therefore not be sharp but bordered by "wings" gradually fading away into the bright background.

Now all the stronger lines in the solar spectrum (where we can use resolving power enough to make sure that our spectroscopes are not to blame) actually show this winged appearance. For the heaviest, like the great H and K lines of calcium in the violet, the effect is conspicuous on ordinary photographs, and it is easily visible for many others in spite of the fact that spectrum photographs have usually been exposed and developed in such a way as to secure the sharpest detail—that is, to cover up the effect under consideration.


Courtesy Mount Wilson Observatory

A GOOD EXAMPLE OF "WINGED" LINES

A section of the sun's spectrum near the D lines of sodium. The Fraunhofer lines run up and down and the horizontal streaks may be disregarded for the present purpose. The two strongest lines are due to sodium. Their great width is due to "broad tuning" and to the fact that sodium is relatively abundant. In 1924 Stewart calculated that the number of sodium atoms concerned in these lines is of the order of 10^{16} per square centimeter column in the solar atmosphere. The less intense lines are due to atoms of other elements

IT was formerly thought that this widening of the line was due to rather high pressure in the sun's atmosphere (since in the laboratory the lines produced in gas at high pressure are widened). But more careful study showed that under pressure some lines of iron, for example, are far more widened than others of equal strength, while this is not at all the case in the sun. It appeared, in fact, that the widened or winged lines in the sun's spectrum belonged to just those elements which there is good reason to believe are the most abundant, and that the strongest lines of each element are the most heavily winged. This made it clear that these wings depend mainly upon the number of atoms which are at work in producing the line, and this is exactly what should be expected on the basis of electrical analogy. The more atoms there are at work on the line the more will be working a greater amount of time, and hence the more light will be absorbed at a given distance from the center of the line, and the wider the wings will be.

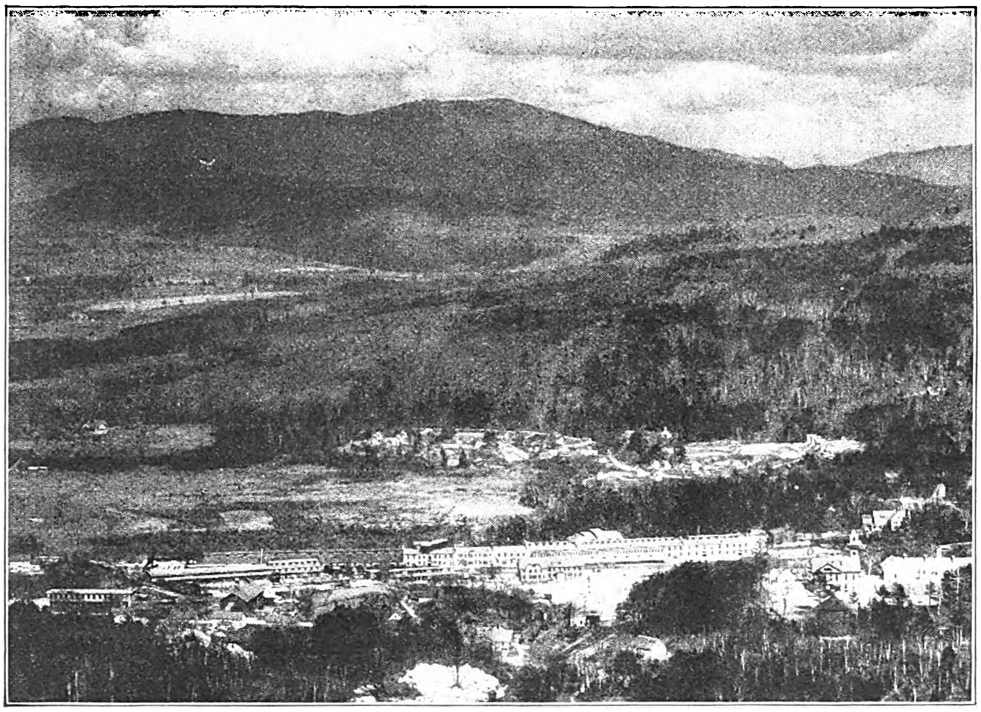
Here then is a new way of studying the sun's atmosphere. It is not merely possible to explain why some lines are wider than others but to calculate how many of the tiny idealized oscillators would be required to produce a line with wings of a given width. The calculations, which were just made by Stewart at Princeton and extended in fuller detail by Unsöld, show that the width across the wings of a line (measured for example from the points where 10 percent of the light is absorbed) should be proportional to the square root of the number of oscillators which were at work. This prediction can be tested, for there are a number of pairs of lines, such as the D lines of sodium or H and K of calcium, for which we have good theoretical evidence that twice as many atoms are at work producing the stronger line of the pair as in the case of the weaker. We should therefore expect the width of the wings to be 41 percent greater for the stronger line.

THE actual widths of the lines are very different, indicating that the numbers of atoms—or at least of "effective oscillators"—which are at work are very different. To produce the strongest lines of all, H and K, Unsöld finds that 27 x 10^{18} (27 billion billions) of atoms should be required above every square centimeter of the solar surface. The strongest lines of sodium and aluminum demand only about a thousandth part as many. These numbers of atoms are enormous but a cubic centimeter of air under standard conditions contains 27 x 10^{18} molecules. So the calcium vapor in the sun's atmosphere, if compressed so as to be comparable with air under standard conditions, would make a layer less than half an inch thick, and the vapors of sodium and aluminum vastly less.

In the latter cases allowance must be made for the fact that these elements are largely ionized. But even so, the conclusion seems inevitable that the whole quantity of these metals which are among the most abundant in the sun's atmosphere would, if taken together, make a layer of gas under standard conditions only a few inches thick. As the actual atmosphere of the sun is hundreds of miles deep it must be of extraordinary tenuity.

There is plenty of other evidence to prove this, but none more convincing. There is indeed no need of elaborate calculations or advanced physical arguments. Sir Norman Lockyer more than 50 years ago pointed out that stronger absorption lines are produced by passing light through a flame less than an inch thick and containing a very small percentage of sodium vapor than appear in the whole spectrum on account of the action of all the sodium vapor in the sun's atmosphere.

Sodium lines are nevertheless among the strongest in the solar spectrum (excepting H and K). Lockyer's conclusion that the sun's atmosphere must be of very low density, although forgotten for many years, was entirely correct. — *Pontresina, Switzerland.*



THE VALLEY OF MARBLE

The Green Mountain area contains some of the finest marble quarries in the world. They are now developed with the aid of powerful electrical and other machinery and production is on an efficient basis. Some of the marble comes from a depth of 320 feet below the surface

Quarrying Marble, the Token of Eternity

Ancient As the Everlasting Hills, Marble Furnishes a Lasting Material for Building Construction and Memorials

By A. E. HOLDEN

WHEN man first sought to perpetuate the memory of a great deed, a noble life, a sincere devotion, he turned to the everlasting hills. There he found no useful stone more inspiring, more beautifully simple, or more enduring than marble. The world's oldest statue and its oldest inscription tablet are of marble. The first, believed to be the replica of an ancient Babylonian king, was discovered by Dr. Edgar James Banks of Chicago University among the Bismya ruins of the Mesopotamian desert. George Byron Gordon discovered the marble tablet, its inscriptions still intact after nearly 60 centuries, in the ancient Chaldean city of Ur.

The tradition of the excellence of marble was ancient when the "Golden Age of Pericles" and the reign of Augustus in Rome achieved those classic works of art and architecture which have set standards of design for all the modern world. Nations, states, and families, illustrious and humble, still carry on the tradition by using this pure, inspiring stone for memorials which will pass on to succeeding generations the record of their noblest devotions.

Geologists claim that at one time the whole Green Mountain area from the St. Lawrence to the present site of New York City was under water. Then the shell fish and lime-producing animals began the work of building marble beds. Ages afterward there came a wrinkling of the earth's crust, which displaced the water with mountains and valleys and gave to the Atlantic a new shore line. Thus was Vermont marble formed and buried in the earth. For ages it lay undisturbed.

Before the Revolutionary War, someone split the first slab of American marble from the ledges of Vermont and used it for a fire-place hearth; others heard about the new material, and carried away, in ox carts, the attractive, heat-resisting stone. In the old churchyard at Bennington, Vermont, is a marble tablet which has weathered the storms since 1768—a space of 160 years. It was raised in memory of John Pratt, and unquestionably was one of the first pieces of Vermont marble to be placed in the cemetery.

IN those days, the marble trade was handicapped through a lack of suitable machinery, transportation facilities, and other trying obstacles, until in 1870, there entered the field a man who took a slipshod mill and a half-developed quarry and organized the Vermont Marble Company.

Let us start with the unopened quarry and trace the methods of raising the marble from the Vermont mountains and making it ready for the market. The experienced quarry hunter, when he finds a promising spot, calls for the coring machine, with its revolving drill, pointed with diamonds, which may be sunk to practically any depth. By this means, a cylinder of stone two or three inches in diameter may be taken out, which shows the structure and quality of marble through which the drill has passed. When the conditions warrant further development, a varying amount of waste must usually be removed before sound marble can be reached. The cost of this work frequently amounts to 50,000 dollars.

After more or less dirt and rock have been dislodged and carried away—a process which calls for careful and systematic blasting, the marble floor is ready for the channeling machines. The channeler runs on a movable track, and cuts a groove about an inch in width. When it approaches the end of the track, it is automatically reversed. Thus it goes on cutting its way downward until the groove has been lowered to a depth of several feet. The work is done by five chisel-pointed drills, clamped together in a row and attached to the end of a long bar. The resistless up-and-down motion of the bar forces the row of drills into the heart of the marble bed.

When the quarry floor has been lined with parallel grooves of the required depth, the channelers are run across at right angles, dividing the strips of marble into squares. The quarry blocks thus formed are known as "key" blocks and are broken off at the bottom by drilling and wedging. After the key courses have been cleared away, the remaining blocks in the floor are split out, at both the sides and the base, by the same process of drilling and wedging.

There are several ways of removing blocks from the quarries. At Danby Mountain, the marble is brought down over a mile of cable track, a drop of about 900 feet. At the West Rutland quarries, a part of the blocks are raised by derricks; others are drawn over an inclined cable track. This track is 500 feet long, and rises at an angle of 45 degrees. On the quarry floor, 300 feet below the surface, it connects with under-ground electric roads which extend 800 feet into the tunnel.

Once the marble is loaded on cars, it is ready to go to the mills. The modern marble mill is constructed of steel. A track, over which the stone is brought in, runs from end to end of the structure. The adjoining space is divided into stalls, any one of which will accommodate a large quarry block. Sawing is done by smooth iron bands, set in a moving horizontal frame, and acting in conjunction with sand and water.

WHILE the soft strips of iron drag to and fro across the marble, the water pours over the top of the block, bringing the particles of sand which serve as teeth for the saws.

In the days of the old mill, a few teams could haul all the sand that was needed. When the business increased, a short cableway was constructed, but the buckets soon began to come back empty. Finally, the cable was extended for two and a quarter miles over the mountain to a larger sand deposit. It now brings in sand at the rate of 500 pounds every 28 seconds.

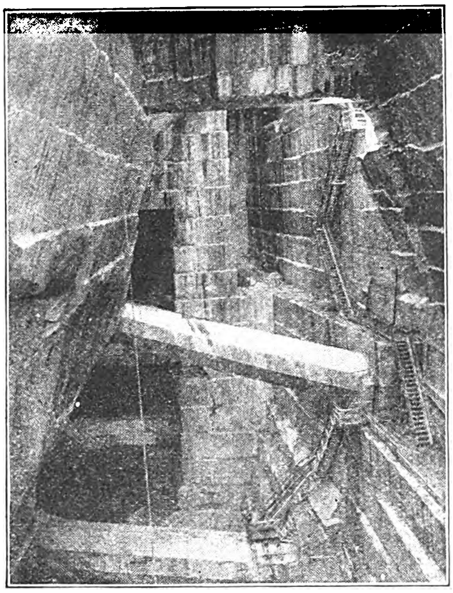
On leaving the mills, some of the marble goes directly to the monumental shops, some to the building department. If it comes out in the form of thin slabs, it will probably be used for interior building work. Within the shops it may go into one of the large lathes—for marble, like iron and steel, can be accurately turned—or it may be taken to one of the planing or molding machines.

If it is too large, it can be placed under the diamond-disk saw. The rim of this saw contains approximately 125 diamonds, and will cut the hardest marble, if it is well supplied with water. By far the larger part of the marble is delivered at the rubbing beds. There it is held in a fixed position on the surface of large revolving iron disks. The sand and water, which are spread over these disks, take away the roughness and irregularity from the marble faces. Then it is ready for the cutter and polisher.

The marble cutter of today can do almost anything with pneumatic tools. He still uses the hammer and mallet now and then—there are times when they are safer and more satisfactory—but ordinarily, the modern workman, even the carver who executes the finest of sculptured work, turns to the chisel that is driven by compressed air.

MARBLE is available in a variety of finishes, and much of it is finished entirely with pneumatic tools. This process often takes the place of sand, hone, or polish. Marble for the interior of the building is usually given a high polish. Large flat surfaces can be polished by machinery. Curved and molded faces must be rubbed down by hand. The polishing machine is a small whirling plate attached to a movable arm. These plates are of several kinds. Like the saws and the rubbing beds, they must be given plenty of water, but they use no sand. The one first employed is coated with carborundum; the second has a face of aloxite; the third is made up of fine hone-stone. The hone finish, which is a sort of dull gloss, is one that is often specified, especially for monumental work. The last plate is covered with felt and is used in connection with polishing putty. In hand polishing, the process is much the same, although more time is required to complete the work.

The "Wellhole," a comparatively recent opening on the West Rutland vein, has, as its name implies, a small opening at the top through which the blocks are raised to the surface. Quarrying in the West Rutland deposit began about the year 1844. The financial results at first were not encouraging. In fact, it took over 30 years to bring these quarries to a satisfactory state of development. In recent years from 400,000 to 600,000 cubic feet of marble have been removed each year, and there is still an almost unlimited quantity available.

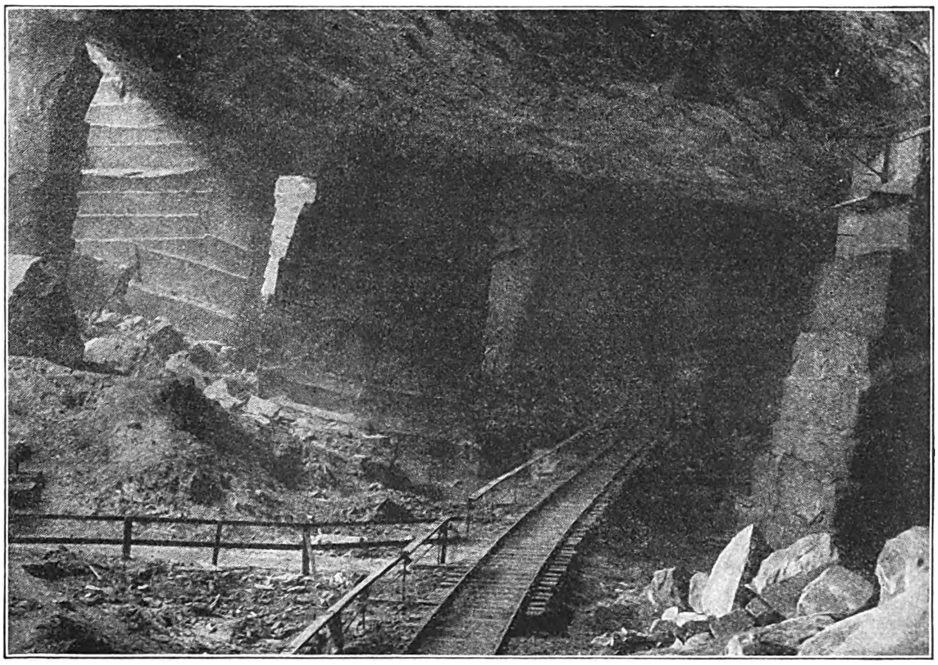


FOLLOWING A VEIN OF MARBLE

Here marble is quarried at a depth of 320 feet. The lateral pressure is resisted by immense reinforced concrete struts as shown

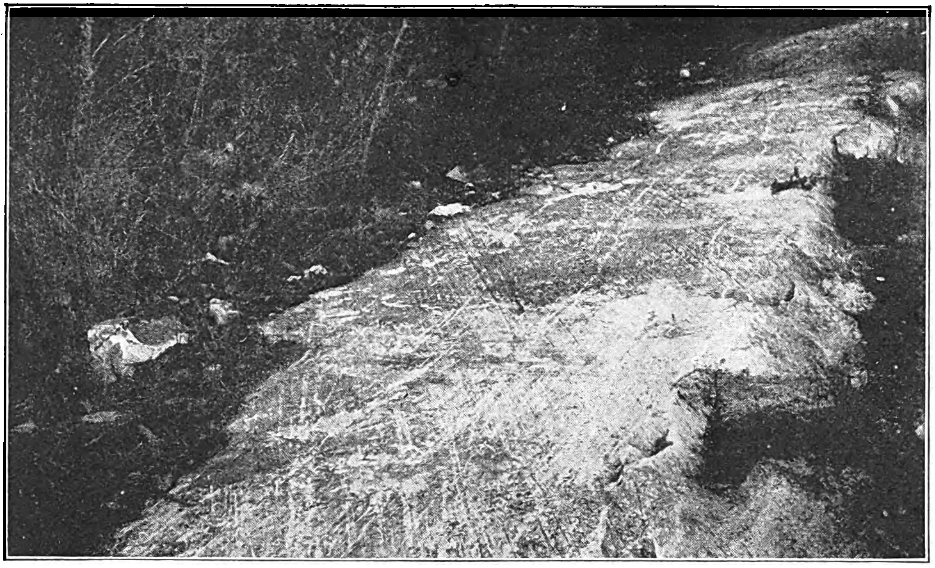
Not counting the various grades of blue marble which lie to the west of the white deposit at West Rutland, this remarkable vein produces 15 different grades of marble for monumental and interior building purposes. These range from the almost pure white to the dark greens.

The obstacles surmounted in the



IN THE UNDERGROUND QUARRY

Huge piers serve to sustain the roof while the electric railway brings the quarried marble to the "Wellhole." It took 30 years to develop these quarries for profitable production



GLACIAL SCRATCHES

This outcrop of marble is interesting on account of the glacial scratches which show that the marble was in place before the great ice cap scraped the hard stones over the soft marble

Pittsford Valley quarries at Florence, Vermont, are suggested by the illustrations. Following a comparatively narrow vein of marble to a depth of 320 feet, the tremendous lateral pressure is held in check by immense reinforced concrete struts. These quarries present to the architect and engineer one of the most interesting developments of the Vermont region.

The Pittsford Valley quarries produce large quantities for cemetery memorials and several varieties of interior and exterior marble. The quarries are notable for the large sizes which are obtainable. Blocks for monolithic columns measuring 32 feet long and over four feet square have been readily secured, the hoisting of pieces of this size being the major problem.

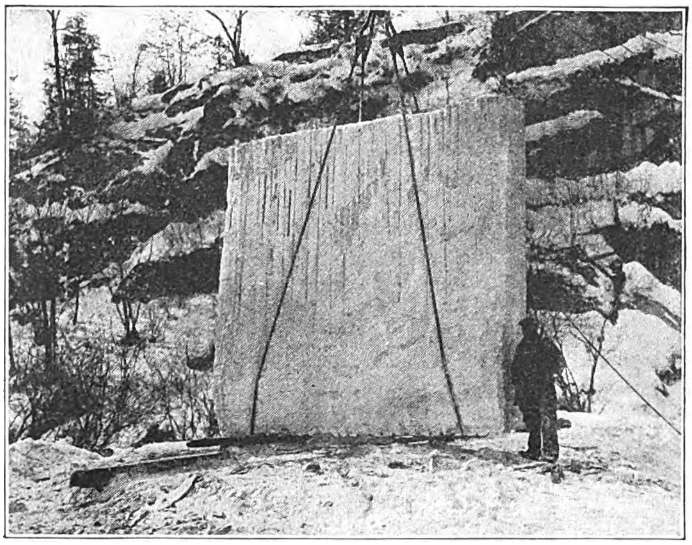
For the Bridgeport Savings Bank, the Pittsford Valley deposit furnished two of the largest caps ever finished in Vermont marble, each containing 117 cubic feet. The pilasters for this structure were made up in three sections, each piece containing 116 cubic feet. One of these blocks weighed 52 tons, another 55 tons.

Verde Antique is the standard dark green marble of America, and was first produced about 1850. The original quarry, located at Roxbury, Vermont, was operated in a limited way until 1893. The earlier methods were crude in the extreme and the quantity of marble produced was very small in comparison to the present output which, in 1924, was over 12 times that in 1901. During the last ten years, several new quarries, all in central Vermont, have been developed. Verde Antique occurs in isolated masses which, roughly, are of the shape of a double convex lens standing on edge. The marble is of such extreme hardness that the quarrying presents a difficult problem. The machinery is the same as that used in other quarries, but specially tempered cutting steel is provided. The finishing also presents an unusual problem. The bulk of this work is done at an especially designed and equipped plant at Swanton, Vermont. There at the lower falls of the Missisquoi River, where water power is available, are 24 saw gangs and a large finishing plant.

The early settlers in the vicinity of Danby Mountain discovered its deposits of marble and, from the outcroppings in the valley, split off pieces for memorials to their dead. Headstones bearing dates as early as 1765 are still standing, their crude lettering sharply defined in spite of the passing years. In 1836, at Erie, Pennsylvania, there was erected from the Danby quarries the first marble public building in America of which there is any record. Constructed originally by the United States Bank of Pennsylvania, it was purchased by the Government in 1850, and is now used as a Custom House. It is still well preserved.

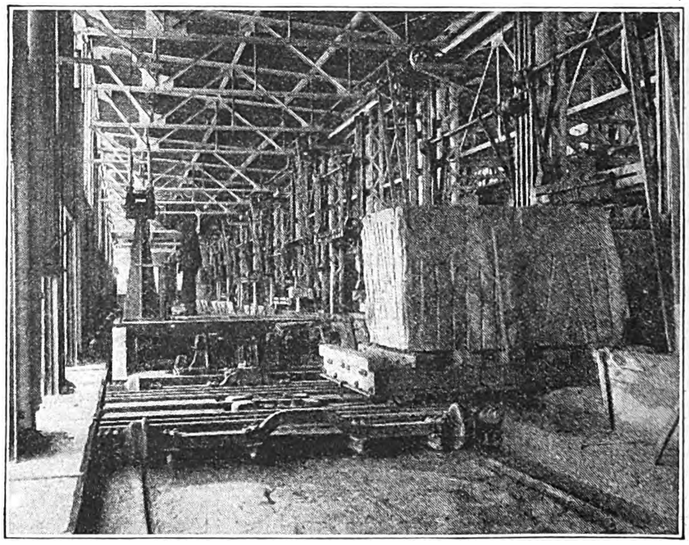
As the demand for marble increased, quarries farther up the mountain side were developed, the blocks at first being drawn down by teams. This crude and dangerous method of handling finally gave way to an inclined railway, operated by immense cables. The steam cutting machines, which were first used, were replaced by modern electric channelers, and there was finally evolved the remarkable quarry development of the present day.

Tunnels have pierced this mountain to a distance of 400 feet, and lateral branches have been added until more than two acres of quarry floor with an average depth of 30 feet, are now furnishing blocks. The quantity production of marble whose quality has been proved by over a century of use is now possible. Storage yards always contain upwards of 15,000 blocks.



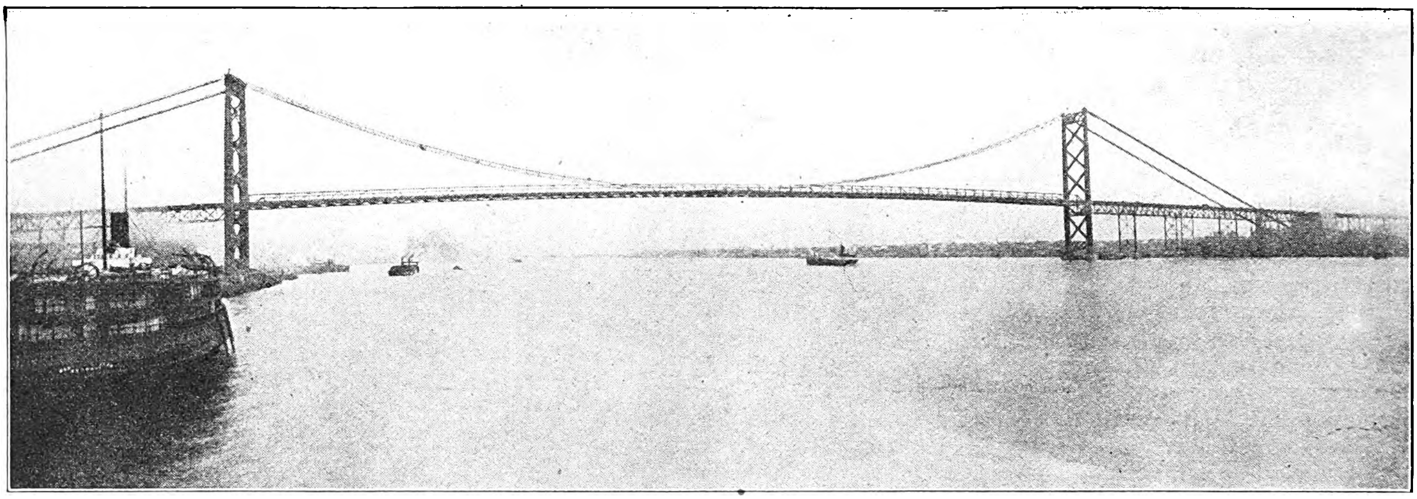
A 63-TON BLOCK

It is rarely feasible to quarry just what blocks are required for current orders but there are some exceptions and here is one



A MARBLE MILL

Giant lathes and planers machine the blocks and slabs for building or monumental purposes. Pneumatic tools are very largely used



"BECAUSE OF, AND FOR, AUTOMOBILES"

Tremendous increases in automobile traffic, by ferry, between Michigan and Canada made this bridge necessary. It connects Detroit with the great Ontario peninsula between Lakes Ontario and Erie and cuts many miles from the trip north to Niagara Falls

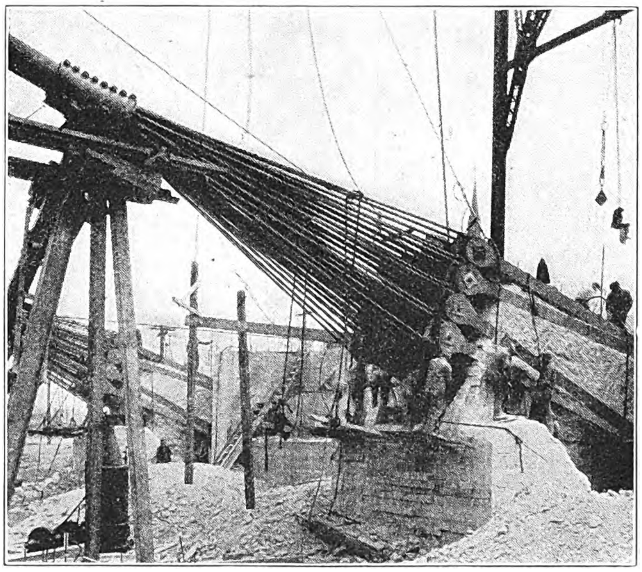
The Detroit River Is Spanned

At An Extremely Important Point, Economically, a Beautiful Bridge at Detroit Has Largest Span in the World

BY F. D. McHUGH

BRIDGE engineering has reached such a stage of design today that one expects to find a certain massive beauty in any new span that rises. Slim skeletons of steel pointing skyward from river or river bank piers and holding high their thin webs which, in turn, support a gracefully curved floor, all seemingly conscious of the combined estheticism and utilitarianism that have been worked into their design by skillful engineers, grip the imagination and give rise to a feeling of pride in the works of man.

When, however, such a structure becomes also a new tie to bind two great peoples into a closer friendly relationship, when it serves to promote the exchange of raw and manufactured products, and when it removes another section of the physical barrier between one country and its best customer and source of outside supply, it has an added significance; it is a "most important contribution to international amity." Such a bridge is the appropriately named Ambassador Bridge over the Detroit River between Detroit, Michigan, and Sandwich, Ontario, which has just been completed and was dedicated on November 11, 1929.



TWO ANCHORAGES

Cutting away the concrete from around the cable terminal eye-bars. This shows the manner in which cable terminals and eye-bars are finally embedded in massive concrete

WITH the longest main span of any suspension bridge in the world at the present time, the Ambassador Bridge was built because of and for automobiles. In the olden days the missionaries Brebouf, Chaumonot, de la Richardie; the explorers Joliet, LaSalle, and Cadillac; the chieftains Pontiac and Tecumseh; and the generals Brock and Harrison had to cross the natural barrier of the Detroit River in boats. With the rise of the so-called border cities there was much agitation for the bridge. Just prior to construction of the present bridge, a bridge to include a deck level for railroads was contemplated and almost decided upon; but this, along with other bridge ideas, had to be abandoned because of the tremendous increase of automobile and bus traffic. The completed bridge provides primarily for automobiles and incidentally for pedestrians.

The location of the new bridge is unique in that three great general trade routes intersect at this point. These are the Canadian routes from the north and west which terminate in the east in Montreal, Quebec, and other eastern Canadian points; the American trade lines from east to west across the peninsula and eastern Ontario; and the Canadian-American trade route connecting the Canadian east with the American middle west, far west, and south. Thus it will be seen that the location has the economic significance of the famous caravan cities of the ancient Oriental countries.

DURING a recent six months' period, customs figures show that 135,000 tourist cars crossed the border at this point while the estimated total, including holiday and week-end visitors, was 675,000 cars. With an average of four and a half persons per car, this would give a traffic of around 3,000,000 passengers during that period of time. It is anticipated that completion of the bridge will tend to increase this traffic to a very large extent because of the fact that from any point north of Chicago, the bridge route to

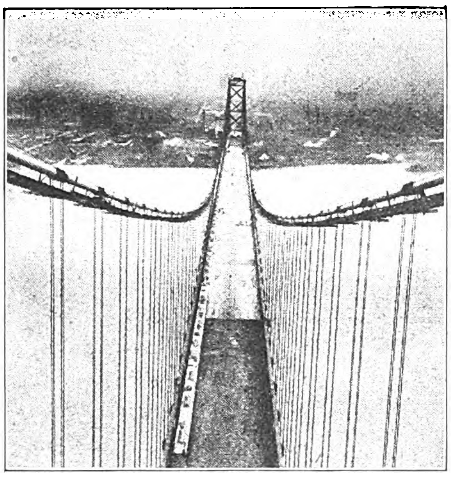
Niagara Falls is very much shorter than the route by Cleveland, as shown by the following table:

To Niagara Falls From	Via Bridge	Via Cleveland	Saved
Detroit............	254	391	**137**
Chicago............	543	578	**35**
Grand Rapids......	401	505	**104**
Battle Creek.......	369	446	**77**
Kalamazoo.........	393	470	**77**
Fort Wayne, Ind....	422	432	**10**

Many problems were encountered in preparing the plans for the new bridge. Early surveys were inaccurate; clearance of the bridge above water was first made too low, inasmuch as ship's masts have lately been made higher due to the demands of improved radio equipment; the span of the bridge was originally planned to be 1770 feet.

THE main span of the bridge is 1850 feet and the suspended floor clears the water 150 feet at the center and 135 feet at the towers. The bridge itself is 9000 feet long from the end of one approach to the other, 7400 feet of this being structural length. The Canadian approach is 2420 feet, while that on the American side is 1480 feet. The approaches on both sides spread out into wide plazas and each approach has nearly 30 customs and immigration gates for expediting traffic and preventing traffic tie-ups. There are two towers approximately 380 feet high above mean water level, each resting upon two 38-foot concrete cylinders. The dead load on each cylinder is about 20,000 tons.

Two great cables, each 19⅜ inches in diameter, support the roadway and stiffening trusses. These cables are swung on 67-foot centers and rest upon massive rocking cradles on the tops of the towers, these cradles being designed to take care of any expansion due to temperatures up to 120 degrees.



FROM THE CANADIAN TOWER

Cables, suspender ropes, catwalks, and floor can be seen in this view of the bridge

The total width of the suspended roadway is 55 feet, 47 feet of this being divided into five vehicular traffic lanes and the remaining 8 feet being a sidewalk.

Construction on the bridge began on May 7, 1927 and proceeded so rapidly that it appeared it would be completed long before the scheduled date of August 16, 1930. Then the unforeseen occurred.

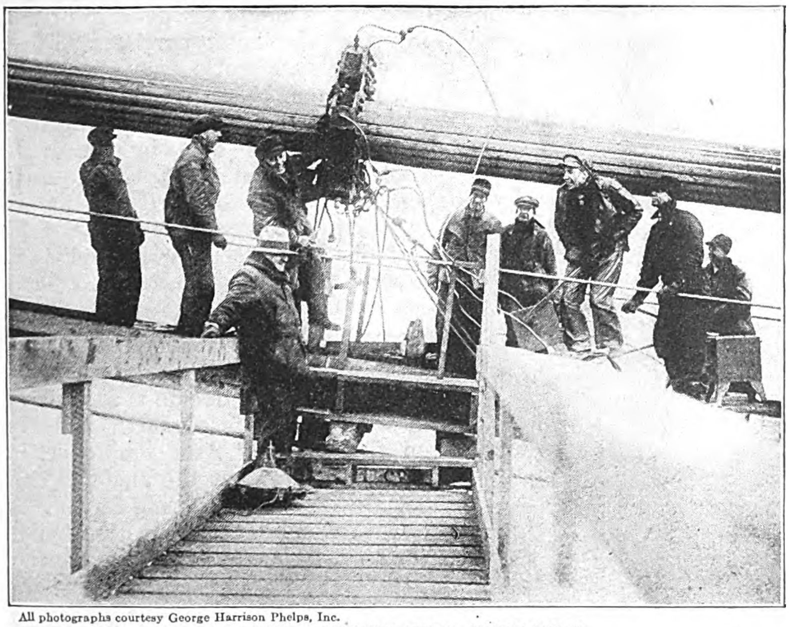
The great cables had been erected; the two foot-walks used in spinning the cables had been removed, cut into sections, and the sections used as suspenders for holding the bridge floor; and a part of the roadway structure had been erected when news of breakages in a similar structure, the Mount Hope Bridge, was received. No important breakages had been found in the cables of the Ambassador Bridge, but they were assembled from a new steel wire exactly the same as that used in the cables of the Mount Hope Bridge and produced by a special heat-treating process. Therefore it was decided to scrap the cables before something serious did happen and replace them with cold-drawn steel wire that was known to be dependable for suspension-bridge work.

Riveted girders that had been placed at the roadway were taken down, new cables to hold two new catwalks were made ready, and the catwalks themselves put up. Then when the suspender cables had been removed, everything was ready for the work of dismantling the cables.

THE cables themselves were composed of 37 compacted strands of Number 6 galvanized wire, each strand containing 206 wires. Back at the anchorages the concrete was broken away so that the end of a strand could be gripped and pulled from the cable by means of a hydraulic jack. The removed strand was then cut with an oxy-acetylene torch into lengths of about 30 feet which were, in turn, hauled along the catwalk to the towers and then lowered by crane to be carried away and sold as scrap.

The cold-drawn wire of which the new cables were to be spun was ready when the process of disassembly was completed. This work of destruction had taken but 20 days. Spinning of the new cables proceeded rapidly and the bridge was completed long before the date originally scheduled for its completion. It was dedicated, as stated above, on November 11, 1929 and was opened for traffic on November 13.

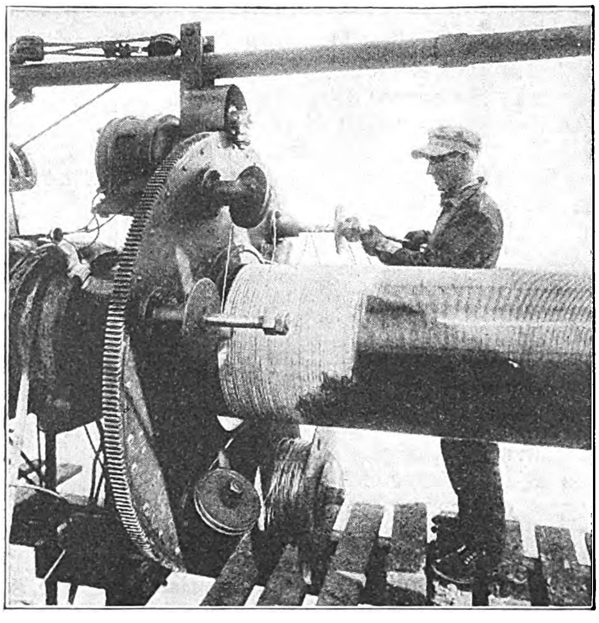
The Ambassador Bridge is the property of the Detroit International Bridge Company. It is expected that tolls will pay for the structure within a comparatively few years.



All photographs courtesy George Harrison Phelps, Inc.

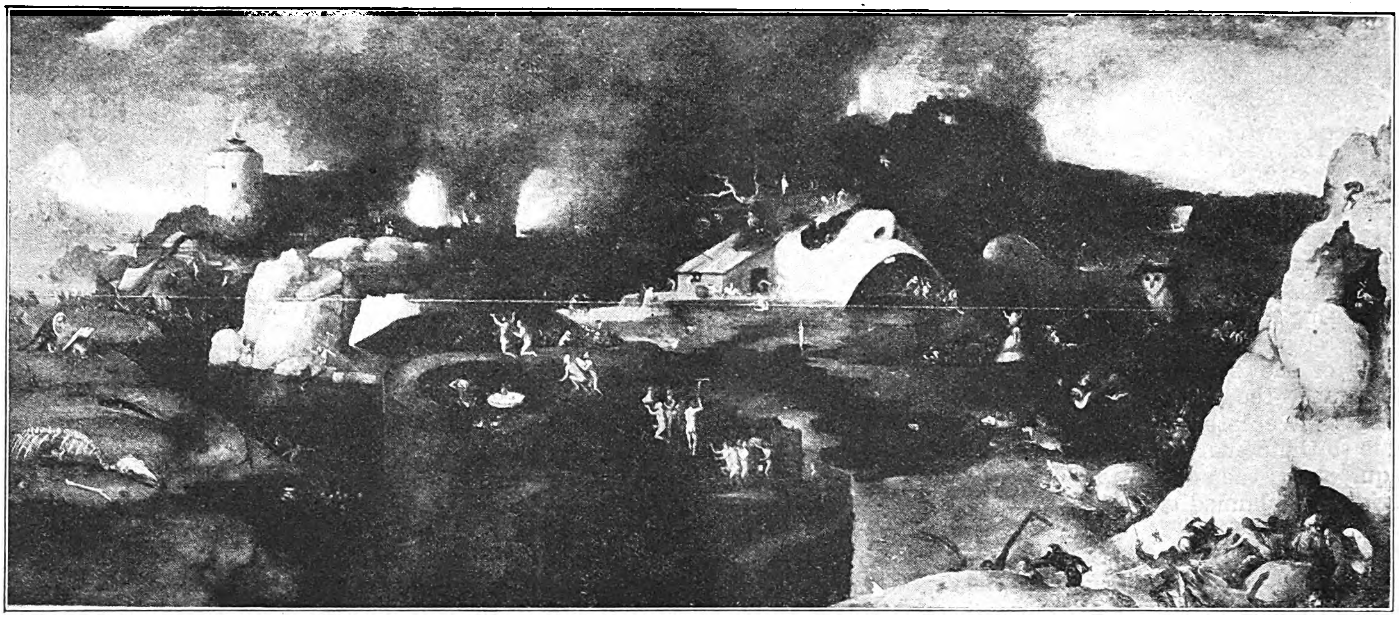
COMPRESSING THE STRANDS

A compressor similar to the one described in a previous bridge article, with radial hydraulic jacks, press the strands into a round section



WRAPPING THE CABLES

This machine wraps a binding of soft iron wire around the cables, 300 miles of wrapping wire being used



AN OLD MASTER'S CONCEPTION OF HELL

Christ's Descent Into Hell, by H. Bosch, a Flemish painter (1462–1516). Early writers who wished to depict a horrible hell and thus frighten the common herd into better morals would doubtless have used with avidity the modern scientist's knowledge of heat and cold

A Modern Inferno

What the Civilized World Owes to the Scientific Research of the Modern Chemist

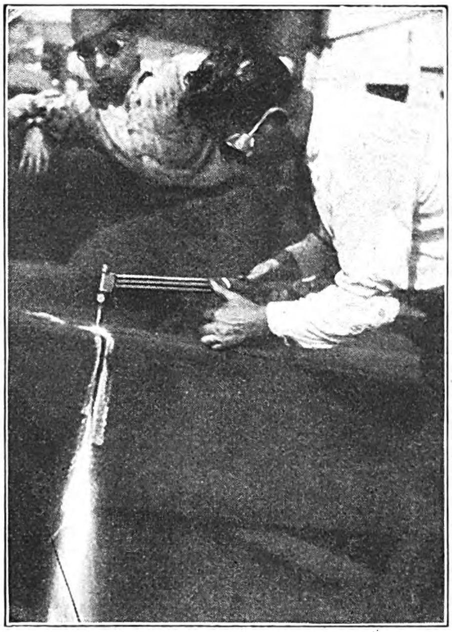
By MARTIN MEYER, Ph.D.
Assistant Professor of Chemistry, College of the City of New York

CHEMISTRY is a branch of knowledge especially wrapped in the cloak of mystery which that non-existent individual, the average man, is inclined to throw about any matter which he considers difficult or profound. Until recently very little has been popularly known about it. Despite the dramatic horrors of the World War and later widely advertised discoveries of tremendous business importance, the word "chemist" still evokes mental images of the owner of the corner drug store.

Although the realm of chemistry is one of the most fascinating and absorbing fields of human thought, one can as a rule obtain little general attention to it. It has had, so to speak, no "sex appeal."

IT still remains for some one to do for it what H. G. Wells has done for history and Will Durant for philosophy. It shares with astronomy the honor of being the oldest branch of man's knowledge of nature and none has had a greater influence upon the course of civilization. The history of the human race is more truly reflected in the story of the progress of science than in the narrative of political biographies and names and dates of military conflicts that has long held the name.

In the records of the earliest Egyptians it is found that simple chemical experiments were communicated from generation to generation of priests who practiced them as a form of magic to befuddle the uninitiated. One frequently hears the science referred to as the Hermetic Art, from an old priestly devotee, Hermes Trismegistus. The Greeks had systems of natural philosophy which included chemistry and these, too, have transmitted their cultural influence to our own time. The commonly used phrase "exposed to the mercy of the elements" refers to an early conception of the chemical elements. The problem of the nature of matter is still a fundamental one.



Courtesy Linde Air Products Company

6300 DEGREES HOT

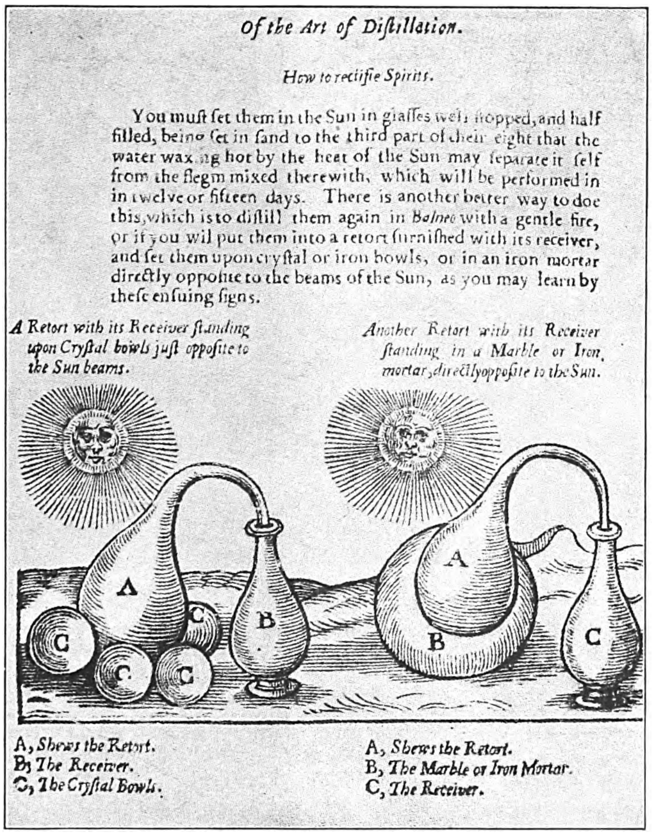
The oxy-acetylene flame cuts through solid metal like a warm knife through butter. What would early science have thought of it?

A belief of the same period was that all matter is composed of four primal things, or elements: earth, air, fire, and water. Aristotle was struck by the inadequacy of such a conception to explain the existence of the varieties of matter which he saw about him. He invented a fifth element, the "quinta essentia," the sublimated essence of everything, to account for the very apparent discrepancies. It survives in the word "quintessence."

ONE might be inclined to think that it hardly required a monumental intellect to decide that a silver coin was not made of earth and fire even though they were employed in its manufacture; but the ancients and especially the Greeks were lacking in the methodical experimentation which is the cornerstone of modern science.

Most of the knowledge of the ancients was acquired more or less by accident. If it had practical value it was practiced as an art by rule-of-thumb methods. Nevertheless they were remarkably efficient in many things which are today regarded as highly technical operations—the manufacture of glass and porcelain articles, the metallurgical processes and the fabrication of swords and implements with cutting edges. Some things which they knew have become lost arts and have not yet been rediscovered. It is highly doubtful that the modern "mortician" could embalm a body so that it would remain in the truly remarkable state of preservation for thousands of years exhibited by the mummies in museums.

We could, if space permitted, trace the story of the science of chemistry among the Romans, the Arabs, the Chinese, and during the Middle Ages, and point out fascinating little bypaths for reading — such widely unrelated things as that the caliph Al Mansur, of Arabian Nights fame, was a patron of the alchemists, the medieval ancestors of the modern chemists, and that the romantically mysterious cult, the Rosicrucians, had vaguely chemical aspirations. Incidentally, the private lives of a few of the chemists would rival the pages of the daily tabloids for human interest.



Of the Art of Diſtillation.

How to rectifie Spirits.

You muſt ſet them in the Sun in glaſſes well ſtopped, and half filled, being ſet in ſand to the third part of their height that the water waxing hot by the heat of the Sun may ſeparate it ſelf from the flegm mixed therewith, which will be performed in in twelve or fifteen days. There is another better way to doe this, which is to diſtill them again in *Balneo* with a gentle fire, or if you wil put them into a retort furniſhed with its receiver, and ſet them upon cryſtal or iron bowls, or in an iron mortar directly oppoſite to the beams of the Sun, as you may learn by theſe enſuing ſigns.

A Retort with its Receiver ſtanding upon Cryſtal bowls juſt oppoſite to the Sun beams.

Another Retort with its Receiver ſtanding in a Marble or Iron mortar, directly oppoſite to the Sun.

A, *Shews the Retort.*
B, *The Receiver.*
C, *The Cryſtal Bowls.*

A, *Shews the Retort.*
B, *The Marble or Iron Mortar.*
C, *The Receiver.*

EARLY LABORATORY METHODS

An early method of heating laboratory apparatus, from "A Compleat Course of Chymistry," by G. Wilson, London, 1709

IT is the modern science of chemistry which is the greatest miracle and its story begins about 1770 with the great French chemist, Lavoisier. It begins to differ from its ancient forbears by the introduction of the so-called "scientific method." This is a system of logical thinking, characteristic of all modern sciences, the result of a slow process of growth during a relatively short time, the last 200 years. Like many another thing it is a matter which, from the everyday viewpoint, is more clearly and easily illustrated than defined. It consists chiefly in the careful observation, classification, and explanation of the facts of nature, with laboratory experiment under regulated conditions. Largely by the genius of Lavoisier was such systematic method introduced into chemistry, and the French people showed their appreciation of his work by sending him to the guillotine during the Revolution.

But there were many at the same time and later to carry on his work, men whose names have become household words in the science—Scheele, Priestley, and Berthollet who made fundamental observations, Dalton who formulated the basis of the modern atomic theory, probably in its present form one of the noblest and most daring bits of speculation ever developed by man. Then, too, there was Faraday who studied the nature of electricity, which has since progressed to where the following old joke has lost its point: A professor of chemistry was lecturing on electricity to his class and happened to notice a student in a rear bench who was apparently fast asleep. He waited for a few moments to make certain of his observation, in the true spirit of science, and then addressed the impolite undergraduate very sharply:

"Mr. A., what is electricity?"

Jolted suddenly into consciousness, A. rose slowly to his feet and, mustering all the resources of a college education to a situation which was probably not unusual, answered the unheard question with a stammering:

"Er . . . I knew this morning, but I have forgotten."

"What a pity," replied the professor, "the only man in the world who knew what electricity is and now he has forgotten."

The modern chemist and scientist can tell, however, what electricity is with a degree of confidence. Electricity is matter. Matter is also electricity. The two are reduced to one, although we do not know which one it is, and that too is an interesting story.

Then there were Davy, Berzelius, Liebig the father of agricultural chemistry, Dumas, Kékulé, Mendelejeff, Ostwald, Perkin, the Curies, and a host of others who laid the foundations of the many branches of modern chemistry.

Within the last 30 years chemical knowledge has grown like a snowball rolling downhill, until the chemist's laboratory is the land of marvels. One of the foremost reasons for this has been the increase in the methods by which the scientist is able to control the conditions of his environment. Examples are too numerous to give in detail, so let us choose merely one as an illustration—temperature.

High and low temperatures enable us to produce many things that are not to be found in the heavens above, the earth beneath or the waters that are under the earth. About us we find a relatively narrow range of variation. In the habitable portions of the earth's surface the thermometer rarely goes below −40 degrees in winter and above 115 degrees in the summer. For centuries the temperature of ice, 32 degrees, and that of an open fire, about 1600 degrees, remained the greatest variation that man could produce for himself.

YOU recall the poet Dante's immortal story of his visit to Hell, and of the souls of the historically famous and infamous damned who were being tortured there by exposure to the torments of the extremes of ice and fire. The grandeur of the poetry will probably never be surpassed. But the modern scientist's only comment upon the scene it pictures is upon the poverty of the omniscient imagination which would employ such altogether ordinary temperatures to produce the desired effects. The scientist has liquefied air by cooling and compressing it and allowing it to expand repeatedly. The product is a pale blue liquid which resembles water from a distance but has a temperature of −310 degrees. In comparison, a cake of ice is literally red hot. By a similar process applied to helium he has produced a temperature below −458 degrees or less than 1 degree above absolute zero, the lowest temperature which can possibly be attained.

On the other hand, going up the scale, he can burn a mixture of ordinary illuminating gas and air in a blast lamp and obtain a temperature of 2700 degrees; with an oxy-hydrogen torch, 3600 degrees; and with an oxy-acetylene flame, 6300 degrees. The latter will cut through a quarter-inch steel plate with about the same ease that a hot knife goes through a cake of butter. Then in the electric arc he can produce temperatures which are limited only by the resistance of the furnace itself as it melts and breaks the circuit, the highest temperature so far being about 9000 degrees or more than half the estimated temperature of the sun.

Picture for yourselves the sublime heights of torture which could be attained in an inferno properly designed and equipped with up-to-date heating and cooling devices by the scientist, and compare it with the feeble attempt of the theologist. For the scientist, of course, these are merely the tools with which he works, but with them and others he achieves the wonders which distinguish the present world from any which precede it.

The extent to which this age is indebted to the chemist and the science of chemistry is boundless. There is no phase of man's activity which has not been profoundly influenced. In an age of machines and tremendous engineering attainments he supplies the materials—iron, steel, concrete—of which they are made in an endless stream, improves old ones, devises new ones to take their places, and makes processes of manufacture ever cheaper and cheaper.

IF the true test of human greatness is, as has been said, that of making two food plants grow where there was only one before, then here, too, the chemist has a just claim. By study of the soil and the growth of plants he has been able to double and triple the productivity of a given piece of land. With the help of the engineer he has been able to make the desert blossom as the rose, and render altogether unproductive areas fertile. He has delayed to a much later date Malthus' mournful prediction that within a comparatively short time the increase in the population of the earth will starve the human race to death. By scientific methods a very small portion of the United States could today feed the entire world.

In politics, too, the chemist quietly plays a prominent part. Histories of Europe of older days recorded the interplay of political forces as an attempt to maintain very delicate balances of power. Today a much more important matter is that of maintaining a balance of steel production, and one can better understand the desires of nations for disputed bits of territory if he consults a map of the location of iron ore and coal deposits than by consideration of vague feelings of racial fraternity. Military power itself is maintained more by high explosives, poison gas and flame, and the materials for producing and employing them than by the mere number of available soldiers. These are all essentially chemical problems.

Sociology seems to be as far away from the activities of the chemist as anything reasonably could be. Even here one of the pressing questions of the day is the solution of the drug and narcotic difficulty. It has been said, and many believe, that the synthesis of morphine recently reported will solve it, and one can be hopeful when he considers the achievements of the past.

America's great contribution to civilization has been a democracy that works. Here chemistry plays a major role. Chemistry is the great agent of democracy. You can declare men equal by legislation but that which really makes them equal in their own eyes is equal opportunity to satisfy their desires. Although closely related, men value the ability to enjoy the luxuries of life above mere cold equality before the law. Chemistry has placed the luxuries of life within everyone's reach. There was a time when a certain purple dye was so expensive that it could be purchased only by the very rich, and the wearing of the purple was synonymous with wealth or noble birth. The chemist has analyzed Tyrian purple and made it so cheaply that all may have it, then discarded it for others of greater beauty and more lasting value. So has it been with precious stones as the ruby and sapphire, and with the more beautiful of the textiles such as silk.

At present we are writing another interesting and important chapter in the story of chemistry—Chemistry in America. Many are the marvels of applied science but these are based upon the discovery of the principles of science itself—pure science as it is called. This in turn rests upon the abilities of men who in the quiet and isolation of their laboratories devote years to the researches which will never be rewarded by the plaudits of the crowd or the luxuries of riches. Rarely does the pure scientist also discover the practical application for which these are the compensation.

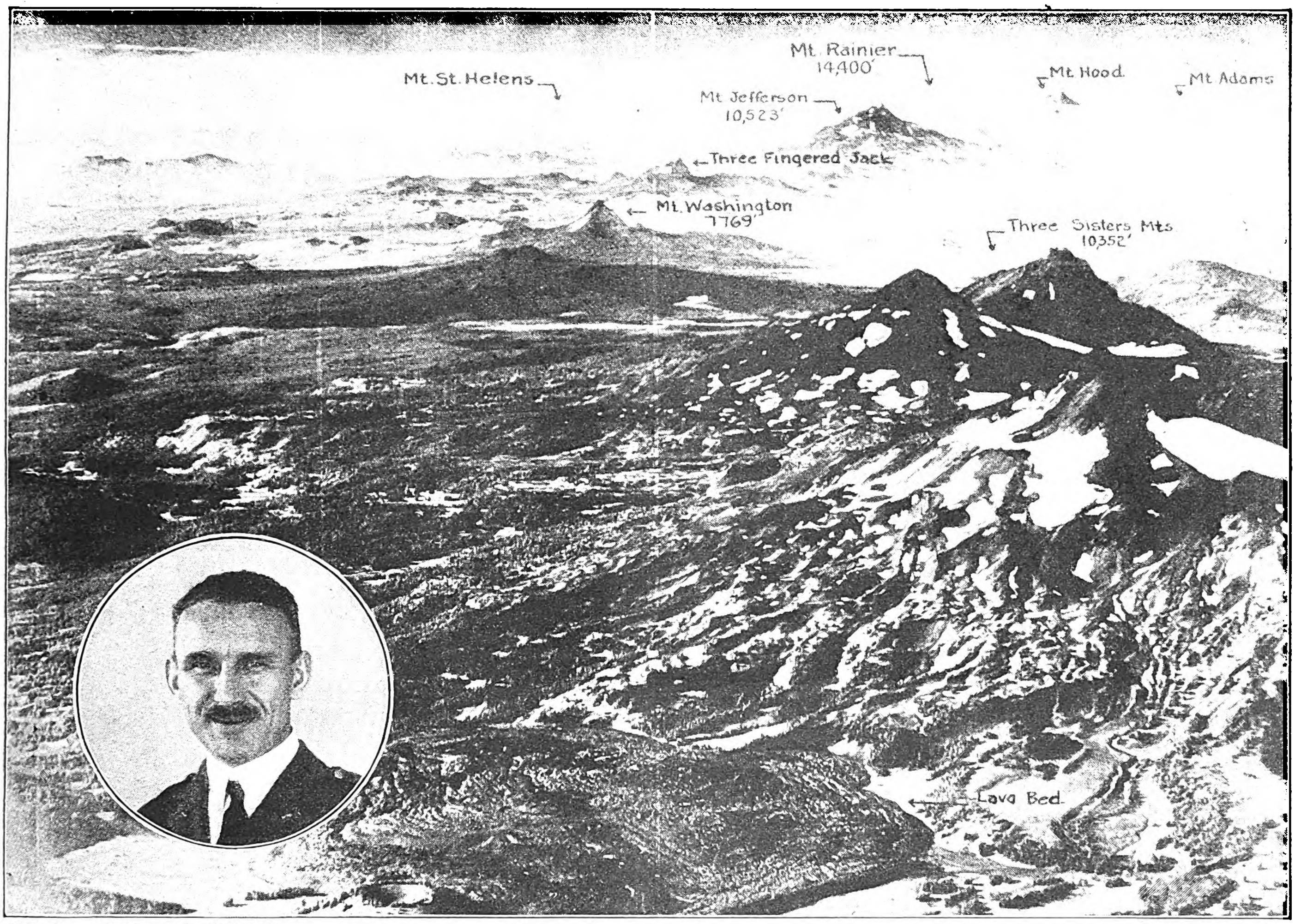
Yet it is upon the labors of these men that the progress of science depends. This is a matter to which it would be well to devote serious thought. A famous educator recently deplored the loss of able scientists from the universities and colleges to industry which can pay better salaries. The fact is true, but one is inclined to doubt the reason. If human experience proves anything, rarely have the feet of genius been led from the path of loyal devotion by poverty or physical suffering. Again, in many branches of science such work today is more highly paid than similar work in industy.

The statement may be interpreted as a serious criticism of the home of pure science itself—the colleges and universities. Often the positions of rank and eminence in their departments are held by men not at all distinguished by achievement, intellect or culture, but rather by the possession of that qualification so aptly described by Cabell as a much surer means of advancement. As a result, to the delicate sensibilities which always mark the man of intellect the situation frequently means intellectual suicide. He goes into industry because, whatever may be the unquestioned faults of the dollar as a standard of value, it has at least the advantages that it is impersonal and objective, two attributes imperative in the scientist.

Courtesy Linde Air Products Company

TEMPERATURES EARLY CHEMISTS NEVER DREAMED OF

"Picture for yourselves the sublime heights of torture which could be attained in an inferno properly designed by the scientist, and compare it with the feeble attempt of the theologist"


Mt. St. Helens
Mt. Rainier
14,400'
Mt. Hood
Mt. Adams
Mt. Jefferson
10,523'
Three Fingered Jack
Mt. Washington
7769'
Three Sisters Mts
10,352'
Lava Bed

Illustrations courtesy Eastman Kodak Company

AERIAL PHOTOGRAPH SHOWING PEAK 227 MILES FROM THE CAMERA. INSERT: CAPTAIN STEVENS

Army Flier Secures Record Photograph

USING a special camera equipped with film sensitized to the infra-red rays that penetrate smoke and haze, Captain A. W. Stevens, of the Army Air Corps, recently photographed Mount Rainier, in the state of Washington, from a point 227 miles away. Flying at an altitude of nearly 17,000 feet above a landmark that could be identified on a map, Captain Stevens pointed his camera in the direction of Mount Ranier and took his pictures despite the fact that he could not see his objective. When the photographic negative showed that Mount Ranier had been recorded, the distance was measured on a map from the mountain to the landmark over which the record-breaking picture had been taken.

Captain Stevens is head of the photographic branch of the Air Corps stationed at Wright Field, Dayton, Ohio. His pilot was Lieutenant John Corkille, also of Wright Field. Last winter the same fliers made a picture from an altitude of 37,854 feet, higher than a camera had ever been used before, using the same type of equipment. The War Department authorized the flights because of the valuable contributions to military photography that are expected to result from Captain Stevens' experience.

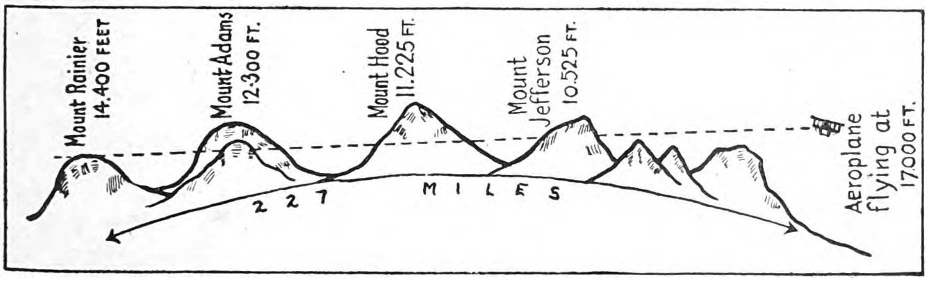
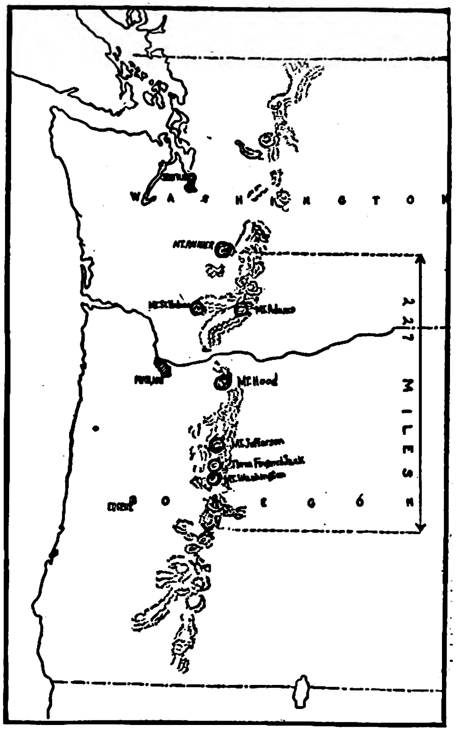

Mount Rainier
14,400 FEET
Mount Adams
12,300 FT.
Mount Hood
11,225 FT.
Mount Jefferson
10,525 FT.
Aeroplane flying at 17000 FT.
227 MILES

DIAGRAM SHOWING CURVATURE OF THE EARTH

Although Mount Ranier has an altitude of 14,400 feet, it seems to be lower than Mount Jefferson, which has a height of 10,525 feet. This is due to the curvature of the earth


WASHINGTON
MT. RAINIER
Mt. St. Helens
Mt. Adams
Mt. Hood
Mt. Jefferson
Three Fingered Jack
Mt. Washington
OREGON
227 MILES

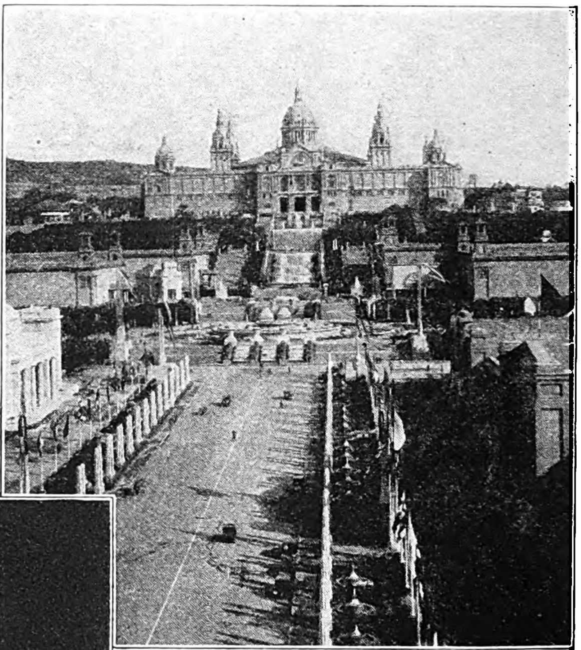
TOO FAR TO SEE

Although the mountain was invisible, it was recorded on the sensitized film

Painting With Light in Barcelona

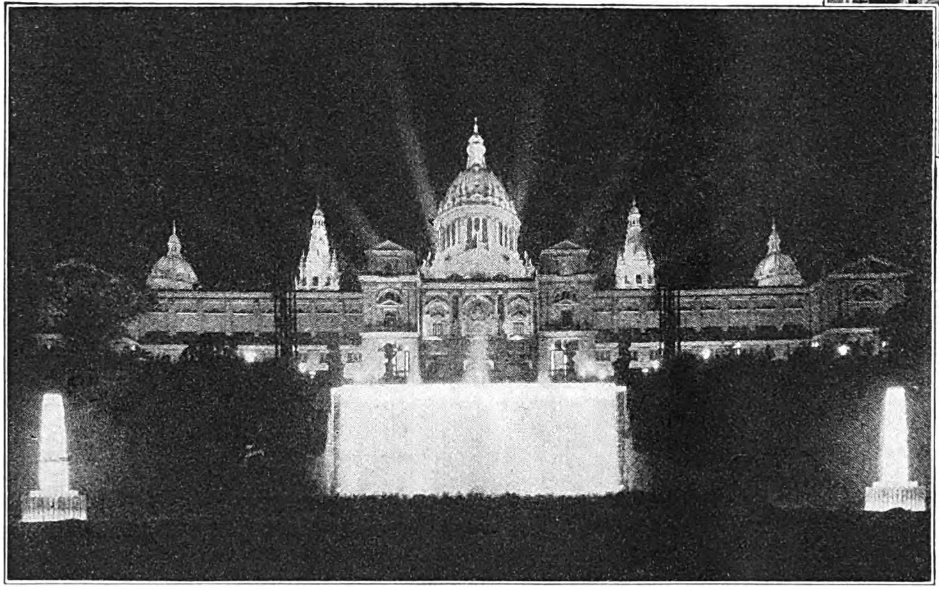
Spectacular Electrical Lighting Effects Enliven the Spanish International Exposition

THE Barcelona International Exposition, located near the outskirts of the city on the slopes of the mountain of Montjuick, occupies nearly a square mile. Taking advantage of the exceptional natural position of this mountain side, the planning architect, Don Carlos Buigas, worked out a system of illumination which surpasses all that has been done heretofore in exposition lighting.



THE EXPOSITION GROUNDS

Looking up the principal avenue toward the Palace, art center of the exposition



ABLAZE WITH COLORED LIGHT

Fountains and cascades in ever-changing colors dominate the decorative display

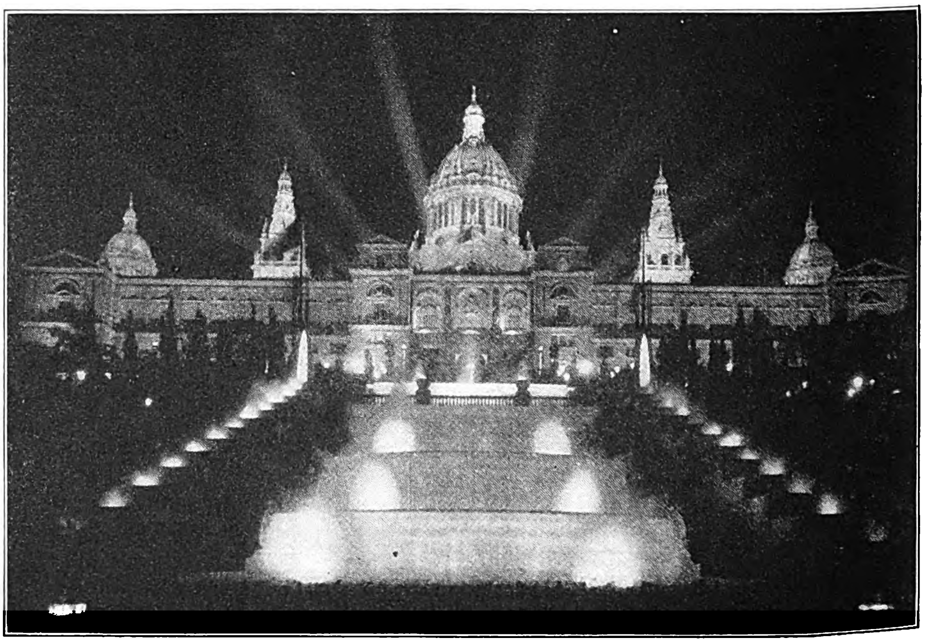
The idea dominating the entire project is the absolute suppression of direct lighting. Illumination is obtained in all cases by indirect means, either by concealing the lamps and reflectors in corners, or in decorative "motifs" of the buildings' piazzas and façades. By mounting lights within luminous crystal elements of attractive design, fantastic imitations of flowers or plants are obtained.

In addition to the light obtained by such methods, additional illumination is produced by colored lights submerged in the innumberable fountains and cascades located within the decorative area.

As in other electrically illuminated fountains in America and abroad, the lighting effects are made to vary in intensity and color to suit the fancy of the operator.

Control of all illumination at the exposition is centered in a tower at the main entrance. This arrangement was adopted in order to make it possible for a lighting expert to look out over the entire decorative area and "paint" the exposition grounds with any color effect he might desire. The controls are operated from a switchboard of special design.

One of the most effective displays is a mobile lighting program, automatically controlled, which consists of waves of colored light, flowing in rythmic succession over the entire exposition grounds. For example, a white wave appears at the National Palace, progressing slowly through the various cascades and fountains toward the Plaza de Espana. As the white wave reaches Reina Maria Cristina Avenue, a yellow wave leaves the National Palace and follows the path of the first, at the same rate of speed. The wave of yellow light is succeeded by one of red, and finally by another of blue. The waves progress at the rate of less than ten feet per second,

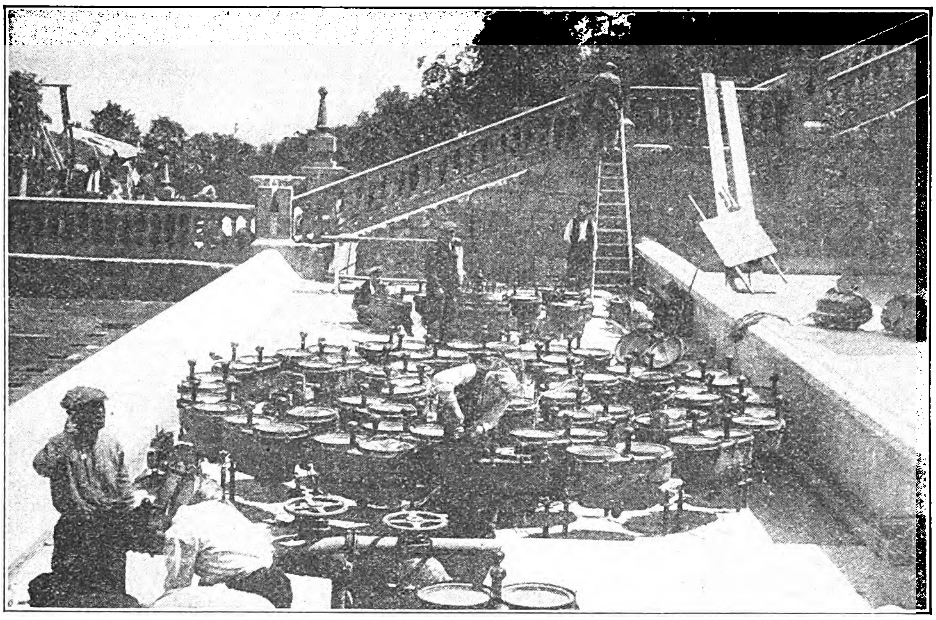


THE "NATIONAL PALACE"

The Palace against a black background with an aurora of colored light beams and the entire program lasts about ten minutes.

The total electricity required in the decorative area for illumination and lighting effects is about 5232 kilowatts. It would have been almost impossible to regulate this current by direct means, since it would have been necessary to use cable of inadmissible size, and control apparatus of undesirable dimensions. By means of a system worked out by lighting engineers of the Westinghouse Electric and Manufacturing Company, the entire illumination system is powered and controlled by comparatively simple means.

The plan utilized in this system provides indirect control by means of pilot lines of extremely small diameter. This is made possible by using special three-coil reactors, wound on iron cores. The two outside coils are connected in series for carrying the load current, and the middle coil is connected in a direct-current circuit regulated from the control station in the tower.



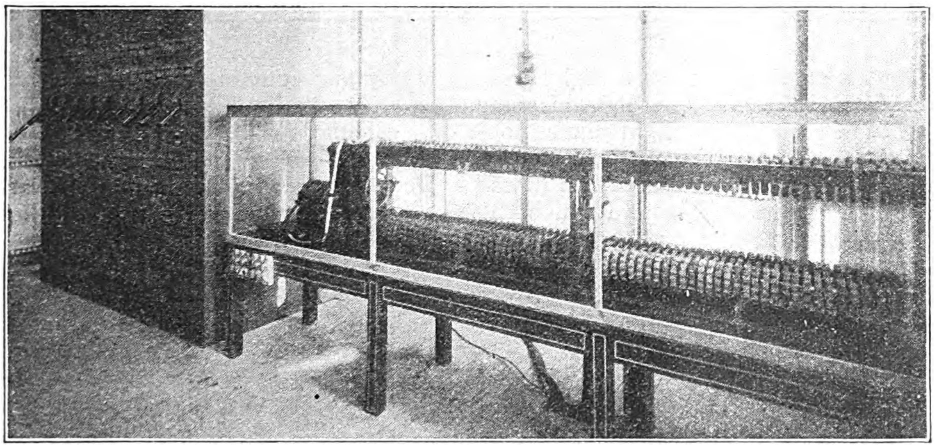
REVEALING THE SECRET OF THE ILLUMINATED CASCADES

Construction photograph showing the operating units of one of the cascades; when in operation these spray and lighting units are submerged beneath several inches of water

When no current flows in this direct-current coil, the two alternating-current coils possess a high reactance in series with the light. The whole is so calculated that, when there are enough lights in circuit to correspond with the full load of the reactors, the lights are practically extinguished. Upon passing current through the direct-current coil, the flux in the core of the transformer will increase, and upon reaching saturation point, the outer coils will have practically no effect and the lights will have their full brilliance. Between these two extremes, any intermediate degree of brilliance may be obtained.

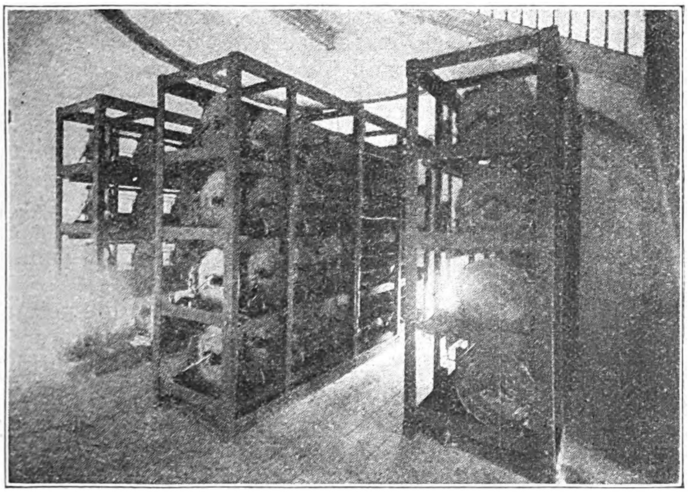
By this means, since the current absorbed by the direct-current coil is very small, it is possible to control a large amount of power with a small rheostat and very fine wires. The reactors used in these controls are the largest ever built, varying in size from 16 kilowatts, 125 volts to 200 kilowatts, 6000 volts. All of the reactors are oil-insulated. A total of 200,000 cubic meters of water is used each day in the fountains and cascades. Powerful electric pumps are used to circulate the water.

The largest of the fountains plays a stream 200 feet into the air, and the smaller sprays and streams surrounding the main stream are so arranged that it is possible to change the effects into 32 different shapes.



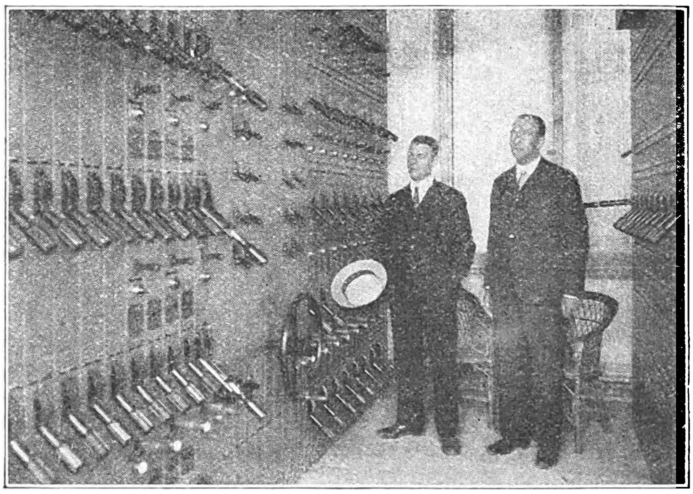
"FLASHER" CONTROLLING WAVES OF COLORED LIGHT

This automatic control unit regulates the movement of successive waves of colored light, which start at the National Palace and progress slowly over the entire decorative area



AUTOMATIC DIMMER BANKS

View of the individual electric motor-driven dimmer banks used in the mobile lighting program, regulated by the flasher illustrated above; the waves of light move at the rate of ten feet per second



SWITCHBOARD FOR LIGHTING EFFECTS

American engineers designed this special switchboard, by means of which a lighting expert can "paint" the entire decorative area of the exposition grounds with any effects he may desir

The Winning Design in Our Light-Plane Contest

A Detailed Description of the Tandem Biplane With Steel Fuselage That Won the Scientific American Medal

American Airmindedness Proved

SO often is the aphorism repeated "Americans are gradually becoming air-minded," that we are entitled to scan the facts for proof.

A recent questionnaire sent to our subscribers in a geographical cross-section of the United States, shows that 75 percent were alive to the importance of the developments in aviation and 24 percent actively use this service, while 27 percent are potential airplane owners.

In the SCIENTIFIC AMERICAN competition for the best light airplane designs, 80 individuals were interested enough to write in for specifications and 19 complete designs were finally submitted in the contest. Considering the amount of work necessary to draw up detailed calculations, draft the three views and extend the tabulation of specifications for the particular design, it will be evident at once that widespread and sincere interest in the art has been demonstrated in places and among persons who hitherto had not revealed themselves to general public cognizance. Also, there is a decided interest shown in articles on aviation, particularly from the investment standpoint. Like all developments that have an appeal to the heroic or mystical element in us all, investment in aviation has probably attracted more people than is realized, for surely the flotation of aviation stock has gone on apace; in fact the industry itself has outsped the preparation of a market for the output.—*The Editor.*

THE SCIENTIFIC AMERICAN announced in the March, 1929, issue a light-plane contest and through the generosity of Colonel R. Potter Campbell, President of American Cirrus Engines, Inc., it offered a prize of 500 dollars and gold medal, a silver medal, and a bronze medal for the best three designs of a light two-seater airplane.

The object of the contest was to interest the public in the possibilities of a comparatively undeveloped field in aeronautical design, as we believe a light two-seater for training, sports use, and private ownership built to sell for a reasonable price without sacrificing aerodynamic efficiency, is the type needed to give additional impetus in this new industry.

The country with its ever growing airports, its unlimited resources, and its large market should lead the world in the light-airplane field.

The contest rules called for a plane to be designed about the Cirrus Mark III engine, an air-cooled, 4-cylinder motor designed by Maj. Frank B. Halford, principally for use in the De Haviland Moth, a low-powered two-place biplane. It has also been installed in the Avro Avian, the Great Lakes Trainer, and many other light planes and in the last few years has established an enviable record. This engine has been supplied to all the light-airplane clubs subsidized by the British Ministry. It also holds such records as Lady Heath's famous flight from London to Cape Town, a flight from England to India, the light-airplane altitude record, the light-plane non-stop record, and the distance record for a pilot unaccompanied. So it was selected as the one around which the design for this contest should be drawn.

THE rules of competition were, essentially:

1. The design was to be one for a plane which would be most suitable either as a training plane or as a sport plane for private ownership.
2. Minimum equipment allowed by the Department of Commerce in the way of instruments was required.
3. The fuel system had to provide for five hours at full throttle.
4. Provision for 50 pounds of baggage and a baggage compartment.
5. Minimum gliding speed of 40 miles per hour. Maximum speed to exceed 95 miles per hour.
6. No restrictions were placed on the type of design. The fuselage was to be of metal construction, but the wings could have been of wood construction.
7. Each competitor for the prize was required to submit the following information:
    (a) Three views of plane and main dimensions and characteristics.
    (b) Detailed weight estimate.
    (c) Balance diagram and stability and control considerations.
    (d) Preliminary performance calculations.
    (e) Preliminary stress analysis.
    (f) Drawing showing power-plant installation with gasoline system.
    (g) Drawing showing accommodations for pilot and passenger.
    (h) Sketches or preferably drawings illustrating the structure of the plane, wings, fuselage, tail surfaces, landing gear, and controls.
8. The designs were rated according to:

(a) General suitability of the plane for training and private ownership purposes and general excellency of the design	20 points
(b) Performance	15 points
(c) Power plant installation	15 points
(d) Construction and ease of maintenance	80 points
Total	130 points

The judges of the competition were:

Miss Amelia Earhart—representing woman's accomplishment in aviation.

Mr. George Palmer Putnam—private plane owner.

Professor Alexander Klemin of the Daniel Guggenheim School of Aeronautics, New York University.

It can be seen from the point rating that the plane's construction and adaptability to quantity production were of the utmost importance.

A large number of designs were submitted by students, draughtsmen, and salesmen and were received from every part of the United States and England.

The plans submitted showed almost every type of wind and fuselage arrangement: biplanes, high, mid- and low-wing monoplanes, and even a helicopter.

The judges found the designs excellent as a whole and after much deliberation chose the design by Mr. Rigby for the prize. [See page 45, January 1930 issue. Editor.] He was awarded 120 out of the possible 130 points. Mr. Rigby's plane is a tandem biplane with a steel fuselage and wooden wings.

The fuselage is of low-carbon steel (1025) using the full Warren truss and welded joints. The two cockpits are located out beyond the wing, giving good visibility and accessibility.

The gasoline tanks and the baggage compartment are located forward of the cockpits near the center of gravity. Thus the designer provided a small movement of the center of gravity under all possible loading conditions.

The wings are of the conventional wood and fabric type with built-up box spars, pinjointed at the fuselage. Ailerons are used only on the upper wing.

The landing gear is of the split-axle type using disk shock-absorbers and the tail skid using rubber cord.

The tail surfaces are of dural, having an adjustable stabilizer and fin. The rudder is balanced and all surface controls are of the cable type.

The performance for the winning ship follows:

Landing speed	39 m.p.h.
High Speed	95 m.p.h.
Climb	693 ft. per min.
Service ceiling	14,500 ft.
Absolute ceiling	16,500 ft.
Endurance	5 hours

The structural specifications:

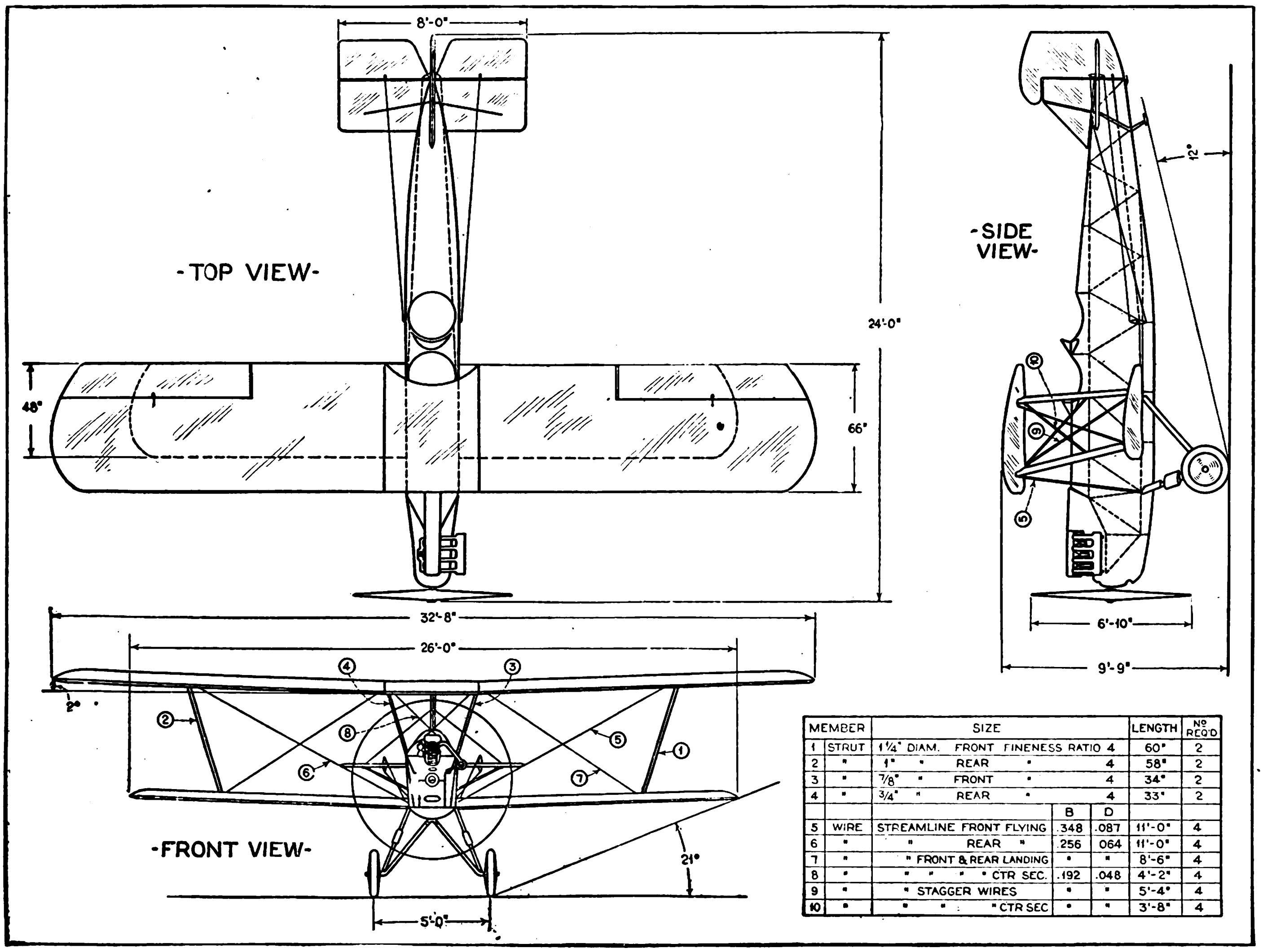
Type	Biplane
Span, upper	32.8′
“ lower	26′
Chord, upper	66″
“ lower	48″
Height	9′9″
Length	24′
Stagger	18″
Gap	60″
Incidence	0°
Dihedral	2°
Area, upper wing	165 sq. ft.
“ lower wing	88 sq. ft.
“ total	253 sq. ft.
Aileron area (upper)	24 sq. ft.
Area, stabilizer	16 sq. ft.
“ elevator	12 sq. ft.
“ fin	4 sq. ft.
“ rudder	8 sq. ft.

Airfoil U. S. A. 27

Mr. Huep was awarded the silver medal for his design of a low-wing, full cantilever monoplane with tandem seating accommodations. The unique feature of this design was the convertibility from an open cockpit to a cabin model with a slight increase in weight.

Mr. Beebe's design was awarded the bronze medal for a side-by-side, low-wing, semi-cantilever monoplane. The ailerons extending the whole length of the wing could be used as flaps or as differential ailerons.

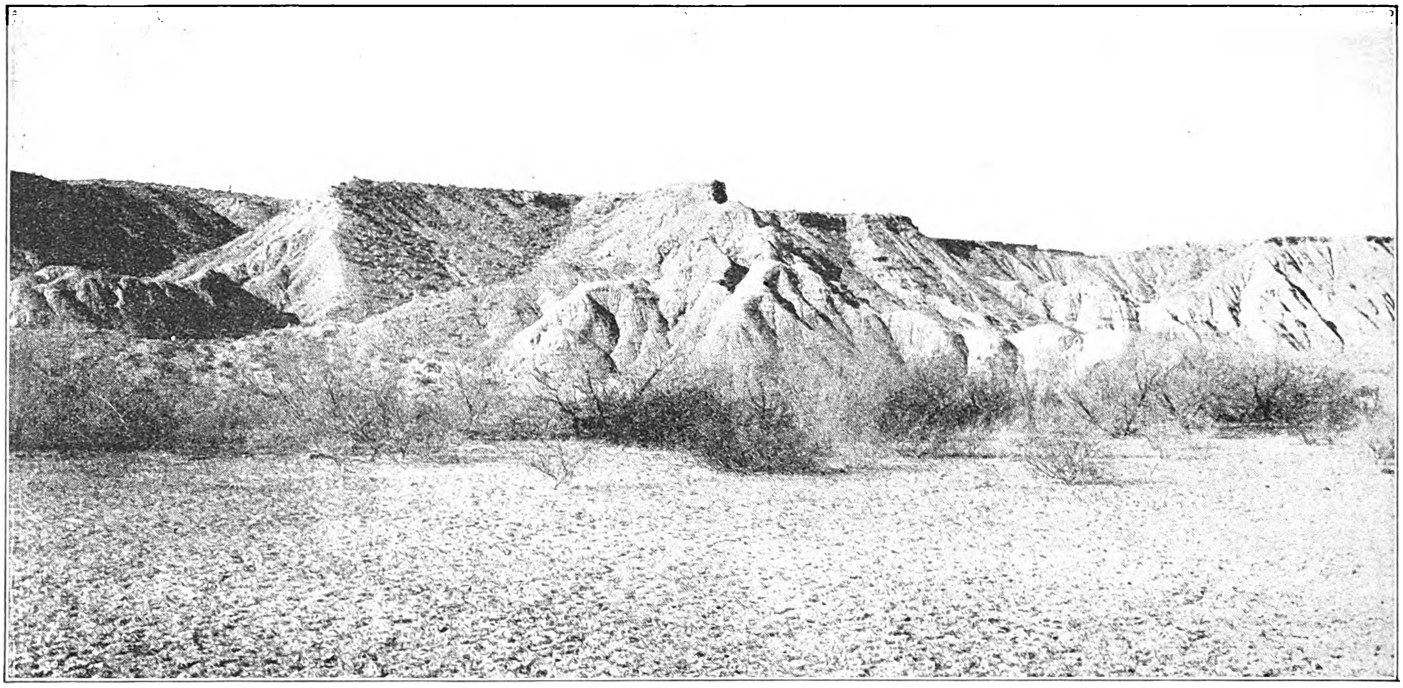
Viewed from all standpoints the contest is a decided success, as much interest has been aroused in the possibilities of the general development of the light airplane for use by persons of average airmindedness.



MEMBER		SIZE			LENGTH	Nº REQ'D
1	STRUT	1¼" DIAM. FRONT FINENESS RATIO 4			60"	2
2	"	1" " REAR " 4			58"	2
3	"	⅞" " FRONT " 4			34"	2
4	"	¾" " REAR " 4			33"	2
			B	D		
5	WIRE	STREAMLINE FRONT FLYING	.348	.087	11'-0"	4
6	"	" REAR "	.256	064	11'-0"	4
7	"	" FRONT & REAR LANDING	"	"	8'-6"	4
8	"	" " " " CTR SEC.	.192	.048	4'-2"	4
9	"	" STAGGER WIRES	"	"	5'-4"	4
10	"	" " " CTR SEC	"	"	3'-8"	4

THREE VIEWS OF THE PRIZE-WINNING DESIGN

Out of a possible 130 points, this design was awarded 120, and so was proclaimed the winner. Note the clean appearance of the front view, and that ailerons are used only on the top wing. Details of the performance of this ship are given in the center column directly above



MESA HOUSE RUIN FROM THE FLATS BELOW THE MESA OR TABLE LAND

The ruin lies just back of the central point of the picture. The elevation of the mesa above the bottom lands of the river valley, in the foreground, is 120 feet. The steep slope, up which the attacking tribes must fight, made the defense of the chosen position relatively easy

The Last Stand of the Nevada Pueblos

In Southern Nevada Another "Lost City" of the Early American Indian Has Been Discovered, Throwing Light on Pre-Columbian History

By IRWIN HAYDEN

Assistant Archeologist, Southwest Museum, Los Angeles

THAT the peace loving Pueblo Indians who occupied southern Nevada at the opening of the Christian Era, hard pressed by hungry nomads, were finally compelled to build fortified villages on inaccessible mesas, is the mute testimony of ruins recently uncovered by a party of field workers sent out by the Southwest Museum.

A handful of Mormons and a small band of southern Piutes have inherited what was, when Jesus was born, a veritable Garden of Eden to these Pueblos, who lived and prospered by thousands in the lower valley of the Moapa River. There they built their houses, often in such large groups that these have been called cities. There they planted maize, squash, beans, and cotton in the fertile and friable soil, irrigating their crops with the waters of the stream which meandered lazily over the bottom lands between the high and barren mesas which form the eastern and western rims of the valley.

For many centuries they had lived there; first, apparently, a rude people who made baskets and used the dart-thrower, not knowing the bow and arrow, ignorant of the art of making pottery; then a people who not only had learned to cultivate maize and beans but to make pottery and to substitute for the dart-thrower the bow; and finally a people who knew the art of building rectangular houses consisting of single rooms, with vertical walls and flat roofs, of mud and stones and mesquite poles and thatch of arrow bush and arrow cane.

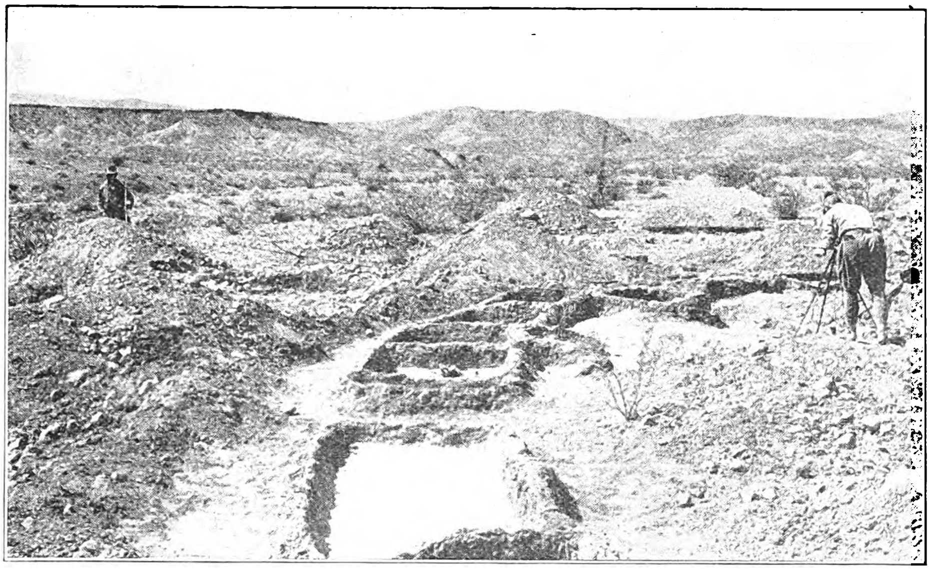
THESE people lived richly. The land smiled upon them, yielding bountifully the foods they liked best to eat, the maize or Indian corn and its "little sisters," beans and squash, which in the long ago other Indians had domesticated in the high plateau country of middle America. Their cotton-fields supplied material for their well woven textiles. In the neighboring highlands mountain sheep were plentiful; wild fowl teemed in the ponds and marshes. Fuel and water were there; and so were numerous sources of flints and obsidian for arrow points and spear heads, knives and scrapers. Pure rock salt for flavoring food, for ceremonials and trade; clay for pottery; magnesite for the clean white slip with which they coated the inside of the food bowl, red paint stone for the red slip; Spanish bayonet and iron stone for the paint used for the black designs on the bowls; turquoise for ornaments—all of these things and more they had, these early Pueblos, there in the Moapa Valley.

In that valley, as related in the SCIENTIFIC AMERICAN for July 1925, M. R. Harrington, with the help of Mr. Fay Perkins and others, discovered and explored in part the famous "Lost City of Nevada."

The results of that work, done under the auspices of the Museum of the American Indian, Heye Foundation, brought to light the ruins of a large settlement which was at the peak of its development in the early centuries of the Christian era, at a time when in all of North America there probably was no place more thickly populated or more "prosperous," as we of today would say, than that section of southeastern Nevada.

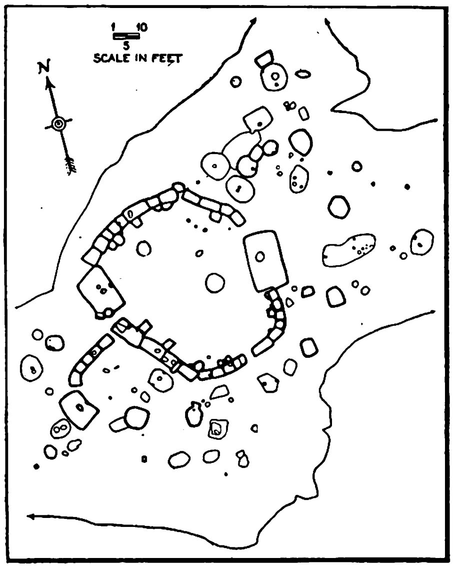
It was the good fortune of the writer to have been assigned the task of excavating another "lost city of Nevada," across the Moapa River from the Lost City, and some eight miles north. The task was assigned by M. R. Harrington, who was in the field as leader of the Nevada Expedition, 1929, sent out by the Southwest Museum of Los Angeles, of which Mr. Harrington is now Director of Research. The Southwest Museum concerns itself primarily with the problem of early man in the southwest area of North America; and the scientists who are directing its research feel confident that buried in the earth and the caves of southeastern Nevada are many secrets, the uncovering of which will help materially in telling the story of the beginnings and the development of the great Pueblo peoples whose brilliantly colored life and history make the territory which includes Arizona, New Mexico, much of Utah, Colorado, Texas, and Nevada, so fascinating to tourist and scientist alike.

THE writer, assisted by his son, Julian D. Hayden, and by James G. Scrugham, Jr., son of ex-Governor Scrugham of Nevada, whose great personal interest in archeology has done so much toward aiding the work of exploring the Nevada ruins, spent three months in the complete and thorough excavation of the Mesa House ruin, about three miles north and west of the Mormon town of Overton. Meanwhile Mr. Harrington roamed the lower reaches of the Moapa River, locating and platting the many evidences of Indian occupation, from Basketmaker pit dwellings to early Pueblo village sites and southern Piute camping places. The lower end of the Moapa Valley is expected eventually to be covered by the waters impounded by the great Boulder Dam. and much of the very important archeological evidence will become lost forever unless it is collected within the next few years.



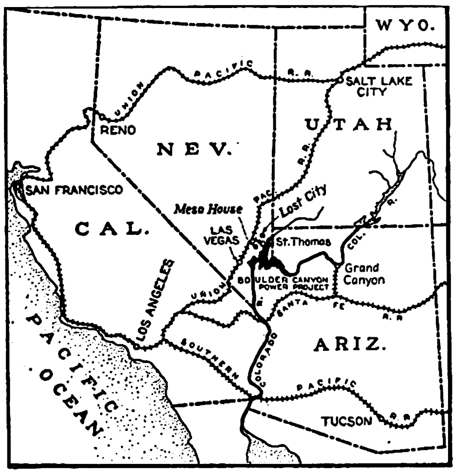
MAPPING THE RUINS ON TOP OF THE MESA

The surveyor is bending over a plane table at the right, his rodman stands at the left of the picture, and a tape, dimly visible in the picture, is stretched between the two points



MAP OF THE RUINS

The enclosed figures on the map correspond with the walls, like, for example, those in the illustration shown above



THE GENERAL LOCALITY

Both Mesa House and the Lost City are indicated at about the center of the map

One very striking thing was brought to light by the exploration of Mesa House, when the situation there is compared with that at Lost City. The mute evidence of stones and fallen 'dobe walls found at Mesa House is eloquent in its story of a people brought to bay by human enemies. The ruins of the Lost City speak as eloquently of a people who were at peace.

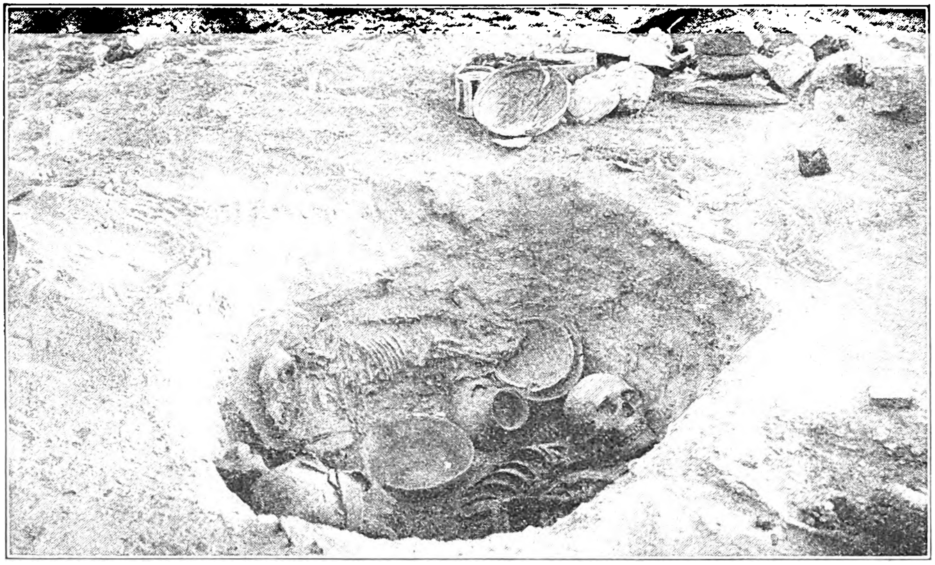
Evidence gathered at both places indicates clearly that Lost City and Mesa House were built and occupied by early Pueblos. Mesa House, however, represents the last stand of these people in the Moapa Valley, before they moved into Arizona (or possibly Utah). The tradition among the southern Piutes who were in the Moapa Valley when the first white men settled there is that the builders of the pueblos went to Arizona and became the ancestors of the present Hopi.

Whoever visits Lost City and Mesa House (it would be well to do so before Lost City becomes inaccessible because of Boulder Dam, as it may) will observe the fact that Lost City houses are grouped in a free and easy way, with no apparent plan. But the houses at Mesa House are built around a central courtyard, in the form of a circle roughly drawn; and there are but three narrow gateways to this courtyard. Here, then, was essentially a walled town. Outside the walls, not too far away, were dwellings, arbors, storage rooms; but at the first alarm all could run into the "fort" and make effective resistance to raiding Piutes, Apaches, or whoever the enemy might be.

Lost City was built on low-lying promontories, near fuel, water, and farms. Mesa House lay on top of a barren mesa or table land, swept by the bitter winds from the Mormon mountains to the north, standing 120 feet above the bottom lands, from which food, water, fuel, and most of the building material had to be carried up pathways rising about two feet in one, so steep are the sides of the mesa.

AS a place to live, Mesa House was decidedly inconvenient. As a place to defend, it was ideal. To the east lay the open valley; to the north a broad cove in the mesa; to the west open country for several miles, in spite of the rising hills; and to the south and close at hand a high place where lookouts could command the entire country side. Indeed, on the very top of this high place were found the remains of ancient watch fires.

In comparison with Lost City, Mesa House produced a much greater number of "wicked looking" arrowheads. But, also in contrast with Lost City and village sites of the Lost City period (for miles up and down both sides of the valley there are ruins of villages identical in pottery with the Lost City), the people of the Mesa House were poor in worldly goods, for the graves at Mesa House contained very meager offerings, while Lost



A LOST CITY BURIAL, WITH POTS AND PET DOG

At Mesa House, however, only one grave contained anything of importance. The potsherds, or pieces of broken pots, tell the trained prehistoric archeologist almost as much as actual inscriptions, for the styles in pottery undergo many changes, thus affording a time scale

City graves, many of them, were rich with pottery, weapons, ornaments and other objects.

In fact, only one grave at Mesa House contained anything of importance. Some thirteen turquoise pendants, 24 arrowheads, several dozen gaming pieces, a flint knife with handle intact, and two very fine war clubs carved from elk horn, were included in the grave of an adult, who must have been, in his lifetime, a leader among his people. This grave was in the center of a great room, apparently built of "wattle and daub"; which means that posts were set up, scantling run across the sides and ends, against which a thatch of arrow cane or tules was laid, and the whole plastered with mud, both sides and roof. The room had been destroyed by fire, perhaps immediately after the burial of the great man.

HARRINGTON insists that Mesa House marks the wind-up of the early Pueblo occupation of the Moapa Valley. That Mesa House is of a later period than Lost City is made clear by a study of the potsherds so numerous in all of these ruins. Fragments of broken pottery vessels, the "shards" so useful to Job in his affliction, the "potsherds" of the archeologist, can be made to tell a great deal about the comparative age of different Indian villages and camp sites, provided always that they are found.

The potters of the Lost City period catered to fashion, just as our modern potters do; just as potters always have done and always will. The Lost City housewife demanded and made pottery which chiefly was either plain or decorated with black lines on a white or a red background. Occasionally some good housewife, as she coiled the rolls of clay 'round and 'round in the building of the pot or bowl, omitted the usual smoothing of the outside, leaving ridges or corrugations for ornamental effect. These corrugations were left straight or were indented or notched, according to the taste of the potter. Lost City potters only occasionally made this corrugated pottery.

Now at Mesa House two thirds or more of all the fragments of pottery found is corrugated. Ordinary plain pottery, or undecorated ware, is noticeably rare; and dishes bearing black designs on white background, the typical black-on-white of the early Pueblo period in the southwest, is infrequently found, while the black-on-red dishes are very rare indeed.

The relatively greater use of corrugated ware at Mesa House, as compared with Lost City villages, does not of itself indicate anything about the comparative dates of the two periods, Mesa House and Lost City.

It happened, however, that on another village site, which plainly was occupied by early Pueblos, the writer unearthed what seems to be a key to the situation. This ruined village stood on a tongue of the same mesa on which the Mesa House was built, and not more than 1500 feet from it. It was discovered by Mrs. Harrington on one of her scouting trips. There, in a layer of accumulated ashes and rubbish more than three feet deep, in spots where everything pointed to a long occupation, all of the broken pottery was of Lost City type, plain, with some black-on-white and black-on-red ware; except that in the uppermost six inches, and on the surface, fragments of corrugated ware appeared.

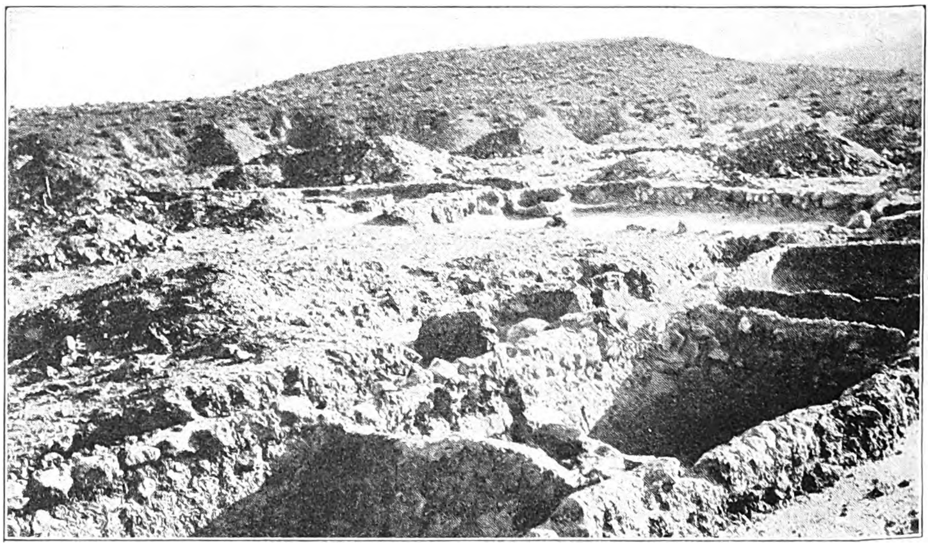
Lacking evidence to the contrary, then, Mesa House is dated later than the villages of the Lost City period.

Using the tentative time scale suggested by Dr. Alfred V. Kidder, Mesa House was abandoned sometime between 500 and 800 A.D.

PERHAPS thousands of years were covered by the development of these peoples in the Moapa Valley. But when did any sedentary, agricultural people, who insisted on peace as a prime requisite to happiness, ever succeed in enduring the constant irritation of raids from destitute, hungry nomads?

Apparently the early Pueblo fought only for defensive purposes. It is evident that his posterity, the present Pueblos, made no offensive wars. Dear to them as the Moapa Valley must have been, it was not sufficiently dear, apparently, to justify their fighting to hold it.

So, if we read the record rightly, they left it to the southern Piutes, who gave it over to a colony of Mormons which Brigham Young sent there to raise cotton.



ANOTHER GENERAL VIEW OF MESA HOUSE

This shows clearly the type of masonry wall construction employed by the former builders and occupants of the ancient community. The houses were drawn up around a roughly circular court yard, but without much planning, as is shown by the map on another page

Opera Comes Into Its Own

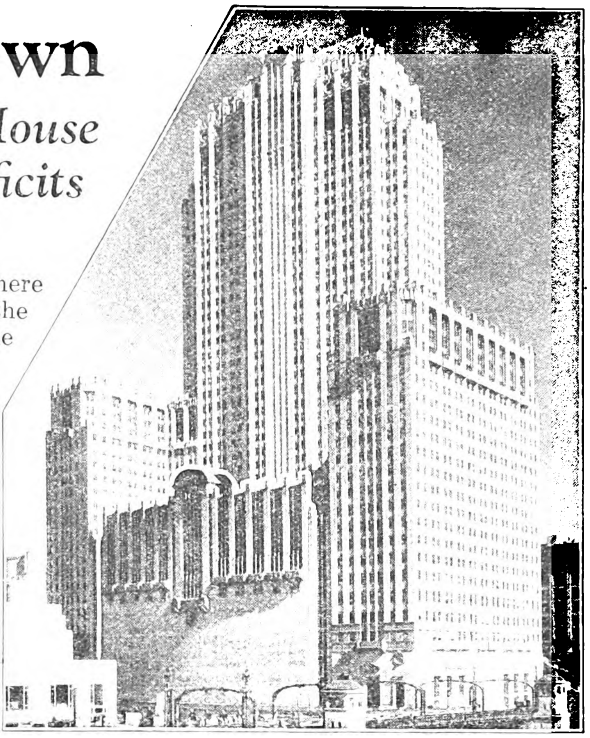
Combining Offices With an Opera House May Solve Problems of Perennial Deficits

By ALBERT A. HOPKINS

CHICAGO goes in for the grandiose and generally succeeds. She certainly has many things which can be classed as the "largest" and many as the best. This has largely been accomplished by a remarkable civic spirit which manifests itself in many non-commercial cultural enterprises of great magnitude. The World's Fair of 1893 gave Chicago a place in the sun, and she has worthily maintained it. It was a few years previous to this that Chicago built a real opera house, the Auditorium, with a modern stage with hydraulically operated bridges. But time makes all things obsolete, and so Chicago felt that her opera was so good that a new opera house was in order, and we shall tell some of the wonders of her 20,000,000-dollar structure which was opened recently with the unfortunate Aida's troubles.

The structure known as "20 North Wacker Drive" is 45 stories high with two 23-story wings. In this skyscraper are the Opera House and the Civic Theater accommodating 3517 and 878 persons respectively. The box-office has been separated from the main lobby so that persons with tickets do not have to mill around with would-be purchasers. The orchestra is so arranged that no late comer has to climb over more than four of his predecessors in order to reach his seat. The dress circle, the balcony, and the upper balcony have been brought forward over the orchestra so that the occupants of these seats are brought much nearer to the stage. There is no seat in the house where the whole stage is not in view. The last seat in the upper balcony is 185 feet from the stage. The chairs in the boxes are of two sizes, the taller ones for the men and the smaller for the ladies.

Every device which modern science has invented for the improvement of stagecraft and the speeding of scene changes demanded by modern opera is called into play. The technical director and stage director have at their command many devices which have never before been used on the stage of any theater in the entire world.

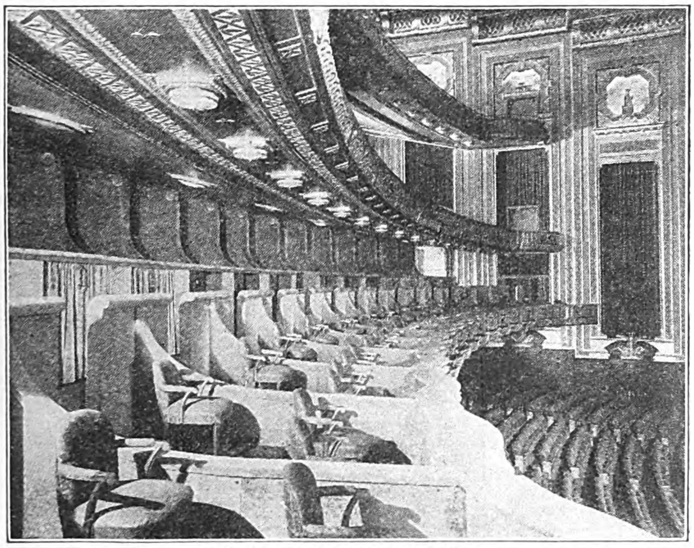


SEEN FROM THE RIVER

The new Chicago Opera House rises majestically 560 feet. The Opera House proper is outlined in white

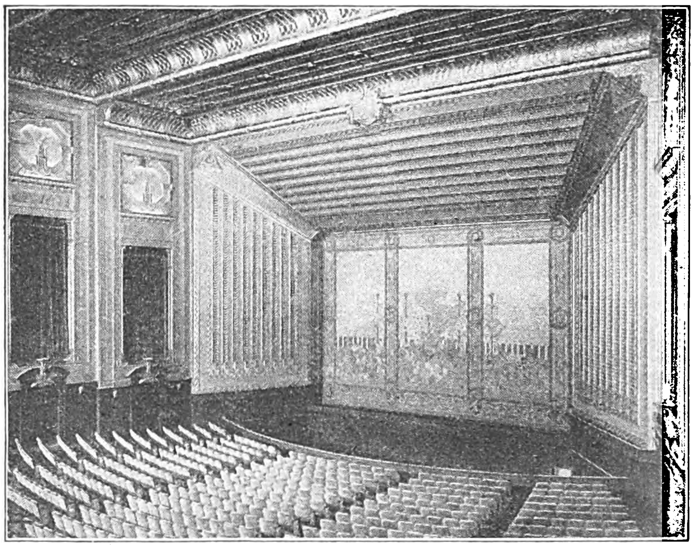
THE stage itself, while not the largest in the world, being exceeded in breadth by one or two stages in Europe, is considerably larger than anything in the United States. It measures 75 feet in depth and 120 feet in width at its widest point. The important element of height which governs the size of drop curtains, cycloramas, trees and foliage, buildings, and so forth, in outdoor scenes, has received special attention.

The stage measures 145 feet from floor to gridiron. The working stage, 50 feet in width, is divided into 20 sections which lift or lower, each of them being 25 feet long by four feet wide, and with a lift of 12 feet and a drop of 12 feet. They can also be tilted to a maximum angle of 35 degrees in either direction. The 20 sections, or traps, are mounted on hydraulic rams. Forty plungers in all are used, two for each trap. All are operated from the main control station at the right-hand side of the stage. Each plunger is fitted with a clamp, holding it secure at any level, and insuring against movement in case of leakage in the hydraulic system. All traps are covered with "roll-away" floors which can be placed in position when any trap is lowered. Between these movable traps and the footlights are three 50-foot traps with "roll-away" floors.



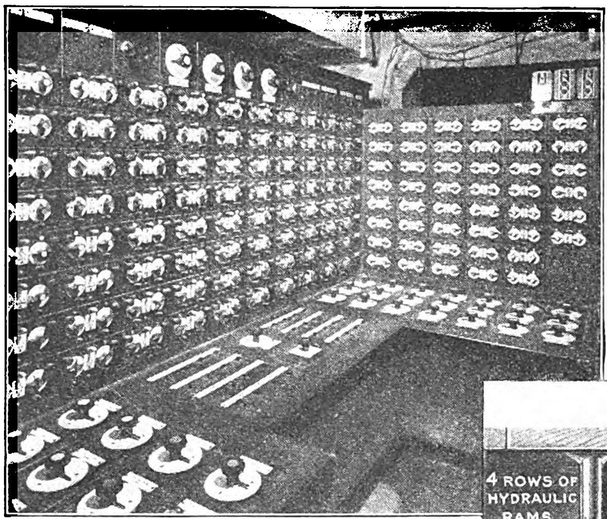
THE GOLDEN CIRCLE

The luxurious box floor of the new Civic Opera House taken from the right-hand side of the auditorium. The chairs for the ladies are made lower than for gentlemen. There are no pillars to interfere



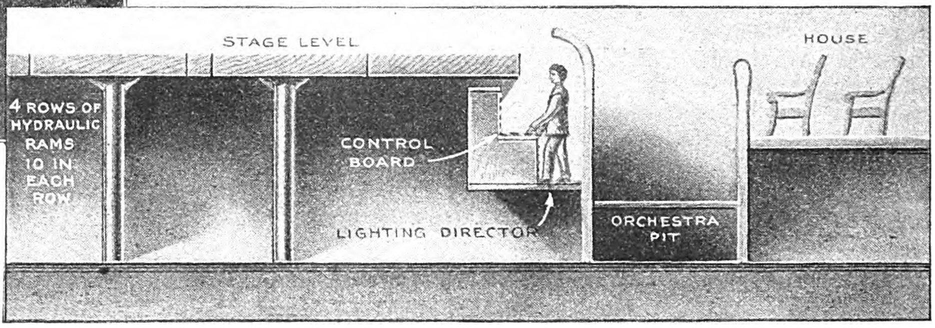
THE COMFORTABLE ORCHESTRA

The musicians are in a pit. The aisles are numerous, so access to any seat is simple. The hydraulically operated steel fire-curtain symbolizes many popular operas by means of pageantry



THE LIGHTING OPERATOR AT WORK

In front of the curtain, the "lighting operator" will control the stage and house lighting as easily as the orchestra conductor directs. The lighting control board is shown above



At the back of the stage is another trap, the giant of them all. It measures 75 feet in length by five in width. It can be lifted five feet above the stage level and dropped 35 feet below. In the vault into which this trap descends are located racks to accommodate the hundreds of drop-curtains required in a season's production of opera. Every rack is neatly labeled with the name of an opera. In all, storage for 2000 drop curtains is provided. The vault containing the racks is fire-proof and damp-proof, insuring complete protection of equipment.

Just back of the footlights a steam curtain is provided for scenic effects. There are two fast-working curtains immediately behind the proscenium, operated by horizontal hydraulic machines. One of these machines is used for the drape curtain and the other for the act curtain. Each is controlled from the right side of the stage.

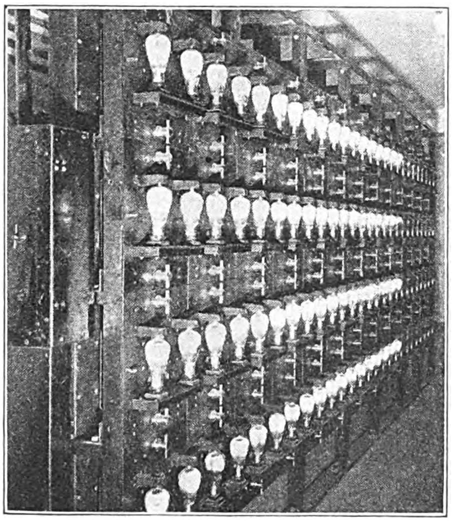
STILL another hydraulic machine operates the huge steel curtain, which can be controlled from either side of the stage. The curtain weighs fifteen tons, and consists of flush steel plates on its face, braced and trussed at the back. It is covered with vitrified asbestos, and the face is decorated with a symbolic painting harmonizing with the decorative scheme of the auditorium.

Drops for from three to ten operas might be hung at one time on the scenery "pipes" of the new theater. They are 106 in number, each 70 feet long, and with a clear lift of 144 feet. At the sides and rear of the stage are three cyclorama frames, eight inches apart, extending from within about five feet of the proscenium opening to within three feet of the back wall, and completely surrounding the stage. They are 240 feet in length and 115 feet high. The frames lift 38 feet above the stage floor, and are suspended by steel tape with channel-iron framing. The lifting and lowering of the cycloramas is controlled from the central control station on the right-hand side of the stage.

To light this huge structure—certain scenes in opera require light more intense than daylight—ample provision has been made for bank-lights in the wings on either side of the stage, for border-lights directly above the stage, and for spots, bunch-lights, footlights, and flood lights.

There are 16 bank-light frames, eight on each side of the stage, between the cyclorama frames and the counter-weight pipes. There are nine rows of border-light pipes, each 16 feet long. All sections of every row operate independently of one another, and all travel from stage floor to gridiron. There are also three light-bridges for spot lights and arcs. Two are located three feet from the proscenium wall, one above the other, traveling in fixed angle guides, while the third swings free directly over the seventh row of border lights, and is used for lighting the cycloramas. Lifting and lowering of the light bridges is controlled from the main rigging control station and also from controls located on the bridges themselves.

There are twelve "spot lines," six on each side of the stage. They cover practically every square inch of the stage, and all are mounted on cars which travel up and down stage and can be locked in the desired position.



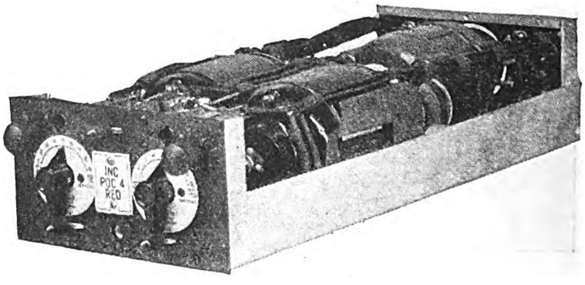
RECTIFYING TUBES

The new control scheme involves the self-synchronous motor and vacuum tubes

More than a hundred hoisting machines are required for this quantity of equipment, of which 61 are controlled from the main control board and a portable control board, worn by the chief electrician when directing the placing of his lights. Remote control is used throughout the stage, not only for raising and lowering the lighting equipment and some of the scenery, but also for dimming and brightening the lights, cutting out sections, changing lighting, et cetera.

Aladdin, with his wonderful lamp, has been outdone in this electrical installation, conceived and designed especially for the Chicago Civic Opera Company's needs by the General Electric Company. The system, which involves new and unique principles and which minimizes time, labor, and valuable space, enables the lighting director to leave his position back stage for the first time in theatrical history and take up a position in front of the curtain along with the prompter.

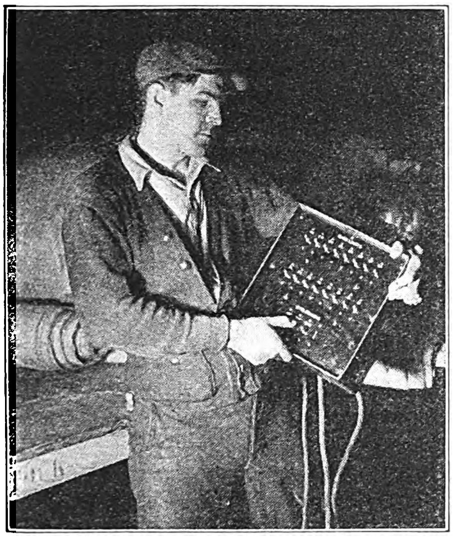
In front of the curtain, the lighting operator controls the stage and house lighting as easily as the orchestra conductor directs the orchestra. In front and on each side of him are arranged dials, knobs, tumbler switches, indicating lights, and so on. By the



VOLTAGE REGULATOR UNIT

The "Selsyn" receiver is the same type of control as is used in the Panama Canal locks for controlling the gates mere manipulation of a single knob all the complexities of stage lighting are controlled, lights of various colors fading and brightening at various points and at the proper moments. Scenes requiring complex lighting effects such as sunsets, sudden thunderstorms, ballet lighting, et cetera, require no more effort for their control than is needed to flick a lighting switch in the home or to turn a door knob.

The advantages of the new method are manifold. Heretofore, the control of theater lights has been centralized in a switchboard back stage which, in the larger theaters, might be as much as 40 feet long by 8 feet high. The operation of the dimmers required much physical effort and agility, and many elaborate and ingenious mechanical schemes were often resorted to in order to simplify the work. Their manipulation made it necessary for the electrician to be at a point "off-stage" where he could not see, except indirectly, the effects he was producing and where he had to rely on cues of words or sounds to inform him when it was necessary to change the lighting effects.



PORTABLE CONTROL STATION

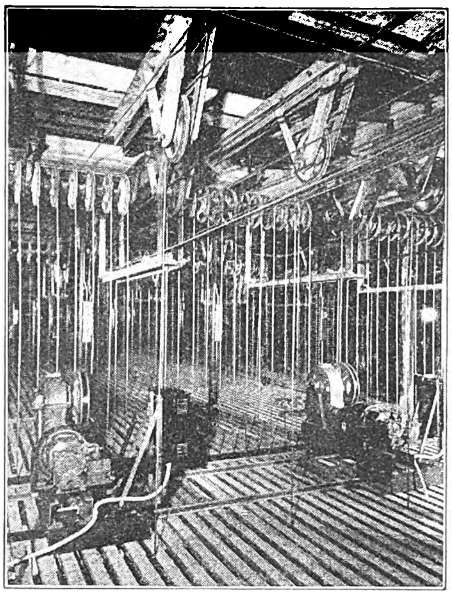
These stations control as much as 500 horsepower used for hoisting everything

For lighting the stage there are 141 individual circuits, each including lights of but one of the four colors used on a theater stage—amber, white, blue and red. The lighting operator could control the lights by manipulating knobs on every individual circuit, but to do so would involve the operation of as many as 141 knobs. A method has been devised, therefore, to govern all the lighting circuits through one knob, or to split the control into major and minor divisions, depending on color, location and function, each group in turn controllable through the agency of a knob.

THE individual circuits are grouped under the control of master knobs governing, for example, all the blue lights in the borders and footlights, all the amber in the pocket lights, all the white in the light bridges, and so on. In addition, all the lights of each color, no matter where located, are controlled by a color master knob. Finally, all the color masters may be operated simultaneously by a grand master knob.

The energy required for the control of any of the individual lighting circuits is approximately one tenth that consumed by a pocket flash light. The energy controlled, however, may run as high as 30,000 watts in a given circuit. The total energy used in maximum lighting effects may be as much as 1250 kilowatts or nearly 1700 horsepower of electrical energy.

Tucked away in the north wing of the building is the Civic Theater which seems a midget in comparison with the Opera House. The auditorium measures 80 by 57 feet, and the height is 47 feet. The stage is 70 by 32 feet, and the height to the gridiron is 71½ feet. Its equipment is very much like that of the Opera House, on a correspondingly smaller scale, but just as complete in every detail.

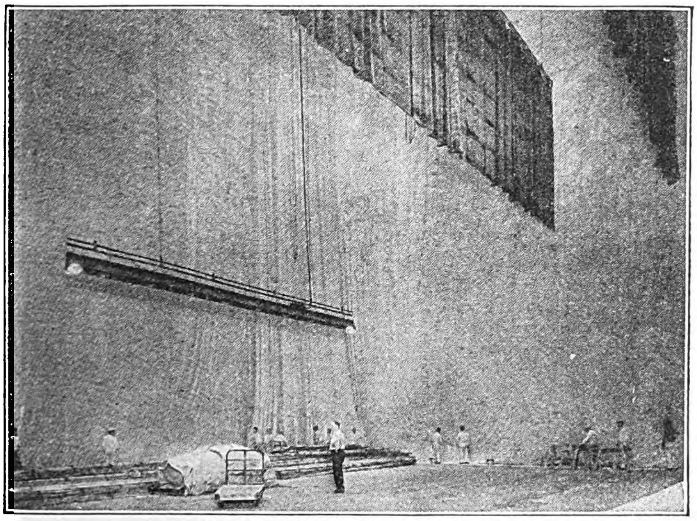


THE GRIDIRON FLOOR

The gridiron floor is 145 feet above the floor of the stage. The vast lifting equipment is the last word in stage economy

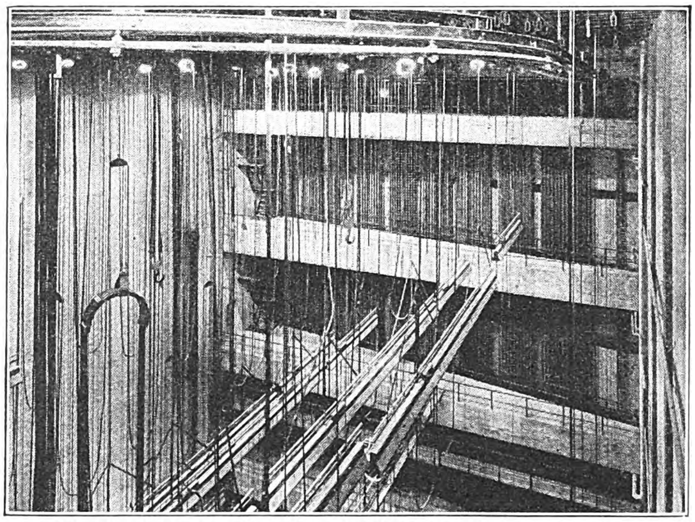
The total load on the foundations of the large edifice is about 202,000 tons, including live loads. At 28 feet below the water level (Chicago River) there is a connection with the system of the Chicago Tunnel Company, by which coal is delivered to the boiler-room and ashes are removed without being taken above ground.

The fire protection is most complete and a large automatic fire-door in the roof over the stage is arranged to open automatically in case of fire and thus keep flames and gases from spreading into the auditorium. The architects were Graham, Anderson, Probst, and White of Chicago, who are also the architects of the Shedd Aquarium and the Merchandise Mart, interesting examples of the art of the construction engineer.



PAINTING THE GREAT CYCLORAMA

Forty men covered 3000 square yards in two and three quarter hours. The huge surrounding cycloramas are 240 feet in length



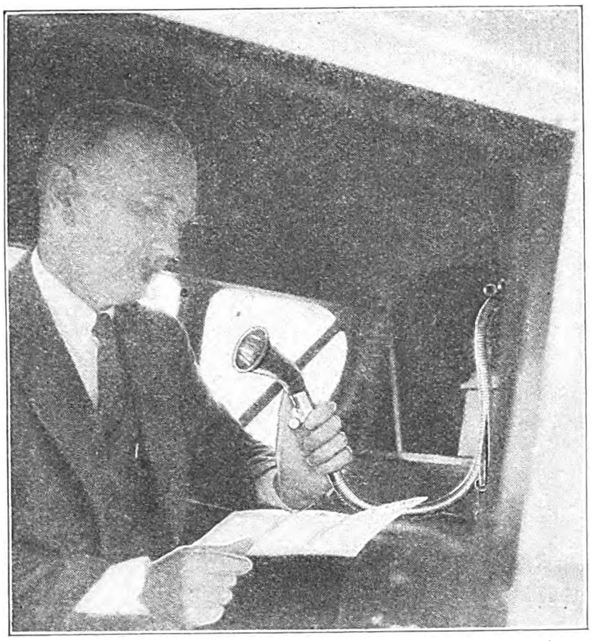
A MAZE OF RIGGING

View from the upper machinery floor showing the cyclorama frames, the border lights, and the fly floors in the background

The Business Executive Takes to the Air

Survey Shows Many Firms Operate Company-Owned Planes

By DOUGLAS W. CLEPHANE



DICTATING AMONG THE CLOUDS

Mr. J. H. McDuffee, a well-known executive, using the equipment provided in a modern "flying office"

RECENTLY the general manager of a large banking corporation with branches in 500 cities was confronted with a problem. Within one week he had to hold conferences in ten cities, including New York, Cleveland, Kansas City, Denver, and San Francisco.

To accomplish this, traveling by train would have required three times the time at his disposal. The board of directors called in the sales manager of a well-known airplane manufacturing company and asked him to prove to the satisfaction of the board that this trip, as well as other business trips, could be made in a company-owned airplane, with assurance that the conference dates could be kept and that the executives would not be subjected to an undue risk.

To the officials of the company, the purchase of a company-owned airplane was a radical departure from their previous methods of doing business. To their amazement, the sales manager showed them that 170 business corporations now own one or more airplanes, that some 30 companies are operating more than one ship, and that at least 10 firms have fleets of six or more planes.

Still not satisfied, the directors wanted to be shown that air travel was safe. As their president expressed it, "It is highly important that these conferences be held on scheduled time. We can save thousands of dollars a year if we can reduce the time our executives spend in automobile and railroad travel. However, if one of these men should be injured or killed, we would suffer a tremendous loss."

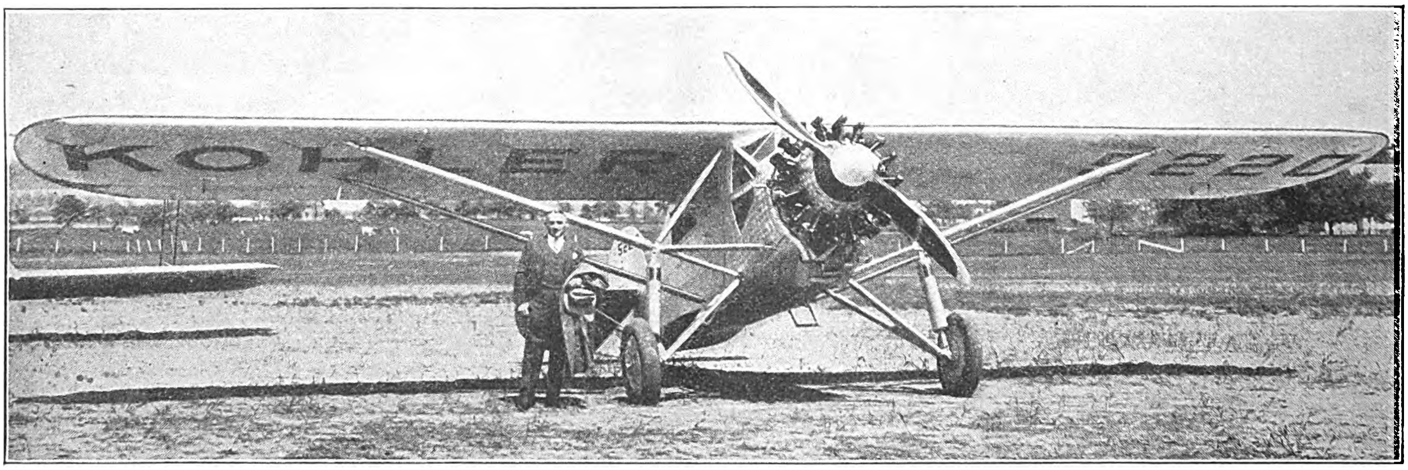
The sales manager, who had met this problem many times before, produced figures compiled by the United States Department of Commerce, showing that there have been fewer casualties on air transport lines considering the number of miles flown and the number of passengers carried, than on the railroads having the highest standards of safety.

He proved to the satisfaction of the skeptical board that modern planes operated by competent pilots have achieved such a remarkable record for safe flying, that travel by other means should not be undertaken without serious consideration of the dangers involved.

Willing to concede that a company-owned airplane would save their executives' time without unnecessary risk, the directors wanted to know if the operation of their plane would involve unwarranted expense. Figures were presented, compiled from complete cost records kept by a dozen corporations which had operated their planes a total of nearly 500,000 miles, showing that the cost of operation of a modern six-place cabin plane would run approximately 23 cents a mile, based on 500 hours operation a year.

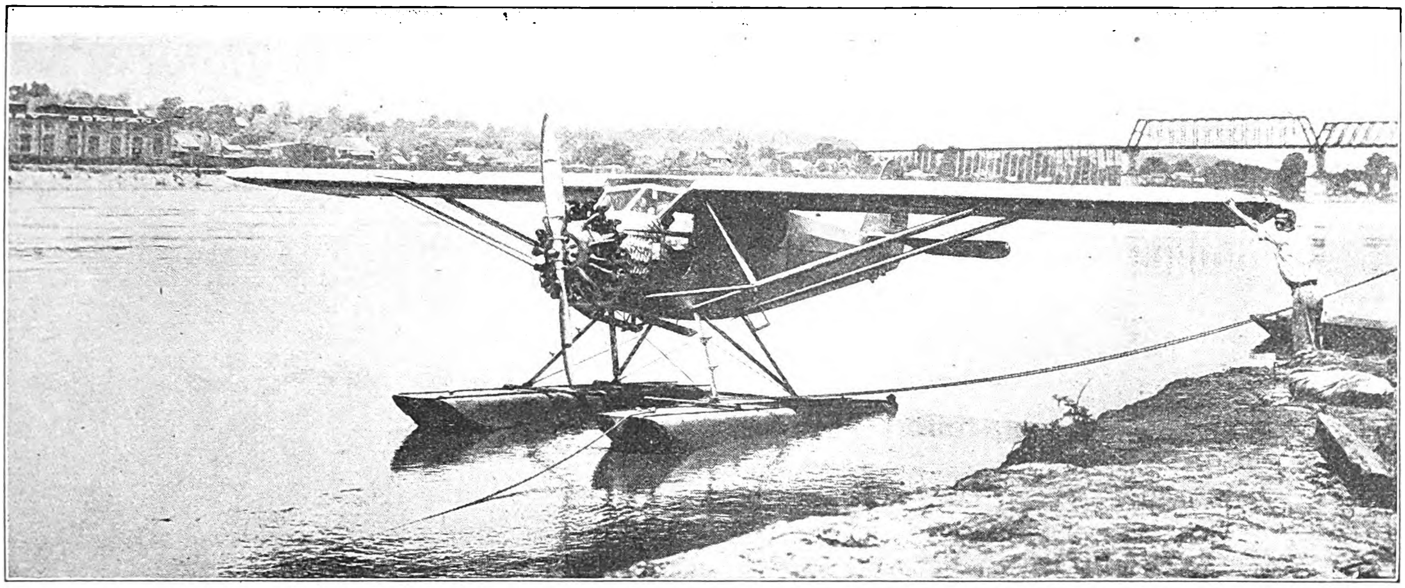
THESE figures included the salary of a full-time pilot, complete insurance coverage, depreciation, interest on investment, cost of overhauls, hangar rent, gasoline and oil, and all other direct and indirect expenses. When a full load was being carried, the cost per passenger would run only a trifle over railroad fare.

Most of the members of the board were convinced, but the chairman, remembering a flight taken in a rebuilt war-time plane five years ago, objected to the discomforts involved in flying. "When I start out for a business trip," he declared, "I don't want to have to clamber up the side of a dirty cockpit. When I arrive for a conference I don't want to be covered with overalls, goggles, a parachute,



POLITICAL CAMPAIGNING WITH A CABIN MONOPLANE

Governor Walter Kohler of Wisconsin recently conducted his campaign for re-election with the aid of this airplane. By flying from town to town, a politician can deliver three times as many speeches as usual and has adequate facilities for preparing his talks *en route*



ANOTHER TYPE OF AIR TAXI POPULAR WITH BUSINESS MEN

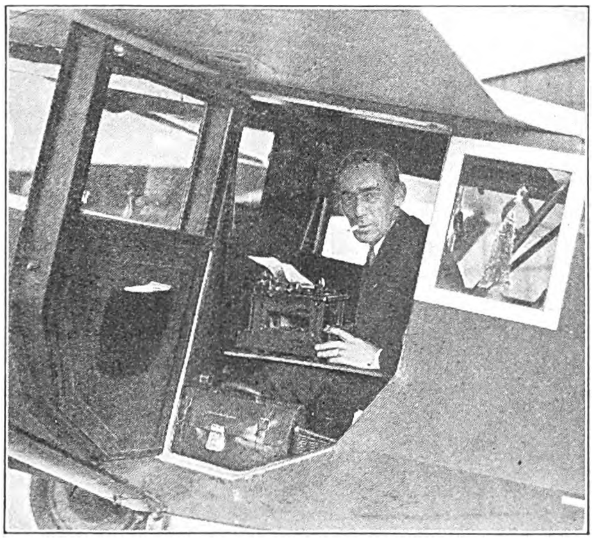
Seaplanes and amphibians are rapidly becoming popular with business men for commuting and general business usage, because of the fact that they do not need prepared landing fields. An amphibian is at home on land or water. This picture shows a new Ryan seaplane

and other flying paraphernalia as if I were a circus performer. Flying is undignified, uncomfortable and does not yet offer the traveling comforts to which I am accustomed."

In answer, the sales manager persuaded him to go to the airport and witness a demonstration of a new cabin plane which typifies the trend toward limousine comfort in privately-owned airplanes. He inspected a plane which still follows closely the sleek lines of the famous "Spirit of St. Louis," made by the Ryan Aircraft Corporation. The banker had been closely identified with Colonel Lindbergh's flight, but had not followed the great strides in airplane design made during the past two years.

He was surprised to find that the seats in the plane, which accommodates five passengers in addition to the pilot, were as comfortable as those in the most luxurious limousine. He found the enclosed cabin as carefully upholstered as the cabin of a fine yacht, equipped even to flower vases and cigarette cases. He was delighted to learn that he could see as well through the curtained windows of the airplane as he could from his own motor car.

The chairman was told that parachutes are no longer necessary as safety devices, and are not used except by student pilots and instructors, stunt flyers, and by pilots who must fly in all kinds of weather. He was amazed when told that the plane could be equipped with a self starter, and that non-shatterable glass was used.



MORE ORDERS PER SALESMAN

George Fridell, a salesman with a western fuel company, considers a plane "indispensable" in his work

He was even more surprised when shown a "flying office" model, equipped with office desk, dictaphone, filing equipment, book case, thermos bottle set, electric cigar lighter, and other conveniences found in an executive's home office.

After accepting an invitation to take a flight, the banker gasped with amazement when the pilot removed both hands and feet from the controls, allowing the ship to maintain a compass course for five minutes without any attention whatsoever. Finally he took the stick himself, for the first time in his life, and found that holding a modern plane on a course, in smooth air, is no trick at all.

The board was convinced, the purchase followed, and in the first month of plane ownership, 11,100 miles were flown over 32 states, 440 passengers were carried, and an average speed of 112 miles an hour was maintained, which is 30 miles an hour less than the maximum speed of the ship.

So successful has been its operation, that the company has calculated that the plane has shown a profit of 8000 dollars in its first six months of operation by conserving the time of highly paid executives. This does not count the indirect saving from closer supervision of all activities of the company, the advertising and publicity value, transactions closed where it would have been impossible to get a man on the ground in time by any other means of travel, increased prestige, and other intangible advantages.

This case has been followed through somewhat in detail because it is typical of the problems that confront many other companies today.

One of the leading manufacturers of airplanes recently made a comprehensive survey of the business use of airplanes, finding that 170 firms in 45 types of business are now operating one or more airplanes. Inquiries from large corporations are being received at the rate of from 10 to 20 a week, and a recent mailing to hundreds of executives brought the information that 60 percent of the companies represented were considering the purchase of an airplane in the near future.

A few years ago an airplane was an object of curiosity and attracted a crowd wherever it landed, drawing attention to the name of the firm and its products. Many companies carried this further and installed flying displays of products, dropped samples and advertising literature and carried on other promotion stunts from the sky. So great was the advertising and publicity value that executives were inclined to overlook the airplane as a daily means of transportation.

LAWYER-PILOT

Charles L. Morgan, prominent attorney, owns and pilots his own cabin plane

Today the use of airplanes still draws some attention to the owner, and the arrival and departure of a plane in the smaller towns still receives news items in the local papers. It furnishes a valuable means of creating good-will among clients and others with whom the firm does business, but undoubtedly its greatest value is as a means of fast transportation. Airplanes are applicable to any line of business where dealings are conducted over a large territory requiring much travel by highly paid salesmen and executives.

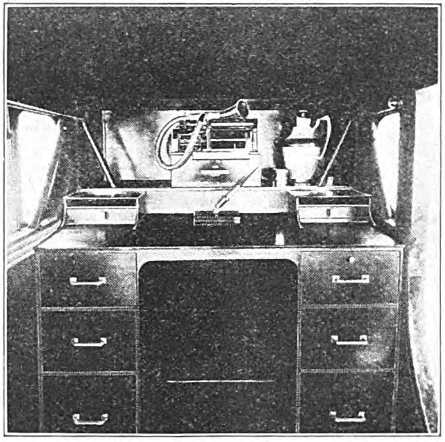
CHARLES L. MORGAN, a well-known attorney for oil and gas companies in the southwest, was one of the first men in the legal profession to see the need of fast transportation. His statement of the use he is making of his cabin plane is an illustration of the modern tendency to apply air transportation to business.

"My plane reduces the state to about the size of a county, if I were using an automobile. Moreover, air transportation is much more comfortable, easier, and cleaner. Personally, if I drive an automobile three or four hundred miles, I am tired, while with the plane, I can do a 1000 miles, accomplish a day's work, and not be any more tired than if I had been sitting behind my desk all day.

"Practically, it works out this way: previously if a client sent me to some remote point in western Texas, I spent two days going, worked one day, and spent two days returning. The client has to pay while I am traveling because he is taking my time. Assuming that my charges are 100 dollars a day and expenses, one day's work cost him 500 dollars plus expenses. With my airplane, I am off right after daybreak. By nine or nine thirty, I am at my destination at work, and at night I am home as usual. I can charge him 250 dollars. My client has saved more than half and obtained quicker action, and I collect 250 dollars per day instead of 100 dollars."

Many salesmen are becoming sales engineers with specialized technical knowledge in addition to their ability to make sales and hold the good will of customers. Such men are rare and often receive more than 10,000 dollars a year. It is an economic waste to allow such a man to spend half of his time in travel, when the investment of a few thousand dollars in an airplane will allow him to treble the time he spends in constructive work.

Edward S. Evans, president of the Detroit Aircraft Corporation, which controls 11 well-known aviation companies, and who is associated with many other business enterprises, recently said, "I believe that in a few years the companies that do not furnish their best salesmen with airplanes will be as out of date as the firms that had their salesmen traveling in buggies when their competitors were using motor cars."



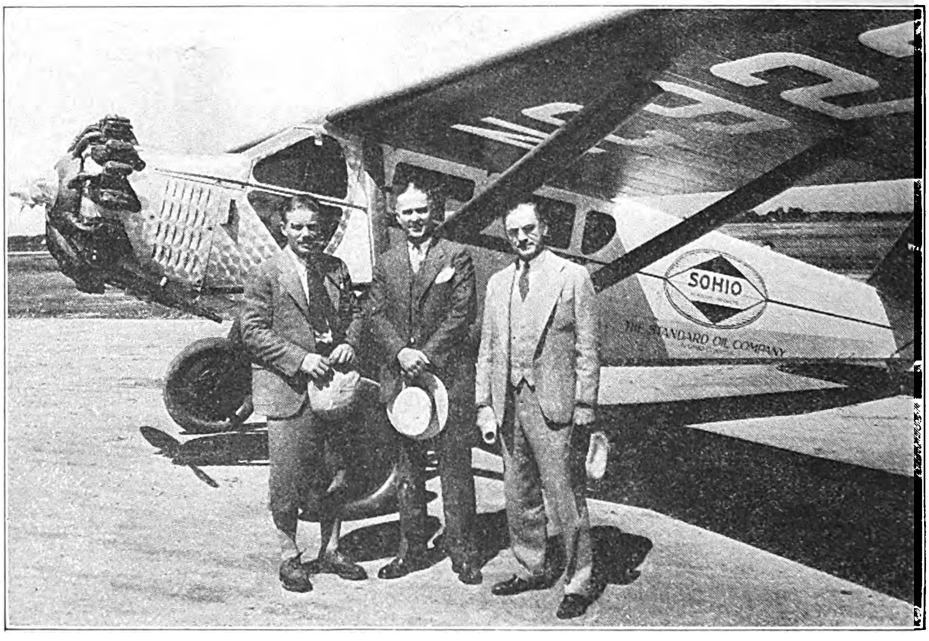
THE RYAN FLYING OFFICE

This cabin model, designed for business executives, is equipped with all appurtenances for transacting a day's work

Another use to which airplanes are readily adaptable is the delivery of equipment and parts required in a hurry. At least 20 oil companies are using airplanes for this purpose. Other industries also are finding the airplane invaluable in this type of service. When a machine breaks down, tying up a whole plant or department, expense is a minor factor compared with the time lost in getting replacements. Several of the more progressive machinery manufacturing companies maintain their own planes for quick delivery service.

TOO much emphasis has been placed on the romantic and unique uses to which an airplane can be put, so that many business men have overlooked the practical value of air transportation in daily work. The writer believes that five years from now, instead of 170 business firms owning airplanes, there will be thousands. The practicality of the "flying office" has been proved and about 20 such planes are now in use by presidents and executives of large corporations. Piloting the newer planes is much more simple than formerly.

Just 100 years ago school trustees in an Ohio town refused the use of a school for a debate on the subject, "Is the Steam Engine Practical." The school trustees wrote, "If God had intended that His beings should go at the unholy rate of fifteen miles an hour, He would have so declared in Holy Writ." A few executives of business corporations still assume somewhat the same attitude toward the adaptation of air transportation to their businesses.



EXECUTIVES AND PILOT READY TO TAKE OFF

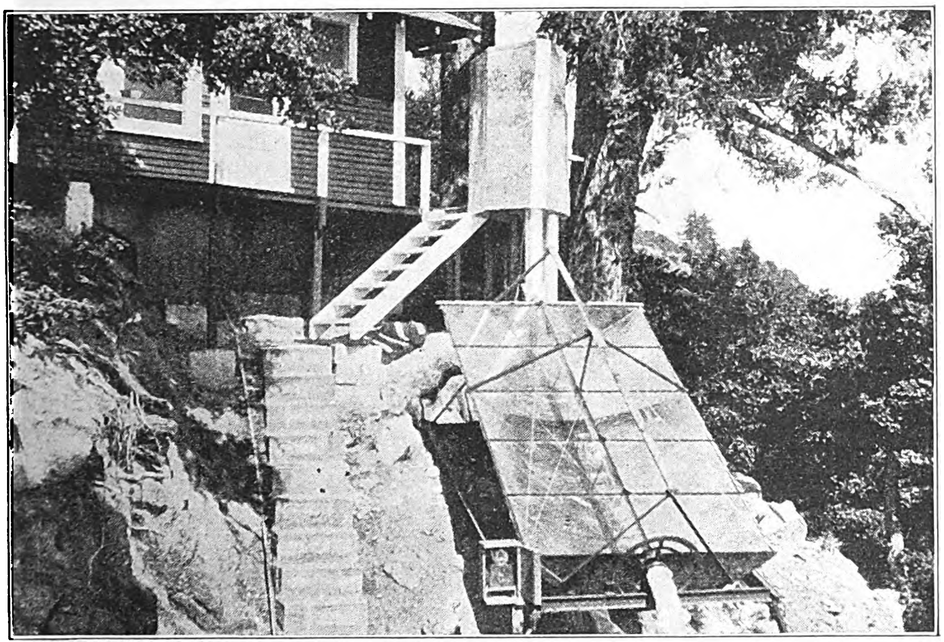
Left to right: Pilot Dewey Noyes with Mr. A. M. Maxwell and Howard G. Jones, officials of the Standard Oil Company of Ohio, about to leave Cleveland Airport on a short journey

A Big Practical Problem for Science*

What Will Be the Power Source of the Future, When the Coal Supply of the World Is Exhausted? Photochemistry Offers One Possibility

By PROF. F. M. JAEGER
The University of Groningen, the Netherlands
Non-resident Lecturer in Chemistry at Cornell University

IT is a well-known fact, that, both for the biological processes in plants and animals as well as for the maintenance of human civilization, a continuous import of energy from outer space to our planet is necessary. The only source of energy that practically needs to be taken into account in this respect, and which daily furnishes enormous quantities of energy, is our sun. In whatever form we meet with energy on the earth, whether it be stored in coal or oil, or be immediately available to us, as in the flowing or falling water, or in the winds, it can in all cases easily be understood that this energy has always its real origin in that of the radiation which the sun continuously emits in all directions into space and some of which strikes the earth.



Courtesy of Dr. Charles G. Abbot

ABBOT'S EXPERIMENTAL SOLAR COOKER

Dr. Abbot, Secretary of the Smithsonian Institution, devised this cooker, installed it at Mount Wilson Observatory and cooked with it. The parabolic aluminum reflecting surface focuses the sun's heat on a pipe which conducts hot oil to a reservoir. Cooking and baking temperatures up to 447 degrees, Fahrenheit, are obtained. The heat can be stored all night

If this radiation is absorbed, it will for the greater part be transformed into heat, which causes the water on the earth to evaporate, and thus gives rise to the mighty formation of clouds. Inversely, the condensation of this water vapor is the cause of rain and snow fall, which in their turn feed the rivers, seas, and waterfalls. The differences in temperature and pressure in the earth's atmosphere that are brought about under the influence of the solar radiation are the causes of air-currents which give rise to the energy of the wind. The radiant energy of the sun given out several hundreds of millions of years ago is now stored up in the form of chemical energy in coal, after having been transformed and accumulated in the living vegetable cells of those far-off eras. Through the process of combustion, this stored-up chemical energy is used by us in our steam engines and gas motors of to-day. This stock of coal, and also of mineral oil, nowadays represents the principal source of energy that man utilizes for the production of mechanical power.

There is no other source of energy on the earth the output of which can even distantly be compared with that derived from the two sources just mentioned. We can safely say that practically our whole need of energy is supplied by that fossil stock of solar energy which is at present stored in our deposits of coal and oil. The necessary consequence of this is that we draw upon our energy capital to so great an extent that it must finally become exhausted, unless some way be found to replenish it by again accumulating this mighty solar radiation against the day when our stores of coal and oil will have been exhausted.

The total quantity of coal on the earth seems not to exceed about 2000 billion tons, of which at the present time about one and one half billion tons are used annually. This yearly consumption, however, is increasing so rapidly that our coal deposits will hardly be sufficient for another thousand years, a period that is very short in comparison with the length of the future existence of mankind on the earth.

BUT the exploitation of the coal deposits that still remain will become impossible long before that time, both for technical and for economic reasons. Within a period much shorter than these thousand years, the ominous consequences of the present reckless demolition of our coal fields will make themselves seriously felt, for the simple reason that the coal must be extracted from ever deeper and deeper levels with consequent rapid increase of the cost of mining.

The question as to whether it then will be possible to obtain the indispensable energy from other sources on earth must, so far as can now be judged, be answered in the negative. Again at the instigation of Sir William Ramsay, the possibility of such an eventual development of other energy sources was in 1910 seriously investigated in England by a number of competent men. On that occasion the possibilities were taken into account of making use of the ocean tides, of the internal heat of the earth, of the energy of the winds and waterfalls, of the kinetic energy of the earth's rotation and of its yearly motion in space, of the chemical energy of wood and peat supplies, and finally of the intra-atomic energy of the atoms of the elements.

This official inquiry showed that the application of the internal heat of the earth, of the kinetic energy of the

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*From the George Fisher Baker Lecture, delivered at Cornell University, and reprinted by courtesy of *Science*.

earth's motions, of the energy of the winds, and the use of wood and peat supplies never would be of any significance for the solution of the problem in comparison to the enormous quantities of energy yearly furnished by our resources of coal and oil. The energy that could be obtained by the disruption of the atoms of our chemical elements would be enormous in amount, but we need not further consider it at this time because in the opinion of our ablest scientists the practical accomplishment of this objective will be achieved only in the far distant future, if ever.

The available water-power on the earth would, according to Engler, amount to about the energy of 70,000,000 tons of coal annually; that is, to about 4 percent of the energy necessary every year. Of course, the total water-power present on earth is much greater, but an appreciable part of it will probably never be available.

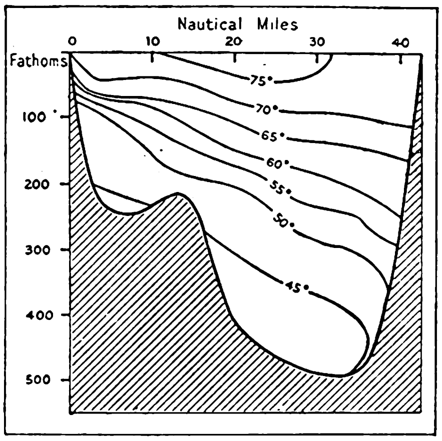
A CALCULATION made in 1922 by Steinmetz seemed to indicate that the energy of the flowing water, corresponding to the yearly amount of rain in this country, would be almost equivalent to that of your yearly coal consumption. Spoehr, however, has emphasized that these calculations are totally theoretical, as a great part of that energy is inaccessible and the distribution of the remaining energy over such an extensive territory would meet with almost insurmountable difficulties.

Therefore, in this respect, America is, for the time being, dependent in a large degree upon her own resources of coal and oil, of which the latter seems to be rapidly approaching final exhaustion, notwithstanding the apparently reassuring fact that new sources of limited extent are frequently being developed.

The possible use of the low and high tides of the sea has occupied the attention of various inventors since the 15th Century. Indeed, the periodically alternating low and high ocean tides would furnish gigantic quantities of energy if it were only possible to use them for mechanical purposes in a not too expensive and complicated way.

In recent times several solutions of this problem have been proposed, some of which have already found a practical application, although only on a relatively small scale, in France, in England, and in several places in Germany (Ditmarschen, Husum, Hüll). The systems with two large communicating water reservoirs, instead of those with a single one, seem to be preferable, as they allow an uninterrupted action both day and night, even during neap tide. Their theoretical efficiency, for a difference in sea-level of about ten feet is, however, less than that of a system with a single tank, and is not greater than about 12,400 kilowatts for each sea-tide and for each square mile of surface of the reservoirs, and in practice this efficiency is appreciably diminished by a number of uncontrollable factors, as, for example, the irregularities in the level-differences of the tides, to the square of which the energy output is proportional.

Such a plant would be extremely expensive and its maintenance would be very costly. Consequently it could economically be operated only under very favorable local conditions. It is therefore probable that no satisfactory solution of the problem of the production of energy in this manner is to be expected.



By Marmer, after Wust, courtesy of the *Geographical Review*

GULF STREAM TEMPERATURES

Cross-section of Gulf Stream through Straits of Florida, Cuban shore at right

Recently, however, there seems to be indicated another way of energy production from the sea, which, in my opinion, may become of high significance in the future. I refer to the experiments of G. Claude and P. Boucherot upon the utilization of the relatively small but very constant temperature-differences that exist throughout the year between the sun-heated surface of the tropical oceans and their deeper layers, the temperature of which is kept at from 37 to 39 degrees, Fahrenheit, by the cold polar-sea currents.

IN 1913 your countryman Campbell pointed to the possibility of obtaining mechanical or electrical energy by means of these very constant temperature-differences, and in 1923 Romagnoli, Dornig, and Boggia made analogous propositions. It was, however, only recently that the well-known French chemist Claude and his collaborator Boucherot succeeded in giving experimental proof of that possibility. They were able to demonstrate that a small Laval turbine designed to be driven by steam within pressure limits ranging from 300 to 3 pounds per square inch can advantageously be driven by water vapor with tensions between only $\frac{3}{5}$ and $\frac{3}{20}$ of a pound per square inch, corresponding to temperature-differences between 77 and 44 degrees, Fahrenheit, only.

According to their calculations and experiments, a net output of 383,000 foot pounds could be obtained from each cubic meter of water between 82 and 39 degrees, Fahrenheit, if there be subtracted the energy that is necessary for pumping the cold and air-free water from the depths of the ocean to its surface. An installation of this kind having a capacity that effects the displacement of 35,300 cubic feet of cold water every second, would be able to produce 400,290 kilowatts of electrical energy, this efficiency being about 30 or 35 times as great as that of a low and high tide plant of the same dimensions.

In their provisional installation at Ougree-Marihaye, Claude and Boucherot recently demonstrated before a meeting of engineers that a turbine could be run by utilizing the slight temperature-differences of the water of the Meuse, ranging only from 82 to 44 degrees, and that it could drive a dynamo with a capacity of 59 kilowatts. The calculations by Boucherot of the necessary costs of installation seem undeniably to indicate that the practical realization of this idea lies very probably within the limits of technical possibilities.

THE question as to whether it would be possible to use our present stocks of coal and oil in a more economical way than is now usually applied is of high importance and has often been the subject of discussion and investigation. In the present exploitation of our oil fields, about three fourths of the oil remains in the soil. This needs, in the future, to be recovered by some process suitable to the purpose.

Even the continuous improvement of the steam engine, or its substitution by turbine or gas motor, can not eliminate the ominous fact that the greater part of the heat of combustion of the coal and oil will, when thus used, always be wasted. At the present time it seems that the most effective way of limiting, as far as possible, this squandering of energy consists in the combustion of the coal at the mines themselves, and the immediate utilization of the heat of combustion for the production of high-tension electric currents.

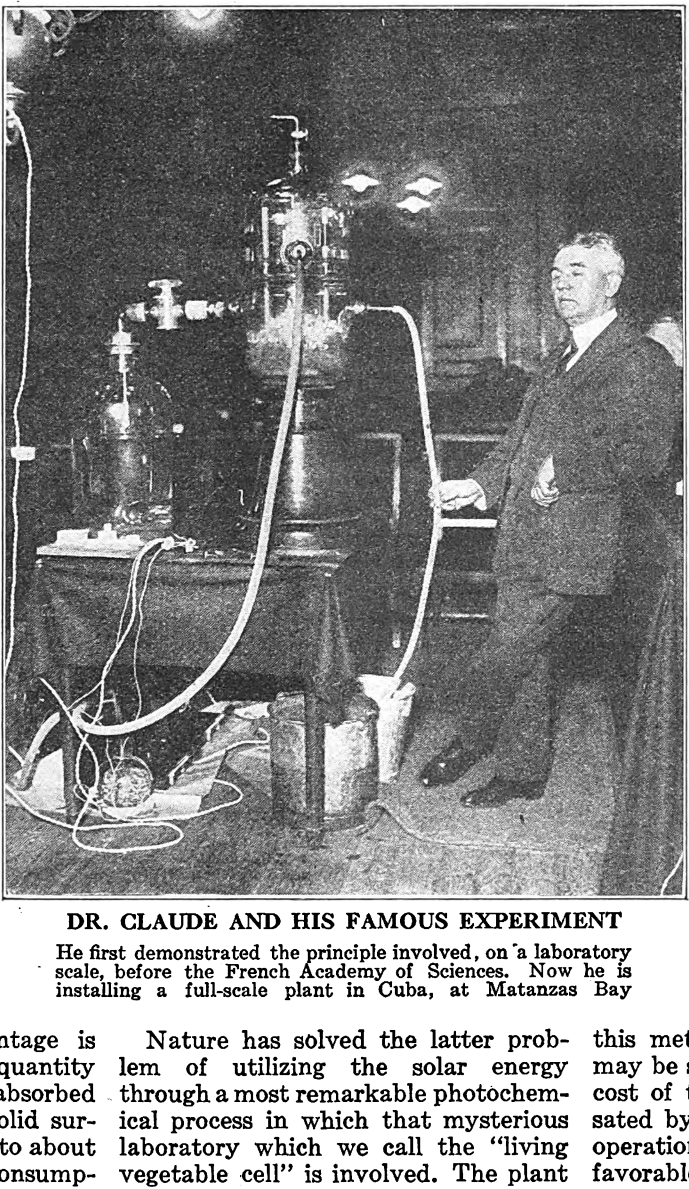
It is possible that some way may be found for transforming the potential energy of the coal directly into electrical energy, but experiments along this line have not yet met with practical success. None of the so-called "fuel batteries" constructed for this purpose in the last decade can be considered as being adapted to practical development, because their current efficiency, even at higher temperatures, remains in each case much too small by reason of the unsatisfactory reaction-velocity of the electrochemical processes going on in them.

As the matter now stands, we can say that in answering the question as to how to make the future necessary energy production most completely independent of the fossil stocks of energy accumulated in former geological periods, we are chiefly confined to the mighty current of radiant energy that is flowing to us directly and continuously from the sun. This quantity of radiant energy appears to be stupendously great, but it is now almost completely lost by dissipation. Some data may give you a clearer understanding of this fact.

According to Langley's measurements of the solar constant, each square meter of the earth's surface receives, every hour, a quantity of radiant energy that is equivalent to 1800 calories. If we regard the sun as limiting itself to an eight-hour working day in tropical regions, it can be calculated that every square meter of the earth's surface receives from the sun's radiation a quantity of energy equivalent to the heat of combustion of 2.86 pounds of coal. For every square mile this is equivalent to 7400 tons of coal, which means that the total annual amount of energy produced throughout the world through the combustion of coal would be equaled by the radiant energy of the sun which, during a like period, falls upon a surface of only 1275 square miles. The desert of Sahara has a surface of about 2,300,000 square miles, and therefore annually receives a quantity of solar energy that is equivalent to more than 1800 times that derived from the world's total yearly consumption of coal.

At present this enormous quantity of energy is almost completely lost; only three percent of it is absorbed and used by the living plants on the earth. Although this percentage is a very small one, the total quantity of radiant energy annually absorbed in this way over the whole solid surface of the earth still amounts to about 15 times the yearly world consumption of coal. But the question arises as to whether and in what way it would be possible to catch the enormous quantity of solar energy that now is dissipated every year, and to apply it to the production of mechanical and electrical energy.

In the consideration of this question two points should be emphasized at the outset; first, the necessity of concentrating and accumulating the solar energy supplied to large surfaces; and second, of absorbing this solar energy to the greatest possible extent. Absorption must precede the transformation of radiant energy into those other forms in which it can be used for our immediate purposes. After absorption, the solar energy may be immediately transformed into heat which may then be utilized in the usual manner for the production of mechanical work, or the radiant energy may be absorbed by special substances in which it sets up a "photochemical" reaction and thereby produces a certain amount of chemical energy. The chemical energy can afterwards be changed into another form of energy suitable for our use.



DR. CLAUDE AND HIS FAMOUS EXPERIMENT

He first demonstrated the principle involved, on a laboratory scale, before the French Academy of Sciences. Now he is installing a full-scale plant in Cuba, at Matanzas Bay

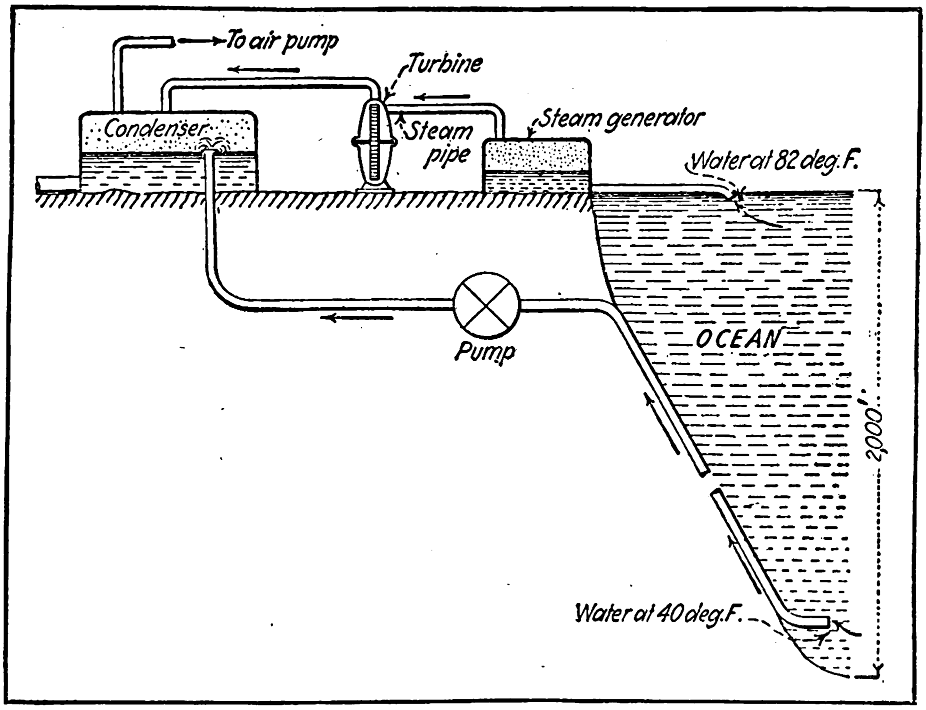
Nature has solved the latter problem of utilizing the solar energy through a most remarkable photochemical process in which that mysterious laboratory which we call the "living vegetable cell" is involved. The plant utilizes the radiant energy of the sun to synthesize a large number of complicated chemical substances in its protoplasm. These compounds accumulate in the plant organism, and their stored chemical energy can later be employed for the production of mechanical work. We also know of other photochemical reactions in which a fraction of the absorbed radiant energy is immediately transformed into electrical energy. I will discuss these more fully later on.

Let us first consider the other and simpler case of utilizing the solar energy by first concentrating and absorbing it, and then transforming it into heat.

Concentration of the radiant energy may be effected either by means of large lenses or by a system of mirrors; the absorbent heat-reservoir is placed at the focus. In actual practice, only systems of mirrors have been used. These are mounted on a light frame which permits them to be easily rotated, which is, of course, necessary because they must follow the apparent motion of the sun in the sky. The radiant energy concentrated by these mirrors falls upon a metallic reservoir which is blackened on the outside and which contains some volatile liquid that shows a considerable vapor tension at relatively low temperatures. Ammonia, sulfur dioxide or certain organic liquids of low boiling point are employed.

An example of this type of installation is that devised by Shulz, in which, using sulfur dioxide, an output of about one horsepower was obtained for each square yard of surface of the absorbent reservoir. At the ostrich farm in Pasadena they have used, and perhaps still are using, a conical aggregate of mirrors of 32 feet diameter, in the focal line of which a steam boiler was placed. This developed steam at a pressure of from 150 to 225 pounds per square inch after only one hour's exposure to the sun, and the device was used for pumping water at the rate of about 2000 gallons per minute, and for driving a dynamo.

It may be possible that in dry and tropical climates this method of utilizing solar energy may be successful on a small scale, the cost of the equipment being compensated by the fact that the expense of operation is very low. But under less favorable conditions this device can never be expected to yield a satisfactory solution of the problem because it concentrates the radiant energy that falls on only relatively small surfaces. The proposal of Claude and Boucherot offers much greater promise in this respect because it utilizes the



SCHEMATIC LAYOUT OF CLAUDE-BOUCHEROT PROJECT

Water becomes steam at air temperatures if air pressure is greatly reduced. Claude and Boucherot do this by condensing the exhaust from the turbine with cold bottom water

energy that is accumulated over the immense surface of the ocean during long intervals of time.

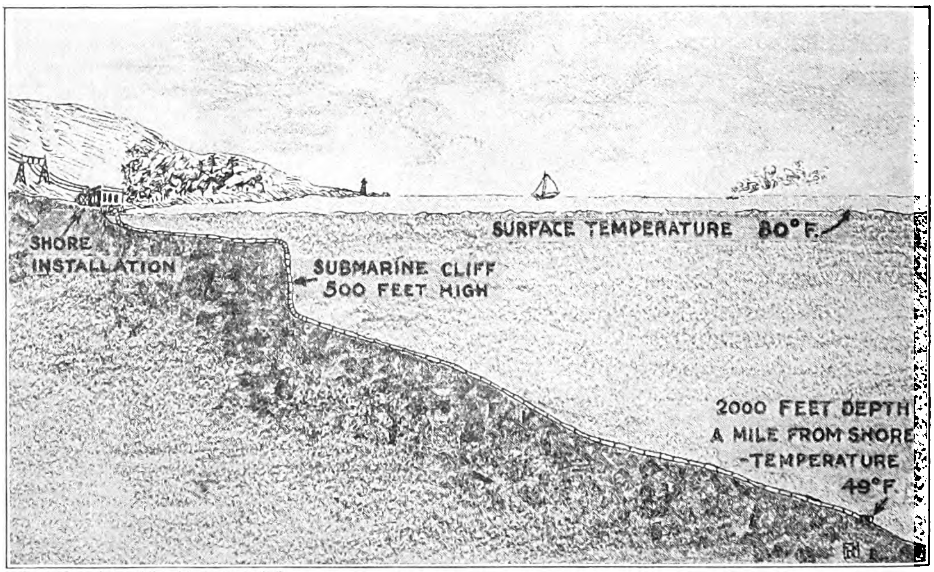
These considerations lead us to the conviction that the final solution of the problem must be sought rather in the utilization of specific photochemical reactions of the radiant energy. I intentionally use the word specific here because experience has shown us that the action of radiation upon chemical substances is highly exclusive in character. The assimilation of carbon dioxide by plants is a well-known example. The radiation is here absolutely necessary for bringing about this reaction which goes on at ordinary temperatures, the living cell being able under the influence of sunlight and with the aid of its chlorophyll to synthesize a number of complicated substances which we in the laboratory, in spite of the high development of synthetic chemistry at the present time, are able to produce either not at all or only with great difficulty, even when high temperatures and powerful agents are employed.

We are still dependent, for the production of most of our foods and drugs, upon photochemical processes that proceed under the influence of solar radiation in the plant cells. Although it seems possible, according to the experiments of Ciamician and Ravenna, to influence these processes within certain limits by special external stimuli, we really as yet have little understanding of the true mechanism of these reactions. But the researches of Baly, which have shown that moist carbon dioxide may, in the presence of certain substances such as compounds of cobalt or nickel, be transformed through the influence of ultra-violet light into substances like sugar, have demonstrated that it is possible to produce, in the laboratory, compounds that are formed in the natural processes of the living plant.

No one as yet has succeeded in carrying on this photochemical synthesis on a large scale. It offers, however, an alluring prospect because, according to Brown's investigations, if it is assumed that a quantity of solar energy equivalent to five calories will transform one liter of carbon dioxide into sugar, and if only 4 percent of solar energy during an eight hour day is assumed to be photochemically active, it would be possible in this manner to produce 374 pounds of sugar every day by the use of a tank having a surface of only one hundred feet square. This amount of sugar, besides its value as a nutriment, would, if used as a fuel, be equivalent to about 154 pounds of coal. It is extremely doubtful, however, whether this method of utilizing solar energy will ever be brought to practical success.

The remaining possible solution of the problem of utilizing the radiant energy of the sun for the production of mechanical work is the application of reversible photochemical reactions which proceed in such a manner that the absorbed radiant energy may be converted into a usable form such as electrical energy. If the reversibility of such photochemical reactions is nearly quantitative in character, the photosensitive system of substances will then, in respect to solar radiation, play a rôle analogous to that of the lead accumulator in respect to electric energy. We might term such instruments "radiation accumulators"; they would be exposed during the day to the solar radiation which would cause a certain photochemical reaction, and then at night when left in the dark this reaction would reverse, the materials would return to their original condition, and the radiant energy absorbed during the day would be set free and stored up for mechanical uses.

It has long been known that such reversible photochemical processes really exist. For example, if a solution of mercuric chloride and ferrous chloride in water is exposed to light radiation, a reaction takes place in which certain amounts of mercurous chloride and ferric chloride are formed, a chemical equilibrium between the four salts being finally reached. If now this solution is placed in the dark, the sub-


SHORE INSTALLATION
SUBMARINE CLIFF 500 FEET HIGH
SURFACE TEMPERATURE 80°F.
2000 FEET DEPTH A MILE FROM SHORE -TEMPERATURE 49°F.

Drawn from data published in *Le Génie Civil*

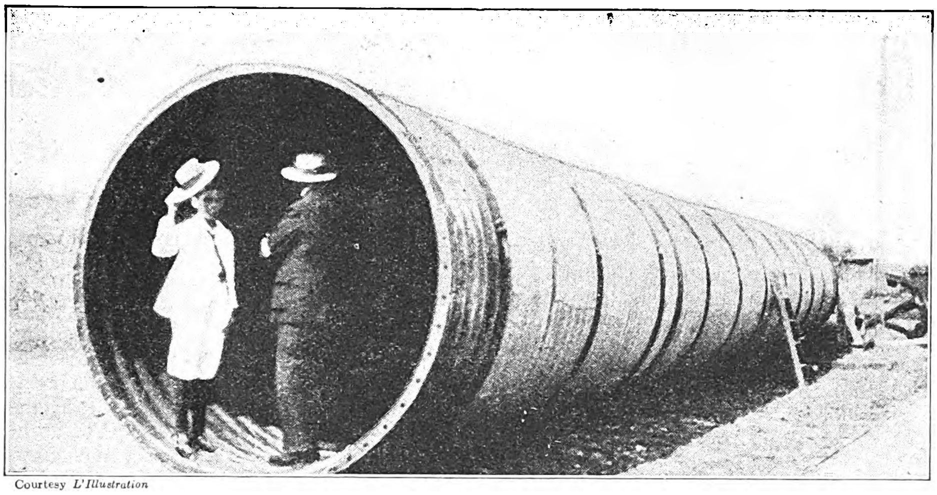
CLAUDE-BOUCHEROT PROJECT NOW UNDER WAY IN CUBA

The tube, seven feet in diameter, is made of corrugated iron. An accident to it recently delayed the project. In the drawing both vertical and horizontal scales are the same stances will revert to their original form, and during this inverse reaction the radiant energy absorbed will be completely set free in the form of electrical energy. It is possible to obtain a tension of 0.17 volt by means of such a photochemical cell; consequently a dozen such cells joined in series will yield the voltage furnished by an ordinary lead accumulator cell.

AGAIN, such a photochemical cell can be made by placing two platinum electrodes to an acidulated solution that contains potassium iodide and ferric chloride. When this cell stands in the dark, ferrous chloride and a certain amount of free iodine will be formed, the iodine remaining dissolved in the excess of potassium iodide. On exposing this cell to the action of light, the chemical equilibrium is displaced in the opposite direction, and potassium iodide and ferric chloride are regenerated. As with the previous cell the absorbed radiant energy is set free as electric energy.

Another remarkable example of a phenomenon of this nature is described by Rigollot. Two plates of red copper, each of them superficially covered with a thin layer of coprous oxide, are placed in a saturated solution of sodium chloride. If now one of these plates is exposed to light radiation and the other is kept in the dark, an electric current passes through the wire that connects the two electrodes. This current continues as long as the exposure lasts. The whole system returns to its original state in the dark. If the other electrode is illuminated, the electric current flows in the opposite direction.

These various experiments furnish definite proof that it is possible to convert radiant energy into electrical energy by means of reversible photochemical processes.



Courtesy *L'Illustration*

SECTION OF TUBING READY FOR INSTALLATION. CLAUDE PROJECT

The tubing is made of Number 7 gage sheet iron, is corrugated, very flexible, and light. The cold bottom water will be warmed only one degree in the pipe, it is estimated

There is, however, one great drawback to the practical application of such a method, and that is the very low intensity of the electrical current that is produced. The electrical work that can be done, which is a product of the voltage and current intensity, is, therefore, in all cases only extremely small. The explanation lies in the fact that the reversible transformations which take place in these cells are characterized by very small reaction velocities, and consequently the energy that is carried off can not be resupplied by the photochemical reactions with sufficient rapidity. The photochemical effect appears in general to be the strongest in those cases of reversible processes in which the oppositely directed reactions are slowest, and because of this fact, some investigators are inclined to doubt whether the utilization of such radiation accumulators can ever be of practical value. This opinion may, however, prove to be unduly pessimistic.

The construction of such cells is wholly a problem of reaction-kinetics. If it should prove possible to devise radiation accumulators or Volta-cells in which reversible and very rapid photochemical changes take place when radiation of such wavelengths as are contained within the solar spectrum is employed, the problem of using solar radiation as a source of energy might be regarded as definitely solved.

We are, however, still far distant from this goal. Photochemistry is still in its infancy and it has not yet outgrown the stage of mere empirism. It is quite possible, however, that when man's existence becomes seriously menaced because of a shortage of energy, photochemistry will rescue him from his distress.

The protection of mankind from this danger rests chiefly upon the physicist and the chemist, and they must ever be on the alert to find solutions for these intricate problems that involve the very existence of our race.

	Power Already Utilized			Total Horse-power Existing
	Horsepower	Percent of World Totals	Percent of Available Being Used	
Germany	1,100,000	3.6	55	2,000,000
Great Britain	250,000	0.8	29	850,000
France	2,100,000	6.9	26	8,000,000
Norway & Sweden	3,200,000	10.7	17	19,000,000
Switzerland	1,400,000	4.6	18	8,000,000
Spain	1,000,000	3.3	23	4,400,000
Italy	1,800,000	6.0	47	3,800,000
Russia in Europe	100,000	0.3	5	2,000,000
Rest of Europe	1,000,000	3.4	10	10,100,000
Europe	12,000,000	39.6	21	58,200,000
United States	10,000,000	33.0	29	35,000,000
Canada	3,200,000	10.6	12	26,000,000
Brazil	400,000	1.3	1.6	25,000,000
Mexico	500,000	1.7	8.0	6,000,000
Argentine	30,000	0.1	0.6	5,000,000
Rest of America	300,000	1.0	1.3	23,100,000
America	14,400,000	47.7	12.0	120,000,000
Siberia	90,000	0.3	0.2	51,000,000
China				20,000,000
Dutch Indies	80,000	0.3	0.5	15,000,000
Japan	3,000,000	10.0	21.0	14,000,000
New Guinea				10,000,000
British India	400,000	1.3	5.0	7,400,000
Rest of Asia				5,700,000
Asia	3,600,000	11.9	3.0	123,100,000
Africa	20,000	0.1	0.01	190,000,000
Australia	200,000	0.7	3.0	6,500,000
World Totals	30,000,000	100%	6%	497,900,000

From data in the *Stone and Webster Journal*

STATISTICS OF THE WORLD'S DEVELOPED AND UNDEVELOPED WATER POWER

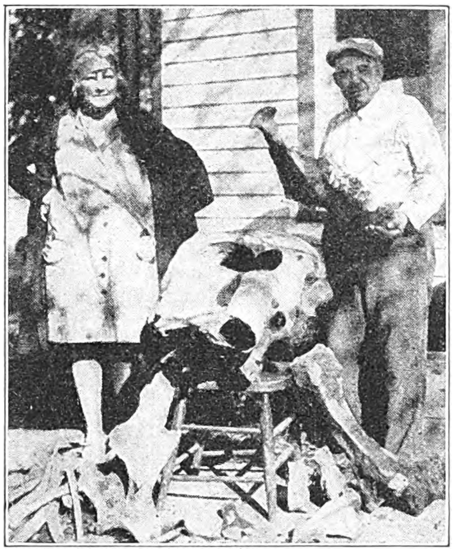
The table shows that the world is using only 6 percent of its potential water power. Yet if every available hydraulic horsepower were to be used, the total would only equal half the present installed power from all sources in the United States alone. Water power is inadequate

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Exceptional Mastodon Bones Found

THE skeleton of a mastodon has just been unearthed in the village of Walnut, Indiana, and has been presented to Field Museum of Natural History, Chicago, by William and T. Bower, owners of the land upon which it was found. The skeleton was discovered by P. H. Yoder, local contractor, and his crew, while excavating an open ditch on the Bower farm.



Courtesy Field Museum of Natural History

P. H. Yoder, a contractor of Argos, Indiana, with skull and other bones of mastodon he discovered

Prof. Elmer S. Riggs supervised the excavation of the bones, which are probably between 25,000 and 100,000 years old. Included in the remains obtained are the giant beast's skull, tusks, teeth, jaws, and what are believed to be more than half of its body and leg bones. The find is regarded by museum authorities as extremely important, as it is seldom that such nearly complete specimens of these great creatures of the dim past are found. The new bones will provide a more nearly complete skeleton of an individual than any previously obtained.

Skeletons of mastodons and mammoths are not rare; in fact it is commonly stated that every marsh or nearly every marsh conceals at least one such skeleton. Nevertheless finders of similar remains are always urged to notify qualified scientific institutions, giving them the opportunity to investigate, as any find may turn out to have unexpected importance.

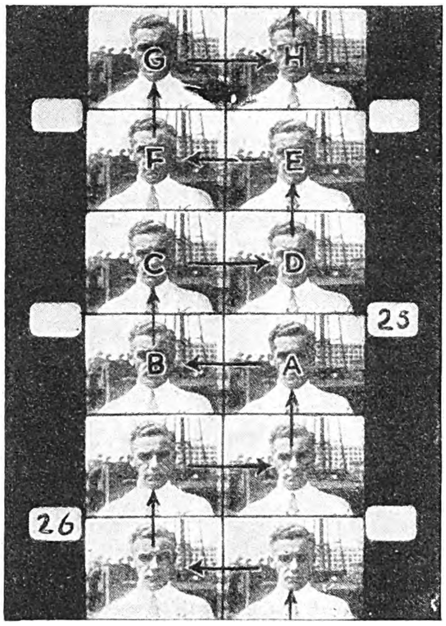
Holes in Submarines Patched Under Water

A NEW device for quickly patching holes in disabled submarines under water has been tested by United States Navy officials and pronounced successful. The device looks something like a pneumatic hammer, but employs charges of high explosive to drive steel studs through the shell of the sunken vessel, fastening an emergency patch over the rent. It is the invention of Robert Temple, of Denver.

The advantages claimed for the new submarine patcher are great speed in emergency operations, and ease of handling under water. The method now in use requires a comparatively slow-working air drill, dragging many feet of cumbersome hose behind it. The new tool drives a steel stud, three and one half inches by one half inch, through a half-inch steel plate at a single blow. It makes no noise, and complete safety for the operator is claimed.

In a navy yard test, a torpedo flask with a hole ten inches in diameter in its side was lowered into the water. A diver went down with a submarine patcher and a steel plate big enough to cover the hole. He fastened the plate in place with eight studs in about 90 seconds.

Further possible emergency uses for the new tool have been pointed out. It is possible to drive hollow studs as well as solid ones with it, and through such tubes water, liquid foods, and air could be supplied to men trapped within disabled submarines. The ends of threaded studs could be secured with nuts, thus making it possible to attach lifting cables at exactly the points desired by the commander of a salvage crew.—*Science Service.*



To illustrate how cheaper amateur movies are made—enlarged film

Cheaper Amateur Movies

A ROLL of 16-millimeter film, such as is used in standard amateur motion picture cameras, costs six dollars for a length of 100 feet which, when projected, gives a screen picture of only four minutes. A similar roll of film used in a new camera, the Homovie, which was recently announced by the Kodel Electric and Manufacturing Company, will give 16 minutes of pictures when projected in the Homovie projector. Besides this lower cost, the Homovie equipment has the advantage of eliminating frequent loading of the camera.

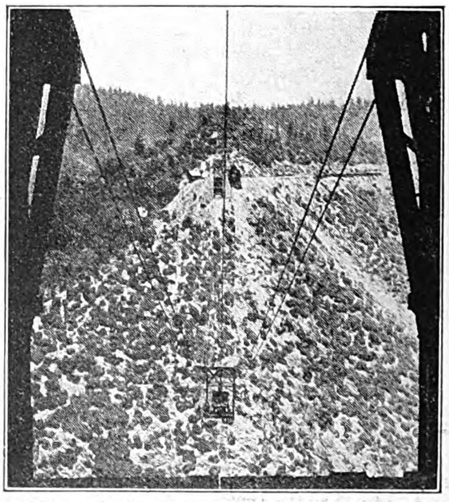
With the new camera, four picture images are made in each "frame" where only one picture is made with other cameras. These are taken in a sequence that will give a cross-wise projection as well as a lengthwise projection. The sequence of the quarter "frames" are: forward, to the left, forward, to the right, and repeat. This is best shown by the accompanying illustration.

Since it is obvious that with a unit length of, say 100 feet, of standard 16-millimeter film, four times as many pictures may be made when using Homovie equipment as may be made with old style amateur movie cameras, it will be seen that the new equipment reduces the cost of amateur movies 75 percent.

Electric Cableway Spans Western Canyon

HIGH up in the western mountains, near the little town of Camino, California, the largest electric cableway in this country spans a canyon a half-mile wide. This cableway, recently completed for the Michigan-California Lumber Company, carries lumber from a loading point on one side to the mill on the other. Because of the heavy weights, high speed, and long distance involved, the installation is one of the most outstanding of its type.

The cableway is operated by electricity, complete equipment for the purpose being supplied by the General Electric Company. A single loaded carrier, carrying a rail car loaded with a maximum of 24,000 pounds of sawed lumber—a maximum gross weight of 29 tons—passes to and fro between the two loading terminals on opposite sides of the canyon. The distance between terminals is approximately 2700 feet, the depth of the canyon is 1200 feet, and the maximum speed of operation is 1800 feet per minute, or a little over 20 miles per hour. The carrier makes a round trip in something over six minutes, including the three and one third minutes required for loading and unloading. The equipment is capable of handling this cycle continuously.



View from receiving and control **building showing aerial tramway cable carrying a heavily laden car**

Four steel cables, each two inches in diameter, support the carrier which runs on 32 wheels. The traction rope is endless and is one inch in diameter.

The electric equipment consists, principally of two 225-horsepower, wound-rotor, intermittent duty, hoist motors, operating mechanically and electrically in parallel, and controlled through suitable primary and secondary magnetic contactor panels. A single manually operated master controller governs both motors. The two motors are geared to two large sheaves, each eight feet in diameter, which engage the traction rope. Each motor is equipped with a motor-mounted brake. Momentarily the two motors are able to exert a combined output of 800 horsepower and, for short periods, most of this capacity is required.

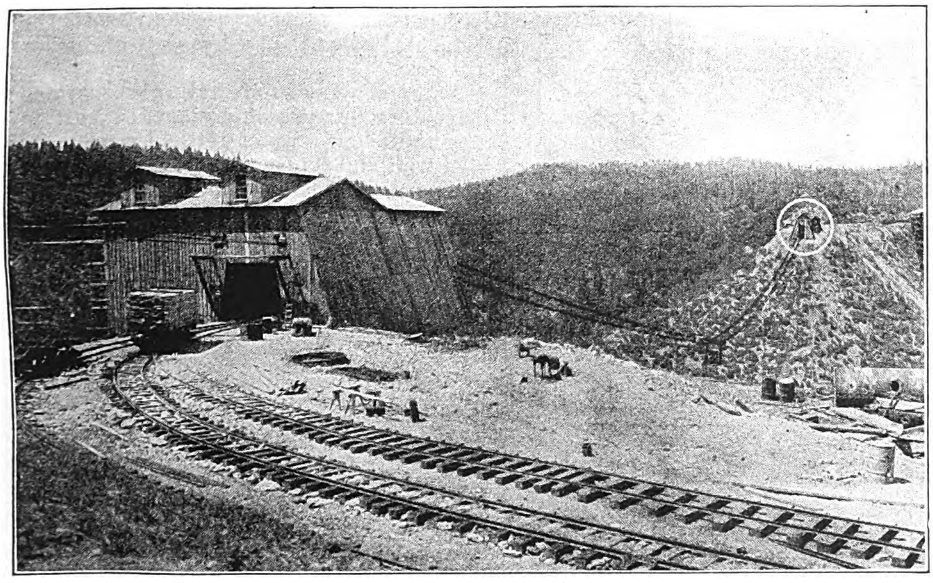
Stopping the carrier at either terminal is normally accomplished automatically, in four graded steps, by means of a geared limit switch. After being so stopped at either end, the carrier is brought to the final position. This requires accurate spotting, in order to roll off the loaded rail car, and the final spotting is done by an operator located at each terminal, through the use of an "inching" push button.

Demonstrating the new cathode-ray television set with which large audiences may be entertained

The motors and power plant are located at one side only of the canyon, and the carrier is started and accelerated by the operator at the main master switch located on the motor or power side of the canyon. The necessity for inching the load to its final position on either side of the canyon by operators located on either side, 2700 feet apart, made it necessary to provide for the transfer of control back and forth across the canyon, with a red and green signal light system and proper interlocking of control circuits for safety reasons.

The entire equipment operates under both overhauling and motoring loads at different times during the cycle of operation. For example, as the 29-ton loaded carrier descends into the sag of the supporting cables—approximately 135 feet at the middle of the span—the motors act as generators for the purpose of limiting speed. At other times, when ascending into the terminals, maximum motoring power is required.

The cableway is also used, on occasion, as a man carrier, as it is often necessary to transport men across the canyon during operations.



Aerial cable tramway with a car, heavily loaded with lumber, part way across the valley. General view showing receiving terminal building and tramway

Cathode-Ray Television Receiver Developed

TELEVISION which can be viewed by a room full of spectators rather than by only one or two, was announced recently by Dr. Valdimir Zworykin, research engineer of the Westinghouse Electric and Manufacturing Company. The use of a cathode-ray tube as a receiver gives this new type of television many advantages over the well-known scanning-disk method of visual broadcasting.

The cathode-ray television receiver has no moving parts, making it more easily usable by the rank and file of the radio audience. It is quiet in operation, and synchronization of transmitter and receiver is accomplished easily even when using a single radio channel.

Another advantage is that, using a fluorescent screen, the persistence of the eye's vision is aided and it is possible to reduce the number of pictures shown each second without noticeable flickering. This in turn allows a greater number of scanning lines and results in the picture being produced in greater detail without increasing the width of the radio channel.

Dr. Zworykin and his cathode-ray tube used in a television receiver

The apparatus described by Dr. Zworykin is now being used in experimental form in the research laboratories in East Pittsburgh. A number of similar receivers are being constructed in order to give the system a thorough field test through station KDKA, which already is operating a daily television broadcast schedule with the scanning-disk type of transmission.

The pictures formed by the cathode-ray receiver are four by five inches in size. They can be made larger or brighter by increasing the voltage used in the receiver.

Dr. Zworykin developed an entirely new type of cathode-ray tube for his receiving apparatus which he calls a "kinescope." In this tube a pencil of electrons is bombarding a screen of fluorescent material. The pencil follows the movement of the scanning light beam in the transmitter while its intensity is regulated by the strength of the impulses received from the transmitter. The movement of the scanning beam—consequently of the cathode-ray pencil itself—are so rapid that the eye receives a perfect impression of a continuous miniature motion picture.

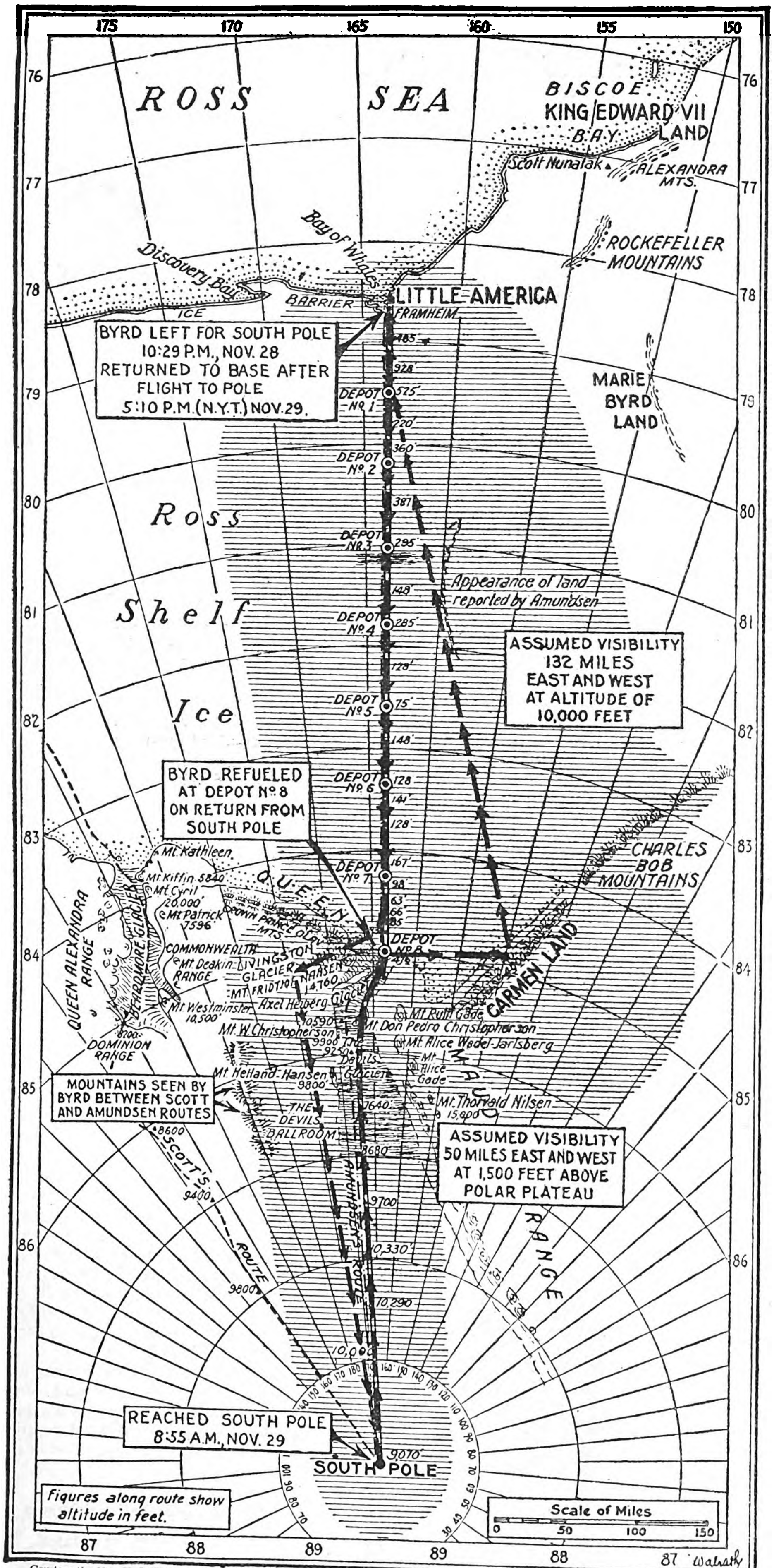
A reflecting mirror mounted on the receiver permits the picture to be observed by a number of spectators.

This condensed description of the methods used by Dr. Zworykin to effect television transmission can give only an idea of the possibilities of the new system. To the radio public it means, when perfected, a means of television which will be simple to operate because it has no scanning disk or other moving mechanical part. The receiver will operate in silence, offering no interference to sound broadcasts.

To the radio engineer the invention is important for the same reasons and because it will not be wasteful of radio wavebands. This is because the transmitter and receiver can be synchronized using but one channel.

Mice Have Hereditary Twisted Noses

TWISTED noses "run in the family" of a strain of house mice discovered by Dr. Clyde E. Keeler of the Harvard Medical School and reported to the National Academy of Sciences, Washington. He found, upon dissecting some of the speci-


175
170
165
160
155
150
ROSS SEA
BISCOE
KING EDWARD VII LAND
BAY
Scott Nunatak
ALEXANDRA MTS.
Bay of Whales
Discovery Bay
ROCKEFELLER MOUNTAINS
LITTLE AMERICA
BARRIER
ICE
FRAMHEIM
BYRD LEFT FOR SOUTH POLE 10:29 P.M., NOV. 28 RETURNED TO BASE AFTER FLIGHT TO POLE 5:10 P.M. (N.Y.T.) NOV. 29.
MARIE BYRD LAND
DEPOT Nº 1
DEPOT Nº 2
DEPOT Nº 3
DEPOT Nº 4
DEPOT Nº 5
DEPOT Nº 6
DEPOT Nº 7
DEPOT Nº 8
Ross Shelf Ice
Appearance of land reported by Amundsen
ASSUMED VISIBILITY 132 MILES EAST AND WEST AT ALTITUDE OF 10,000 FEET
BYRD REFUELED AT DEPOT Nº 8 ON RETURN FROM SOUTH POLE
CHARLES BOB MOUNTAINS
CARMEN LAND
QUEEN
Mt. Kathleen
Mt. Kiffin 5840
Mt. Cyril 20,000
Mt. Patrick 7596
CROWN PRINCE OLAV MTS.
QUEEN ALEXANDRA RANGE
BEARDMORE GLACIER
COMMONWEALTH RANGE
Mt. Deakin
LIVINGSTON GLACIER
MT. FRIDTJOF NANSEN 14,760
Axel Heiberg Glacier
Mt. Westminster 10,500
Mt. W. Christopherson
Mt. Ruth Gade
Mt. Don Pedro Christopherson
Mt. Alice Wedel-Jarlsberg
Mt. Alice Gade
DOMINION RANGE
The Devils Glacier
Mt. Helland-Hansen
MOUNTAINS SEEN BY BYRD BETWEEN SCOTT AND AMUNDSEN ROUTES
THE DEVILS BALLROOM
Mt. Thorvald Nilsen 15,000
MAUD RANGE
ASSUMED VISIBILITY 50 MILES EAST AND WEST AT 1,500 FEET ABOVE POLAR PLATEAU
SCOTT'S ROUTE
AMUNDSEN'S ROUTE
REACHED SOUTH POLE 8:55 A.M., NOV. 29
SOUTH POLE
Figures along route show altitude in feet.
Scale of Miles
0 50 100 150
87 88 89 89 88 87
Walrath

Courtesy the *New York Times*

After over a year of preparation, during which his expedition had been in constant touch with the world by radio, Commander Byrd, accompanied by Bernt Balchen, Harold June, and Captain Ashley McKinley, made a successful flight from Little America to the South Pole, November 28-29, 1929, over the route shown. He is continuing his explorations of the Antarctic

mens, that the peculiarity is due to the shortening of one of the nasal bones, while the other bone grows to normal length. He mated one of the apparently normal brothers of a twist-nosed mouse to a normal wild mouse, and among the offspring found one with a twisted nose; but it slewed to the right instead of to the left as in the original find. This "left-nosed" mouse, paired with an apparently normal litter mate, produced one male offspring with a straight but notably short nose. Upon examination it was found that both of its nasal bones were shortened.—*Science Service.*

Russia Makes Syrup Out of Watermelons

WATERMELONS instead of cane will be the raw material used in a new syrup factory recently established at Stalingrad, fromerly Tzaritzin, on the Volga. The product, known as "nardek" has long been made by a crude hand process, and is so popular that bee-keeping has practically disappeared from the region where it is used. The better grades of the syrup are used in cooking or confectionery, and the poorer grades in the manufacture of alcohol.—*Science Service.*

What Byrd's South Polar Flight Means

IN a special message to the *New York Times* relative to Commander Richard E. Byrd's notable flight to the South Pole from Little America, and return, on Thanksgiving Day, November 28, 1929, the National Geographic Society forecasts many valuable results.

"Data gathered by the Byrd expedition will doubtless fill in many blank spots in regard to the Antarctic continent," said the message. "This will be most evident, perhaps, cartographically. From the mosaic maps made photographically from the plane during the dash to the pole, it will be possible to prepare maps in considerable detail definitely tieing the previously known areas of the southern hemisphere to the South Pole.

"To aeronautics, the expedition has already added much needed data in regard to the operation of airplanes and the behavior of metals and lubricants under conditions of extreme natural cold. Additional data in this connection was doubtless obtained on the final dash to and from the pole.

"Careful meteorological observations have been carried on by the expedition during its long stay at Little America, its sled trips and supplemental flights, and on the polar flight itself. Antarctica has been looked upon as a weather breeder for South America, South Africa, New Zealand, and Australia, and in a sense for the entire southern hemisphere. The detailed meteorological data to be brought back by the expedition may make possible more accuate weather forecasting for the whole world.

"In the radio field Commander Byrd has made history. He is the only man to have sent radio messages from both the North Pole and the South Pole. Throughout the stay of the party at Little America, radio conditions have been closely studied, and it is probable that the data collected may lead to the solution of stubborn scientific problems."

Since the above was written, Byrd has been made a Rear Admiral, retired.

This Bank Directors' room *is paneled in* PRESDWOOD

Typical of the beautiful finish which can be given to the perfect smooth surface of Presdwood. Directors' room in the Security Savings and Loan Company Building, Cleveland. Finish applied by Cuyahoga Lumber Company of that city.

The beautiful grain effects of matched veneers are reproduced so perfectly on Masonite Presdwood that even experts often think it is the natural wood. More conventional finishes can also be applied to this grainless board —quickly and at low cost—with brush or spray gun.

Presdwood is used in hundreds of products. Its smooth surface takes any finish. Its minutely fibrous character effects a perfect bond with either paint or lacquer. Its hardness and strength make the completed article almost immune from hair-line finish cracks.

Does not crack or splinter

Hundreds of industries have adopted Presdwood for its freedom from cracking, splitting and splintering, its great resistance to moisture, and because it never warps when properly handled. Where quality articles must be built at low cost, thousands of identical Presdwood parts are turned out by band saw, milling machine or punch press, for this grainless wood board is easily handled on any woodworking machine.

Presdwood is used in everything from tiny toys to motor truck bodies. It panels ice boxes and builds incubators. It makes strong specialty shipping containers for fragile articles, smooth packing cases for delicate silks. It fashions decks of fast hydroplanes; makes weather-resisting road signs, strong partitions and light shelving.

Lines concrete forms

Presdwood is used to line concrete forms, for contractors find that this grainless wood saves them thousands of dollars in labor costs, facilitates making, erecting and wrecking forms, speeds up the work where time means money, and produces a perfect, smooth surface unmarred by grain and knot marks.

Eighty of the many interesting uses for Presdwood are listed in the Presdwood booklet which is sent, Free, to any manufacturer, builder, or home mechanic. Your copy will be mailed on receipt of the coupon.

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Please send me, Free, a sample of Masonite Presdwood and the Presdwood booklet.

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Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

Junkers "G-38"

QUITE recently the Junkers *G-38* made a successful trial flight at Dessau, Germany, flying for half an hour at an altitude of 1500 feet. The *G-38* is undoubtedly one of the largest land planes ever built, and it shows two distinct tendencies which are apparently in the minds of airplane constructors all the world over—increase in size and the gradual evolution of the airplane to the simplicity of a flying wing.

Exact performance data are not available as yet. It is quite clear, however, that the *G-38* is intended to carry 40 passengers (and *not* 100 as reported in some papers) with a fairly long range, is powered with four engines of 600 horsepower each, and has a wing spread of 137 feet.

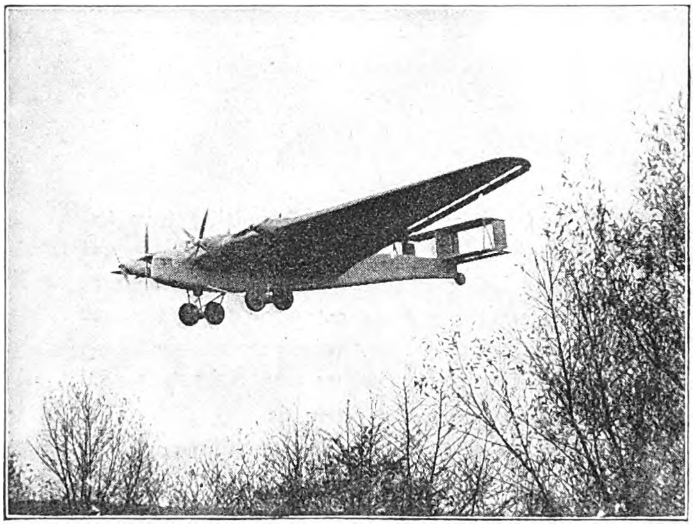
The wing construction is of the usual Junkers type; that is, braced entirely inside the wing, and tapering from root to chord, so that the wing is deepest and strongest at the root where the main stresses are to be found. With an increase in size of the wing, it is naturally possible to approach the ideal of the "flying wing." The depth of the wing at the root is between three and four feet. This allows the 12-cylinder engine, with two banks of six cylinders in V-form, to be entirely enclosed, with the only projection in the form of a streamline boss which covers the extended shaft to the propellers. Also, with the increase in size of the wing, the depth of the wing becomes an important fraction of the fuselage depth. Eventually, the fuselage will merge into the wing, or the wing merge into the fuselage, whichever way you wish to look at it.

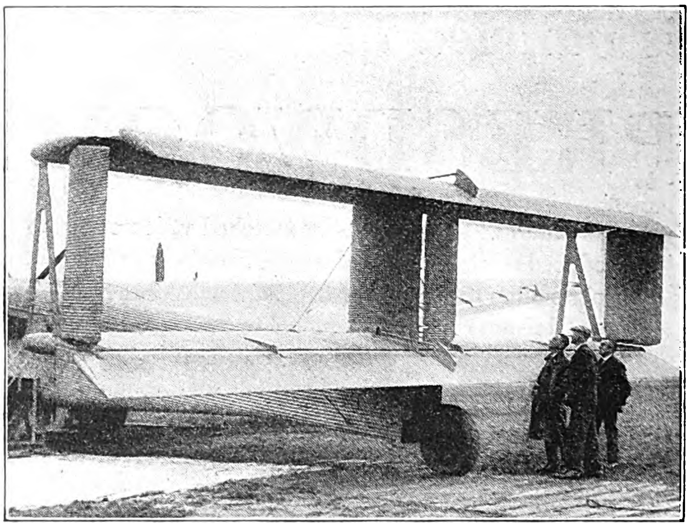
American experience has shown that when a propeller is mounted ahead of the leading edge of a thick wing, it is blanketed and loses much of its efficiency. This undoubtedly explains why the propeller shaft has been extended so far forward in the Junkers' planes.

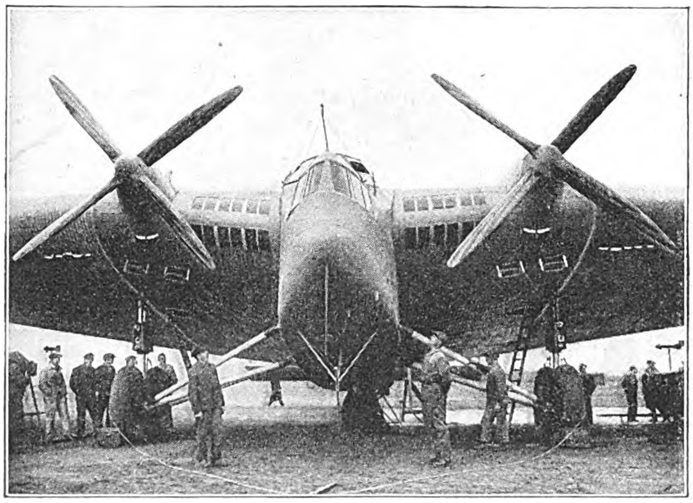
Looking at the photograph of the *G-38* in flight, we note that the two inboard propellers are four-bladed, and the two outboard propellers are two-bladed. Since four-bladed propellers are less efficient than two-bladed propellers, it may be asked why this combination has been adopted. The reason probably is that a four-bladed "prop" needs less diameter for a given horsepower and this allows the propellers to be brought a trifle closer to the center line of the airplane.

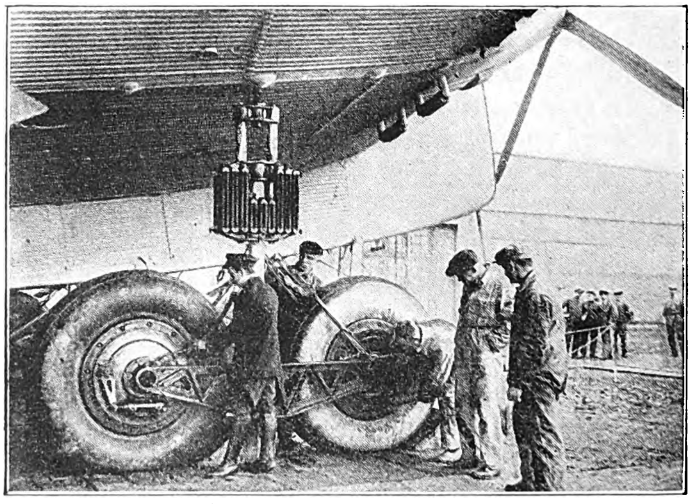
The front view of the *G-38* shows that there are two radiators for each engine, mounted under the wing and capable of being drawn into the wing when less cooling is required. There is one great advantage to the use of water-cooled engines for large planes as compared with air-cooled engines. On very large machines, the water-cooled engine can be housed so as to leave the airfoil undisturbed. This would obviously be impossible with air-cooled engines.

As planes increase in size, the question arises as to whether the pilot will have enough strength to operate the controls. Naturally the airplane constructor wants to stave off as long as possible the day when he must use servo motors, either hydraulic or electric, to operate the controls, since this means increase in cost and complexity.



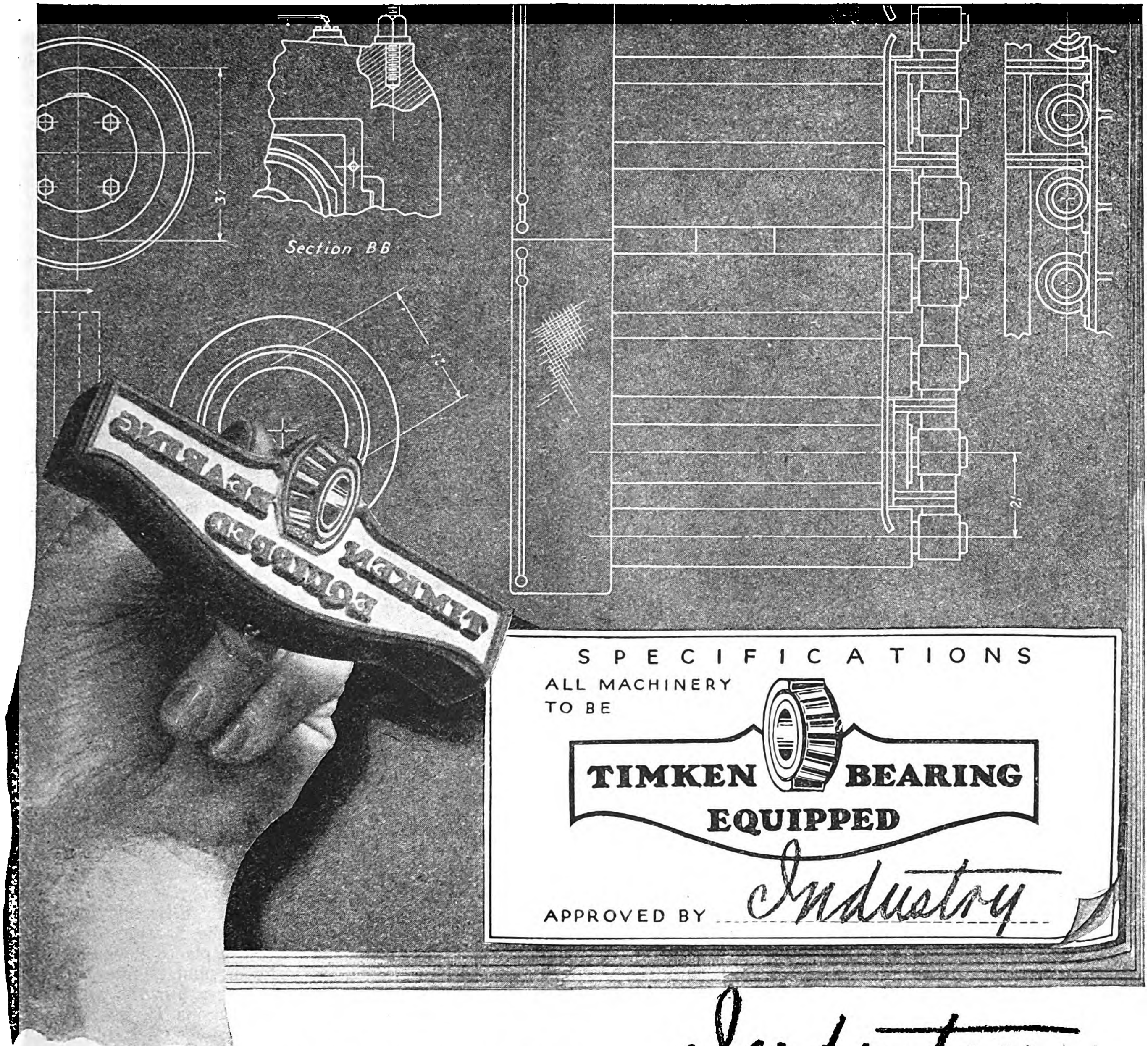






Upper left; The Junkers *G-38* in flight. *Upper right:* The tail surfaces are as large as the wings of a small plane

Lower left: Front view, showing the radiators. *Lower right:* Wheel-connecting truss is hinged in the middle


Section BB
SPECIFICATIONS
ALL MACHINERY TO BE
TIMKEN BEARING EQUIPPED
APPROVED BY Industry
TIMKEN BEARING EQUIPPED

APPROVED BY Industry

America is sweeping aside obsolete methods and machines.

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Years of proof have brought recognition to this exclusive combination: Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken-made Steel. So "Timken Bearing Equipped" sweeps on as the universal *stamp of approval* in a national program of modernization.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

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The way to avoid this undesirable contingency is to pay more and more attention to the balancing of the control surfaces. The ailerons of the Junkers *G-38* are hinged on points well behind the leading edge of the ailerons, the hinge points being supported by a series of arms mounted at the rear of the wing structure proper, and above the aileron. There is also a pronounced slot between the wing and the ailerons, which helps to reduce the turning moment of the ailerons and to improve their effectiveness at slow plane speeds. Both the elevators and the central rudder seem to be balanced in the same way as the ailerons.

Nothing illustrates the size of the *G-38* so well as the view of the tail surfaces. When compared to the size of the three men in our photograph, it can be seen that the tail surfaces are as large as the wings of many an airplane.

A "wrinkle" in design is the careful way in which the control horns are enclosed in a fairing.

There is one great advantage in multi-engined planes—the greater reliability of the power plant as a whole. In the *G-38* this reliability is further increased by the fact that the mechanics can get at the engines in flight, since these engines are enclosed in the wing. There is a small hand-operated trolley in the wing. The mechanic can climb into the wing from the fuselage and rapidly propel himself to any engine which may need attention.

MILEAGE AND TRAFFIC STATISTICS FOR PRIVATELY OPERATED AIRMAIL ROUTES WITHIN THE U. S. A., FOR YEAR ENDING JUNE 30, 1929

Month (all routes)	Length of routes, miles	Miles of service actually flown	Total weight of mails dispatched, pounds	Amount paid to contractors
July, 1928	12,021	653,883	214,572	$445,238.41
August, 1928	11,977	731,714	419,357	821,005.01
September, 1928	11,977	749,156	423,838	843,691.44
October, 1928	12,169	784,663	465,688	915,998.56
November, 1928	12,504	731,027	425,405	851,390.06
December, 1928	13,791	891,811	541,632	1,094,782.54
January, 1929	14,060	795,293	488,709	955,114.33
February, 1929	14,060	778,329	434,260	865,042.52
March, 1929	14,264	912,760	524,537	1,047,657.78
April, 1929	14,400	885,737	508,672	1,003,718.32
May, 1929	14,334	1,135,953	588,428	1,160,089.23
June, 1929	14,345	1,148,403	598,494	1,161,461.00
Totals	159,902	10,198,729	5,633,592	$11,165,189.20

The landing gear is particularly interesting. As planes get larger and larger, the question of the wheels becomes serious. Instead of having four wheels strung along the span of the machine, the designers have used two wheels in tandem on each side of the fuselage. The head-on resistance of the wheels is somewhat reduced by such an arrangement. It will be further seen from the photograph of the landing gear that the wheels are mounted at the end of a bridge-like truss, which is connected at its center to the shock-absorbing system. The truss is hinged at its center, so that the wheels can pivot about their common center, with shock-absorber cord keeping their pivoting motion within reasonable limits. This feature should be particularly useful when landing or taxying on rough ground.

European countries seem to be very slow in adopting the use of wheel brakes. In the *G-38* brakes are used, and with success. It is remarkable that the German designers still employ rubber as their sole means of shock absorption. The oleo landing gear has proved so successful in the United States, that it seems curious that the practice should not be followed in Germany.

Progress of the Year

THE American Society of Mechanical Engineers comprises some 12,000 or more members and is sponsor for a number of divisions which cover the widespread and varied field of mechanical engineering. Its aeronautic division presented at the December annual meeting of the society an authoritative report on the year's progress in aeronautics.

In the engine field there were three interesting tendencies. First: The use of ethylene glycol (Prestone) as the cooling medium instead of water. The boiling point of this chemical being so much higher than that of water, it is possible to use much higher jacket and radiator temperatures and thus reduce the size of the radiators. Second: The use of the Venturi cowl, which, placed around the air-cooled engine, reduces the air resistance of the engine considerably. Third: The increasing use of geared-down engines. The piston speed of the engine has been steadily increasing by the use of higher revolutions per minute, and this has been perhaps the main reason for the light weight per horsepower now obtainable. Unfortunately, very high revolutions per minute of the propeller do not co-ordinate well with the moderate speeds of commercial planes. Hence gearing down becomes imperative for the sake of greater propulsive efficiency.

In aerodynamics, the direction of progress has been largely in the elimination of head resistance, by the use of the Venturi cowling, retractible landing gear, fairing-in of wheels with so-called "trousers," and so on.

Another modern tendency in airplane design is to use wings of constant center of pressure. The ordinary wing has an unstable center of pressure motion. When the airplane pitches down by the nose, the center of pressure moves back and the nosing-down tendency is aggravated. When the airplane noses up, the center of pressure moves forward and the nosing-up tendency is increased. The horizontal tail surfaces are used to provide stability and to counteract the instability of the wing itself.

With the trailing edge of the main wing slightly turned up, it is possible, without much sacrifice in lift or efficiency, to secure a stable center of travel. It is then possible to reduce appreciably the area of the tail surfaces, and also to reduce the weight of the wing. If there is pronounced travel of the center of pressure, then the front spar carries most of the load at one time, and the rear spar at another time. With the constant center of pressure it is possible to make the front spar do most of the work, and to lighten the rear spar accordingly.

Another device which is receiving favorable attention is the floating-tip aileron. Here the aileron is placed beyond the tip of the wing itself, and is free to adjust itself so as to lie always in the wind. The control of the ailerons is, as usual, by lateral movement of the stick, but because the ailerons lie normally in the wind their effectiveness is not reduced at high angles of incidence of the main wing.

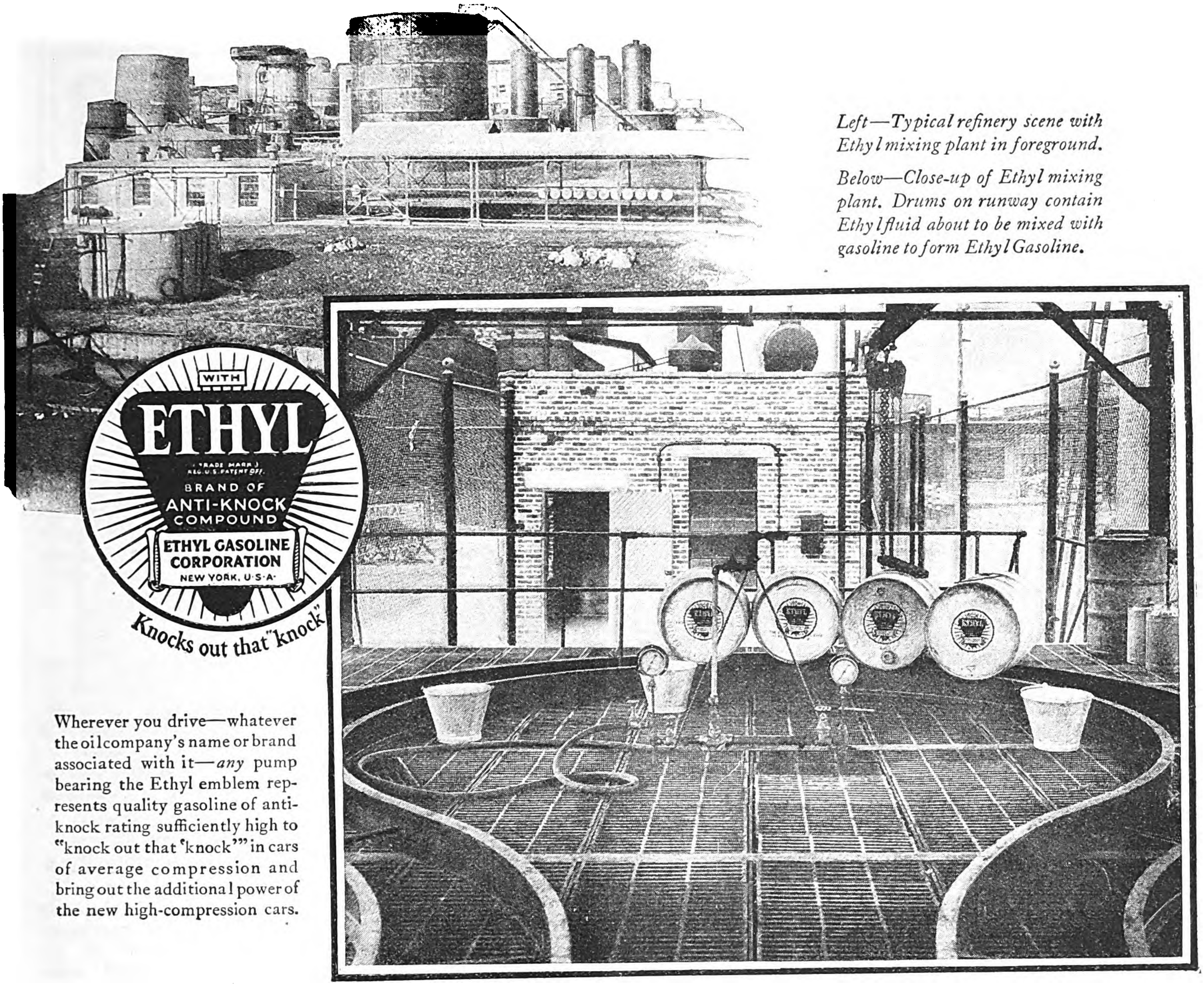
We reproduce two tables taken from the same progress report. One gives mileage and traffic statistics for privately operated mail routes. This shows a rapid and steadily growing increase in the number of miles flown and the amount of mail carried.

The other table shows that the United States now leads the world in scheduled

(*Please turn to page* 166)

AIR-TRANSPORT MILEAGE OF THE WORLD—OPERATIONS OF SCHEDULED SERVICES IN AIRPLANE-MILES

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Australia	....	....	....	....	235,582	262,895	352,847	417,970	453,580	641,831
Austria	....	....	....	....	....	....	....	....	245,043	383,002
Belgium	....	....	....	....	....	160,000	144,500	....	....	....
Canada	....	....	....	....	....	294,778	446,648	631,715	....	....
Columbia	....	2,687	53,650	125,678	134,375	169,500	183,206	....	....	....
Czechoslovakia	....	....	....	....	....	126,400	48,300	170,895	257,888	605,314
Denmark	....	....	....	....	56,000	....	114,500	126,730	116,798	122,215
France	....	505,500	1,460,000	2,015,000	2,115,000	2,249,000	2,946,000	3,243,900	3,755,369	3,753,133
Germany	....	....	....	842,986	885,881	1,860,000	3,070,000	3,816,144	5,921,593	7,030,565
Great Britain	168,000	644,000	225,000	717,000	943,000	936,000	862,000	840,000	769,000	....
Italy	....	....	....	....	....	....	....	....	824,474	1,236,913
Mexico	....	....	....	....	....	....	....	96,800	146,400	....
Netherlands	....	50,850	217,000	246,200	336,000	482,800	679,753	597,500	813,510	1,007,920
Poland	....	....	....	66,293	142,057	233,923	465,847	....	654,873	630,175
Soviet Russia	....	....	....	....	....	288,600	292,595	311,000	....	....
Sweden	....	....	....	....	....	69,280	248,610	222,000	206,766	208,729
Switzerland	....	....	....	....	....	268,400	87,427	210,340	459,720	330,496
United States	393,066	880,028	1,828,354	2,329,296	1,743,030	2,220,761	2,910,611	4,407,263	6,009,226	9,888,307



Left—Typical refinery scene with Ethyl mixing plant in foreground.

Below—Close-up of Ethyl mixing plant. Drums on runway contain Ethyl fluid about to be mixed with gasoline to form Ethyl Gasoline.

WITH ETHYL TRADE MARK REG. U.S. PATENT OFF. BRAND OF ANTI-KNOCK COMPOUND ETHYL GASOLINE CORPORATION NEW YORK, U.S.A.

Knocks out that "knock"

Wherever you drive—whatever the oil company's name or brand associated with it—*any* pump bearing the Ethyl emblem represents quality gasoline of anti-knock rating sufficiently high to "knock out that 'knock'" in cars of average compression and bring out the additional power of the new high-compression cars.

How *Ethyl* Fluid *is mixed with gasoline*

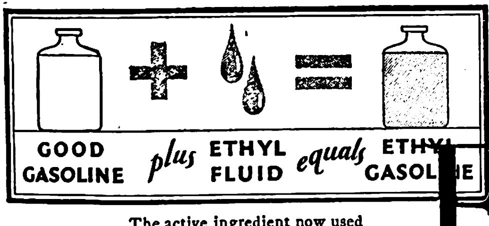
ANYONE interested in practical chemistry would enjoy a visit to one of the plants in which the oil companies mix Ethyl fluid, containing tetraethyl lead, with their gasoline to form Ethyl Gasoline.

What would probably be most impressive would be the *precision* with which it is done. Engineers from the oil company or from the Ethyl Gasoline Corporation supervise every step of the process.

First, the base gasoline with which Ethyl fluid is to be mixed is tested at an Ethyl laboratory. From this test, the exact amount of Ethyl fluid necessary to bring the gasoline up to a rigid standard of anti-knock quality is determined. An accurate measuring device is used at each refinery to insure that this quantity of Ethyl fluid goes into every gallon of gasoline.

Look for the Ethyl emblem.

Ethyl Gasoline Corporation, New York City.



The active ingredient now used in Ethyl fluid is tetraethyl lead.

©E. G. C. 1930

ETHYL GASOLINE

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Aeronautics

Aviation (Facts that Every Aviation and Financial Official Will Want to Know) tells about the efforts of the Better Business Bureau of New York City to apprehend and prevent fraudulent aviation promotion schemes. *Better Business Bureau, 280 Broadway, New York City—Gratis.*

Airplane Fuselage Welding and How To Weld Duralumin are two papers presented in one leaflet. The first is an outline course for welders engaged in aircraft construction; the second describes correct practices for making ox-welded joints in aluminum alloys. *Linde Air Products Company, 30 East 42 Street, New York City—Gratis.*

Sinister Beacons, a booklet dealing with fire hazards of airports and landing fields, lists recommended firefighting materials and apparatus. *American-La France and Foamite Corporation, Elmira, New York—Gratis.*

Electricity

Protection of Electrical Circuits and Equipment Against Lightning (Bureau of Standards Miscellaneous Publication No. 95) tells how and where lightning arresters should be installed in those cases where it has been decided that their use is justified. *Superintendent of Documents, Government Printing Office, Washington, D. C.—25 cents.*

Short-Wave Transatlantic Radio-Telephony, reprinted from the *Bell Laboratories Record,* is an interesting booklet presenting 12 papers which tell the various stages of the development of the two-way transatlantic telephone service over short-wave paths initiated by the American Telephone and Telegraph Company in 1928. *Bell Telephone Laboratories, Inc., 463 West Street, New York City—Gratis.*

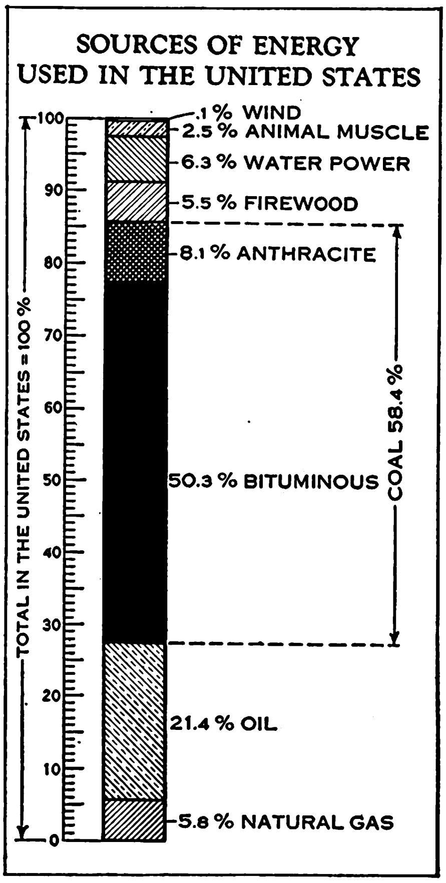
Some Universal Principles of Communication, by John Mills, is an outline of the fundamentals of communication, and the relationship of telephony, telegraphy, sound pictures, and television. *Bell Telephone Laboratories, Inc., 463 West Street. New York City—Gratis.*

Lighting Data, a series of booklets published by the Edison Lamp Works, includes the following new titles: Looking Ahead in Aviation; Floodlighting; Electric Light on the Farm and in Rural Districts; and Luminous Harmony in the Home. All of these booklets are well illustrated and written in non-technical language, presenting valuable information and practical suggestions. *Edison Lamp Works, General Electric Company, Harrison, New Jersey—Gratis.*

Analysis and Measurement of the Noise Emitted by Machinery, by B. A. G. Churcher and A. J. King, is an engineering study of noise, based on an extended investigation now being conducted by the Metropolitan-Vickers Electrical Company, Ltd., *Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W. C. 2, England—Inquire cost.*

Miscellaneous

Shift of Civilization Chart and Manual, by Samuel S. Wyer, is a striking presentation of the most significant steps in the development of science, religion, and law from man's beginning to the present day. *Fuel-Power-Transportation Educational Foundation, 1116 Beggs Building, Columbus, Ohio—Gratis.*



Self-explanatory diagram from the "Shift of Civilization Chart and Manual" mentioned in the text

General Catalog illustrates and lists natural history materials collected and made available to educational institutions by the Frank A. Ward Foundation of the University of Rochester. The materials listed cover the fields of human anatomy, comparative anatomy, zoology, entomology, paleontology, geology, and minerology. *Ward's Natural Science Establishment, Inc., P. O. Box 24, Beechwood Station, Rochester, New York—75 cents.*

Vitamins in Food Materials, by Sybil L. Smith, (Circular No. 84, Department of Agriculture) is a complete review of the authenticated data available concerning the various vitamins and their occurrence in food materials. More than half of the circular is devoted to bibliographies, showing references dealing with vitamin occurrence in each food. The references also cover the techinique for the quantitative determination of vitamins. *Superintendent of Documents, Washington, D. C.— 15 cents.*

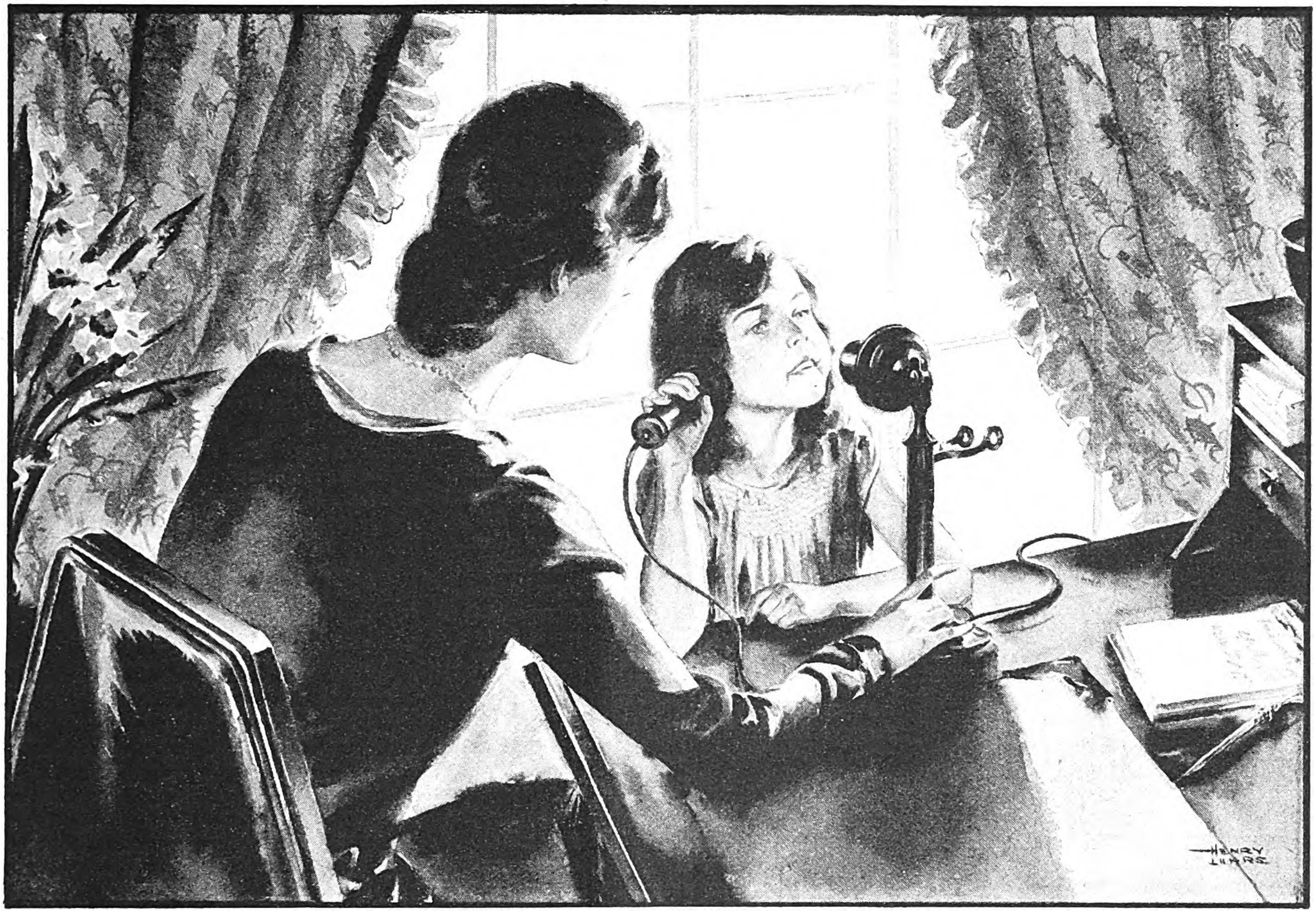
Annual Report of the Smithsonian Institution (1928) is distinguished by its 600-page General Appendix, containing 27 outstanding papers written by leading scientists on a wide variety of topics. *Superintendent of Documents, Government Printing Office, Washington, D. C.—Two dollars (cloth binding).*

Dam or Bridge: Which? Under this title, Mr. Cyrus C. Walker presents a well-prepared plan for converting the interior part of San Francisco bay into an enormous fresh-water lake, by constructing an earthen causeway from a point near Van Ness Avenue on the San Francisco shore to Tiburon on the Marin County shore, including Alcatraz and Angel Islands. The plan is suggested as an alternative for the proposed bridge across the Golden Gate. *C. C. Walker, 230 Upper Terrace, San Francisco, California.—50 cents.*

The Duke Endowment Year Book is an interesting description of the charities promoted by the bequests of the late James B. Duke. The millions of dollars accumulated by the tobacco and power interests of the Duke family are being returned gradually by means of well-directed philanthropies to universities, hospitals, orphanages, and rural churches. *The Duke Endowment, Power Building, Charlotte, N. C.—Gratis.*

Silver Solders is a new booklet describing the specifications and uses of various silver-alloy solders, with suggestions and instructions for correct soldering practice. *Handy and Harmon, 57 William Street, Bridgeport, Conn.—Gratis.*

Spontaneous Combustion of Hay, by Dr. Charles A. Browne of the Bureau of Chemistry and Soils, presents the various theories of spontaneous combustion, summarizing the present knowledge of the subject. Dr. Browne adds a theory of his own, while pointing out the need for more study of the problem. *United States Government Printing Office, Washington, D. C.—10 cents.*



THE TELEPHONE BRINGS THE ADVANTAGES THAT COMFORT AND CONVENIENCE GIVE TO LIVING

This is the telephone's mission

An Advertisement of the American Telephone and Telegraph Company

In this country, a new type of civilization is being reared—a civilization of better opportunity for the average man, comfort and convenience, business enterprise and higher standards that enrich the daily life of all the people.

To build for this new age, the Bell System in 1929 expended more than 550 million dollars. These millions were used to add new plant and further improve service. Hundreds of new buildings, millions of miles of wire, chiefly in cable, eight hundred thousand new telephones—these were some of the items in the year's program of construction. At the same time, better records were made for speed and accuracy in service.

This American development of instantaneous communication, of fast, far-reaching speech, belongs not to the few, but to the many.

It is the aim of the Bell System to permit each personality to express itself without regard to distance.

This is part of the telephone ideal that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

AMERICAN TELEPHONE & TELEGRAPH CO. BELL SYSTEM AND ASSOCIATED COMPANIES

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Baking Powder Leaves No Traces in Bread

A NEW baking powder that leaves no undesirable traces in the bread is proposed by Edwin O. Wig in a recent issue of *Industrial and Engineering Chemistry*. Mr. Wig has investigated the properties of acetonedicarboxylic acid and finds it possesses many qualities which recommend it as a leavening agent.

Authorities disagree as to the physiological action of the products left by baking powders in baked goods. Inasmuch as all common baking powders leave saline cathartics, such as sodium tartrate, Rochelle salt, disodium acid phosphate, or sodium sulfate, and since there is some question as to the physiological effect of aluminum hydroxide, a leavening agent that would leave no residue would preclude the possibility of any controversy and would constitute an ideal baking powder.

Acetonedicarboxylic acid was prepared by adding fuming sulfuric acid to citric acid. The resulting acetonedicarboxylic acid was crystallized from ethyl acetate several times and then dried over calcium chloride. Cornstarch or other starch was dried by heating under reduced pressure in a flask on a steam bath. Starch and acetonedicarboxylic acid were then weighed and mixed so as to give a baking powder which would yield from 13 to 15 percent carbon dioxide, the usual strength of a commercial baking powder.

Cakes, and in one case, bread, were baked, some with a commercial baking powder and some with acetonedicarboxylic acid baking powder. The same recipes were used and the same oven conditions, the two products generally being baked side by side. In every case the acetonedicarboxylic acid powder raised the product as well as the commercial powder.

The investigator is convinced that an acetonedicarboxylic acid baking powder might be manufactured to compete with the more expensive baking powders on the market, especially if cheaper citric acid were made available. Such a powder would have the advantage of leaving nothing in the baked product.

Removing Calcium Sulfate Deposits from Pipes

IN hot water containing sulfates, the presence of even a small amount of lime will cause the precipitation of insoluble calcium sulfate. When pipe lines or integral parts become sufficiently coated to retard circulation, the removal of the deposit becomes an important problem. Calcium sulfate is not soluble in the usual solvents. Chemists of the United States Bureau of Mines have determined that a hot solution of bicarbonate of soda will react with calcium sulfate to form a loose mixture which permits the removal of the bulk of the scales by the current flow of the solution. The remaining scale is sufficiently changed so that a weak solution of hydrochloric acid will completely remove it from the line.

Catalysis Reduces Cost of Acid

ONE of the first things learned by the student in chemistry is that an acid is neutralized by an alkali—in other words, sulfuric acid and ammonia, for example, are at opposite ends of a scale and when they are brought together they destroy each other's identity as completely as Eugene Fields' Gingham Dog and Calico Cat:

"But the truth about that cat and pup—
Is this—they ate each other up!"

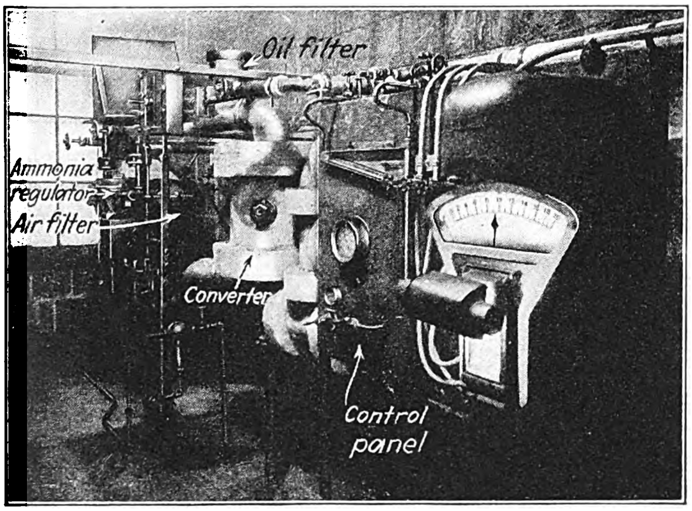
With this basic knowledge of the behavior of acids and alkalies, one would hardly expect an acid to be made by the use of an alkali. Yet this very procedure is finding extensive application in the manufacture of sulfuric acid, where modern chemistry has developed a process of transforming ammonia into the nitric oxides required for the formation of H_2SO_4 in lead chamber plants. Where formerly about three and one half percent of all the nitrate imported from Chile was used to supply nitric oxides in sulfuric acid plants, American manufacturers are now freed from this dependence on a foreign source and enabled to produce cheaper acid by the substitution of ammonia—a by-product of coke manufacture.

This process of oxidizing ammonia has been developed by the Du Pont Company and is similar to the Du Pont process for the production of nitric acid from ammonia. It is fully described by T. R. Olive in a recent issue of *Chemical and Metallurgical Engineering*. The most interesting feature of the installation, from the technical point of view, is its compact form and its automatic operation. The automatic gas analyzer, known as Ranarex, shows exactly what percentage of ammonia is being supplied to the system and another ingenious "robot," the Smoot regulator, adjusts the valve to keep the gas flow just right.

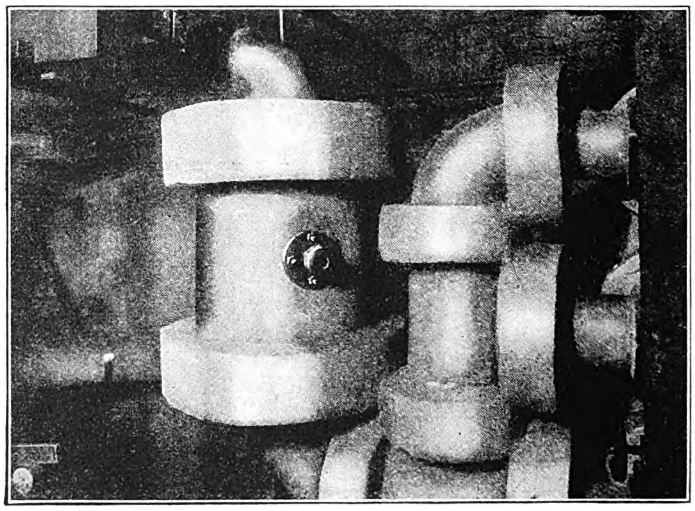
Ammonia gas, mixed with air, is filtered, heated to about 250 degrees, Centigrade, and passed through a converter, which contains a platinum-rhodium alloy gauze. Passing through this gauze, the ammonia is converted by catalysis into oxides of nitrogen. The reaction gives off heat which keeps the wire gauze at a cherry red heat. The surplus heat is also used to pre-heat the ammonia mixture entering the converter, by means of a heat-exchanger. Some of the remaining heat in the converted gas is utilized to vaporize the anhydrous ammonia which is used as raw material. The cooled gas is then delivered directly into the sulfuric acid plant, where the oxides of nitrogen play their vital part in the formation of that universally important chemical.

Different Dynamites for Specific Uses

WHEN Alfred Nobel began making dynamite on a commercial scale in 1865, the product was used for quarrying, submarine blasting, mining, and construction work. Since then, successive chemists have so improved this useful explosive that it is now almost fool-proof



One of the oxidation units of the sulfuric acid plant of the Davison Chemical Company, showing pressure gage, flow meter, and automatic ammonia gas tester



Close up, showing the converter and heat exchanger manifold. Through the sight glass in the converter, one may see the red hot platinum gauze catalyst and there are dozens of different varieties made especially for specific uses. There is even one type, 90 percent gelatin, which is suitable or economical for any other work.

The high grades of straight dynamite, says Arthur LaMotte in a recent issue of *Chemical and Metallurgical Engineering*, have been found admirably adapted for blowing ditches in swamp land by what is known as the propagation method. They also are suitable for mudcapping boulders and rocks in quarry work, but these explosives are not suitable for use in the main boreholes in quarry blasting or in underground work. Medium-grade gelatins, 40, 50, and 60 percent, are admirably adapted for underground work in metal mining and hard-rock tunneling, but are not suitable for mudcapping or ditching by the propagation method, or for coal mining. Ammonia dynamites are used extensively in mining rock salt, gypsum, clay, and some of the more friable metallic ores, but cannot, of course, be used in submarine work or for ditching by the propagation method.

Waltzing Mice Detect Poison Gas

JAPANESE waltzing mice have been found to be more responsive to concentrations of the deadly carbon monoxide than canaries, long used by the United States Bureau of Mines for this purpose in connection with mine rescue operations. On the other hand, guinea pigs have been found to be unsuited for detecting dangerous amounts of carbon monoxide.

Due to their almost incessant activity, Japanese waltzing mice are more susceptible to carbon monoxide than either canaries, common house mice, or white mice. The Japanese waltzing mouse is thought to be a mutation of the house mouse and is commonly found in Japan and China. They appear to be unable to orient themselves in a horizontal plane, which results in an erratic running in circles—sometimes wide, sometimes narrow, and sometimes in pairs forming a figure eight and repeated many times in rapid succession.

In comparative tests with canaries made at the Pittsburgh Experiment Station of the Bureau of Mines, it was found that the Japanese waltzing mice showed signs of response to carbon monoxide in advance of signs in the canaries heretofore used.

Will Reveals Novel Conception of Immortality

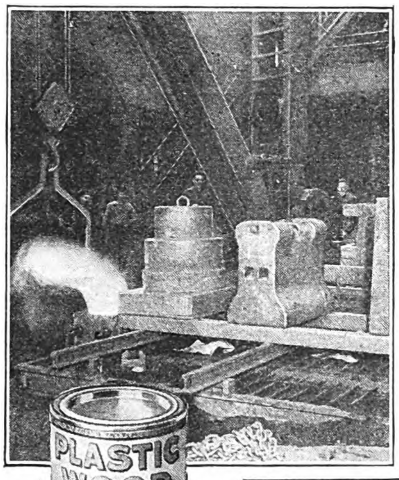
CHEMICAL AGE reprints the following extract from the will of the late Henry A. Wadworth, a prominent and wealthy Englishman, which reveals the writer's unique conception of immortality, via chemistry:

"I believe (and some of the leading scientific men of the day assure me that I believe rightly) that at my death the organic constituents of my body will be quickly converted into carbonic acid and ammonia, and that those gases will, by the law of diffusion, be at once distributed over the whole world and will help to build other plants and in their turn animals, so that in the future every plant and animal in the world will contain an infinitesimal portion of my body.

"The inorganic parts of my body, the phosphates of lime, et cetera, will also be

(Please turn to page 163)

Ingenious Men Have Found Many Uses for This New Product



Plastic Wood, which handles like putty and hardens into wood, has been sold for home repair purposes for some four years. Recent developments in the industrial field have been most interesting.

Holes, cracks, wood blemishes, chipped mouldings—little by little as Plastic Wood made itself useful to men at home, these same men began to see its value in their factories to solve upkeep and production problems. Their ingenuity has created many time and labor saving uses for this unusual product.

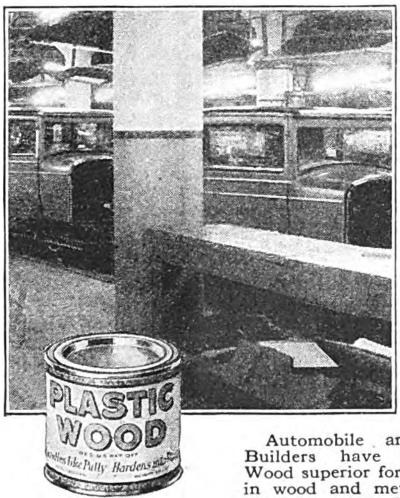
For pattern making, Plastic Wood is more durable than wax or leather.

PLASTIC WOOD

No more "buttons" in this furniture factory. Plastic Wood is the modern method.

The modern pattern shop finishes patterns; the piano manufacturer fills blemishes in oak, mahogany or ebony; the furniture manufacturer has found Plastic Wood unequalled in covering counter-sunk screws; the shoe manufacturer for repairing and re-fashioning lasts.

Practical Value in Unexpected Places



Automobile and Bus Body Builders have found Plastic Wood superior for covering joints in wood and metal bodies, and obtaining a perfect finish over nails, screws and bolts.

Wherever a patching material is necessary, wherever a surface needs to be built up or re-shaped, Plastic Wood is the modern answer. It adheres lastingly to wood, metal, stone, fabric, glass or other products. It will not disintegrate, chip or splinter, can be worked with any wood-working tools, takes paint, varnish or lacquer perfectly, and is waterproof, and greaseproof. Experiments by manufacturers are daily proving its practical value in the most unexpected places. Do you know it?

PLASTIC WOOD
(Trademark Reg. U. S. Pat. Off.)

Handles Like Putty—Hardens Into Wood
Plastic Wood (and Plastic Wood Solvent for softening or thinning Plastic Wood) is regularly carried in stock by Hardware and Paint Dealers

1 lb. can $1.00—1-4 lb. can 35 cts.—Tube 25 cts.

Manufacturers and Industrial Corporations desiring information as to color, bulk sizes, or advice as to the adaptability of Plastic Wood for specific problems are invited to communicate direct with the makers.

Addison-Leslie Co., 50 Bolivar St., Canton, Mass.

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Carbon-Arc or Quartz Mercury-vapor Lights

SINCE the use of the carbon-arc and the quartz mercury lamps has become general there has been much argument as to which is more efficient, which type more suitable for the public, and which type less potential of danger. The carbon-arc lamp provides ultra-violet rays, exactly as does the quartz mercury-vapor lamp. The amount of ultra-violet rays supplied and the amount of infra-red or heat rays supplied depends, of course, on the size of the equipment, the intensity of electrical power consumed, and similar factors.

The carbon-arc lamp yields more heat rays than does the quartz mercury-vapor and should not, of course, be chosen when the heat rays are not desired. By the use of special carbons cored with materials which emit strongly in the longer visible rays and in the shorter infra-red rays, the carbon-arc lamp becomes an excellent source of heat rays. By the use of suitable screens of window glass, in fact, it is possible to screen out the ultra-violet rays entirely and thus to use the carbon-arc lamp purely as a heat lamp.

The American Diet

ONE of the most significant facts of the past 25 years has been the gradual change in the American diet. The amount of food taken is approximately 1000 calories less per day than used to be taken. The old diet consisted primarily of meat, potatoes, coffee, and sugar, whereas it is generally recognized that Americans are eating more fruit and vegetables and that they do pay some attention to the question of vitamins.

Dr. Lovell Langstroth of San Francisco tabulated the diets of 501 persons having degenerative diseases, with particular reference to the amount of protective food substances which they ate, and with a view to finding out whether or not changes in the diet could be related to the degenerative diseases. He found that non-protective foods formed 54 percent of the average diet, and that if all accessory foods were included, the non-protective foods formed 88 percent of the average diet. Bread, butter, meat, potatoes, and sweet desserts formed the great bulk of the diet of most of the people studied. With the exception of butter and cream, which contain considerable amounts of the fat-soluble vitamin A, these diets are vitamin poor.

When the patients were put on a well balanced diet calculated to provide proper amounts of protective substances, the percentage incidence of degenerative diseases decreased. Thus a diet containing 70 percent of protective foods was prescribed in 44 cases of chronic circulatory diseases, 75 cases of chronic arthritis, 55 cases of chronic gastro-intestinal diseases, and 10 cases of migraine. Doctor Langstroth reports that 73 percent of these 174 people were improved by the change in diet. There were changes in their body weight, in the appearance and feel of the skin and subcutaneous tissue, and in the quality and reactions of the mucous membranes.

In discussing Doctor Langstroth's point of view, Dr. George B. Eusterman of the Mayo Clinic pointed out that the known criteria of an efficient diet are simple. They include adequate calories to supply energy, sufficient protein of the right type, a carbohydrate-fat ratio which must fall within certain limits, adequate amounts of fluid, and sufficient fresh fruit and vegetables to safeguard the vitamin and inorganic salt intakes. Overeating of sugar or carbohydrates results usually in obesity. A persistent relative vitamin deficiency is likely to provoke bodily discomfort, impaired tone of the body, and a lowered resistance to disease.

Symptoms of Tuberculosis

INVESTIGATORS for the National Tuberculosis Association have studied the order in which the important symptoms of tuberculosis appear in various people. This is, of course, of the greatest importance, since early diagnosis and treatment are essential to recovery. Cough is the most common symptom reported; frequent colds and expectoration of a good deal of material are also quite common.

One of the leading symptoms is the fact that the person becomes tired too easily and suffers with fatigue early in the morning. Loss of weight and appetite are common in this disease. About one half of the persons examined suffered with pain in the chest. This pain is usually due to the fact that the tuberculous infection produces inflammation inside the chest and adhesions between the lungs and the chest wall. Hemorrhage from the lungs is not so common as an early symptom. The five most common symptoms of tuberculosis in the early stages are cough, being too easily tired, loss of weight, loss of appetite, and pain in the chest.

Inflammation of the Spine

THE human backbone is a most inefficient tissue. The erect carriage of the human being is an acquirement of comparatively modern times, as one considers the age of the earth, and thousands of years are required for the adaptation of tissues to a new function, rather than a single generation. The development of the X ray enabled specialists in orthopedic surgery to study the condition of the spine in a fairly simple manner. Recently Dr. L. W. Allard conducted an investigation concerning spinal inflammation among orthopedic specialists throughout the country and among industrial commissions. When the X-ray plates were examined, it was found that a considerable majority of people over 50 years of age have had at one time or another inflammations of the spinal joints, and that these show in the X-ray pictures even though they may not give any important symptoms.

The most frequent occurrence seems to be in male laborers, which Doctor Allard believes is due to the fact that they are constantly subject through their active life to infection, disturbances of digestion, strains in posture, and repeated accidents. Often a relatively minor accident, such as a sudden twist or fall, which would not affect a normal spine, will produce disability in one which has previously been subjected to infection.

Industrial commissions constantly assert that injuries of the back with disability cause them more trouble than any other type of injury which comes to their attention. Certainly a man with an old inflammation of the spine should not select an occupation which is likely to put new stresses and troubles on any tissue. The United States is not the only country which is confronted with this problem. It has been found among industrial workers abroad that there are seven times as many disabled by inflammations of the joints of rheumatic character as are disabled by tuberculosis.

The primary method of relief for such inflammations is, of course, rest of the affected tissue, with the application of heat, and other common methods of alleviation. Rest may be not only the type that is secured by being in bed, but also rest through the prevention of motion. An inflamed or painful tissue should not be moved or manipulated. The specialist in orthopedic surgery produces rest for inflamed backs by the use of braces and corsets which hold the spine immovable.

The Changing Characters of Infection

AGAIN and again it is necessary to point out that germs are living organisms and that they change their characters exactly as do human beings in response to changes in their heredity and in their environment. The matter has been brought significantly to the public attention in recent months because of reported failures of the ordinary commercial anti-meningitic serum in the case of epidemics of meningitis which have occurred in various parts of the world. Apparently the meningitis germ will change its character from time to time during the intervals between epidemics and the serum which was useful in a previous period may not act against the newer germs. This does not mean that the serum treatment is in any sense of the word to be discredited. When a serum is prepared by the injection of the germs which may be isolated from the current epidemic, it is just as effective and efficient as in previous instances.

In a recent small epidemic in a western city, involving 60 cases of the epidemic type, cerebro-spinal meningitis in ten cases was fatal. Because of the great fatality in these early cases, a different serum was obtained and this was found to give much better results. Of the 21 patients given this serum, 14 lived and seven died. Among patients who did not receive this serum, the mortality was 21 percent higher than among those receiving the special serum.

The study of the epidemic caused Dr. J. Mercer Anderson to conclude that there was a marked variation in the virulence of the meningitis germ and that the serums used varied in potency, so that it is important to determine that the specific serum is active against the specific organism. Fortunately it is possible by immunologic reactions to make such determinations promptly in any instance.

Ajinomoto

THE Japanese eat much rice and little meat. Such a diet has little energy in it. Hence the Japanese add to their food a substance which has a meat flavor but which is not meat. The use of meat in the diet, as is pointed out in a recent editorial in the *Journal of the American Medical Association* is condemned by Buddists, and instead, shavings of dried fish are added to Japanese dishes to improve the flavor.

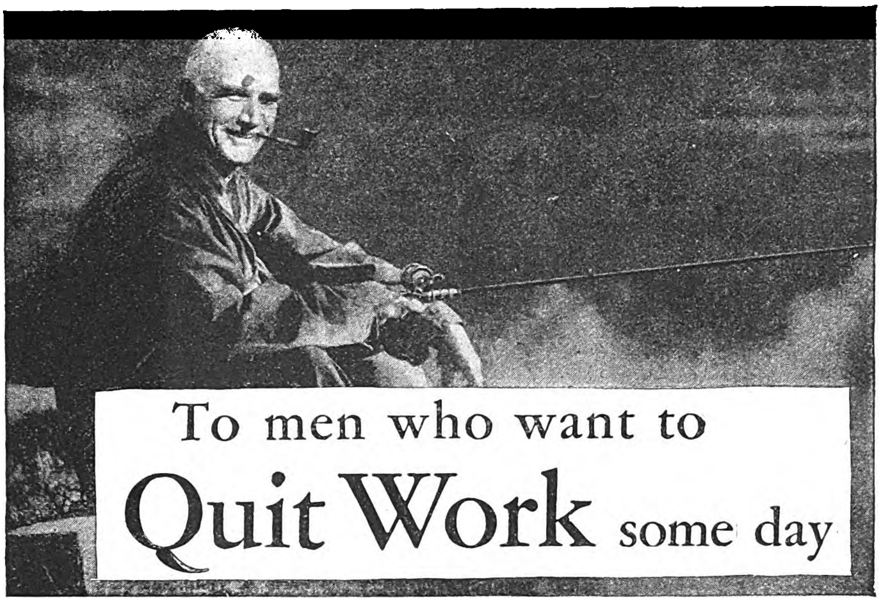
The important substance is monosodium glutamate. It is now available in commerce and is said to be as common in Japanese cookery as is salt in American cookery. This substance is called in Japan "Ajinomoto" or the element of taste. It is reported that it is manufactured by hydrolyzing gluten or soy bean with hydrochloric or sulfuric acid. In this country it costs two to three dollars a pound.

Sugar and Convulsions

WHEN changes occur in the blood, the body reacts in various manners, according to the chemical substances that may be present. If the amount of sugar in the blood is extremely low, the patient becomes confused and may develop convulsions. This has happened in some cases when an overdose of insulin has been taken. Whenever this occurs, it is customary to feed quantities of sugar and orange juice to supply the deficiency, and the convulsions are promptly relieved after taking the food.

Some years ago it was suggested that convulsions in infants following a period of fasting with fever might be due to the fact that there was an insufficient amount of sugar in the blood. Fasting prevents the intake of sugar, and fever burns up sugar in the body. Dr. J. P. Crozer Griffith of Philadelphia determined to test the matter thoroughly on a group of infants and children who had been subject to convulsions. His work caused him to believe that the night fast which the child takes because it is asleep is not of importance in producing convulsions in the morning, but he is inclined to the belief that the amount of sugar in the blood does have something to do with the time of appearance of the convulsions.

There seem to be relationships here which have not been definitely established, since a low blood sugar may exist without convulsions. On the other hand, in some instances the feeding of sugar caused prompt discontinuance of the convulsions, and this factor seems to be of much greater importance in some cases than in others.



To men who want to
Quit Work some day

THIS PAGE is addressed to those thousands of earnest, hard-working men who want to take things easier some day.

It tells how these men, by following a simple, definite plan, can provide for themselves in later years *a guaranteed income they cannot outlive.*

How the Plan Works

It doesn't matter whether your present income is large or merely average. It doesn't matter whether you are making fifty dollars a week or five hundred. If you follow this plan you will some day have an income upon which to retire.

The plan calls for the deposit of only a few dollars each month—the exact amount depending on your age. The minute you make your first deposit, your biggest money worries begin to disappear. Even if you should become totally and permanently disabled, you would not need to worry. Your payments would be made by us out of a special fund provided for that purpose.

And not only that. We would mail you a check every month during the entire time of your disability, even if that disability should continue for many, many years—the remainder of your natural life.

Get this free book

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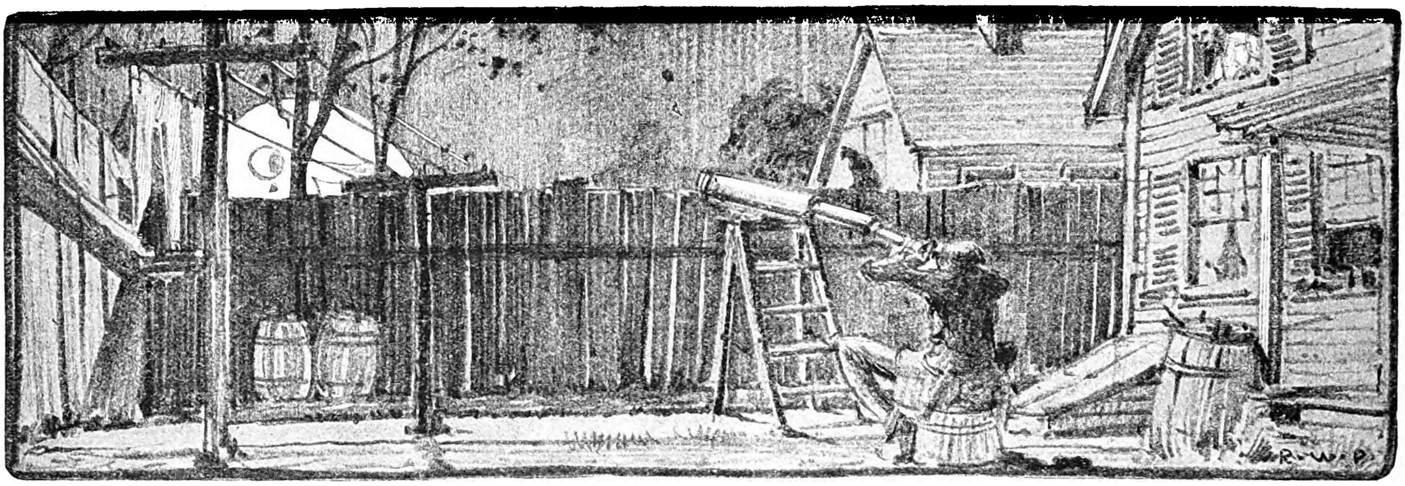


The Amateur Astronomer

THE entire inventory of materials which C. A. Olson, Oakland Avenue, Westwood, New Jersey, used in making his mirror may be seen in the photograph reproduced below. With the exception of the pitch lap, a few chemicals used in silvering the glass, and other inexpensive gadgets, the whole array is of the kind that can be picked up around the average household and is typical of the kind used in telescope making. Note absence of tools; none are used.

Simple equipment for telescope making

THE small observatory shown at the right was made by Albert F. Schroeder, 1175 Forest Cliff Drive, Lakewood, Cleveland, Ohio, and will be described in detail in a later number.

THE upper telescope on the opposite page is a four inch, made by Arthur D. Flagg, from easily obtained materials, the mirror disk being a piece of broken windshield from a motor car. Mr. Flagg used part of an old Ford water pump for his polar axis support. He also used the brass shells of discarded light sockets for making three eyepieces. A magnification of 40 or more diameters may be had from such a telescope.

P. M. JONES, 3421 Second Street, Des Moines, Iowa, whose second telescope is illustrated opposite, used the H C F lap and "found it all that was claimed for it, both in its rapid cutting and the ease of changing the tool to alter the figure." The framework of his mounting is of steel angles. This is very rigid. The yoke is made of three-inch channels welded at the joints. The telescope has a friction drive on both axes, consisting of a 10-inch disk edged to fit a small V-shaped roller held against it by a spring. Setting circles were made of lacquered protractors costing 20 cents each.

WE now continue and conclude below Professor Douglass' informative discussion of "Atmosphere, Telescope and Observer," begun in the last number:

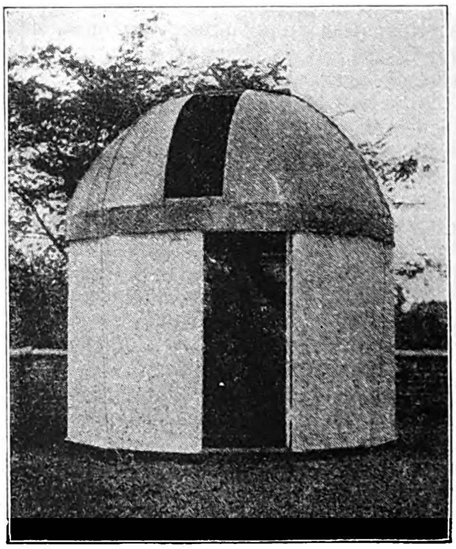
"It is easily a matter of observation that making allowance for the variation in brilliancy of the apparent field when the eye is in the focus, the atmospheric currents are precisely the same in telescopes of different apertures at the same time and place. This is of course what should be expected. But different apertures do change the character of the seeing and this also is what we expect. Conceiving the waves to consist of crests and valleys as the waves on water, we see that the refraction takes place on the slopes between these and that two adjacent slopes refract in opposite directions. If we take the distance from crest to crest as *d* and the mean amount of refraction in each slope as *r* seconds of arc we shall find that in a telescope with an aperture of ½ *d* or less the image in the focus will oscillate through a distance of 2 *r*. If the aperture of the telescope is *d* we would see in succession, if the waves were all of perfect form, first a haziness of the planet, then a displacement of *r* seconds in one direction, then a haziness followed by a displacement of *r* seconds on the other side of its original position, then a haziness as at first, and so on; the haziness in each case being due to the presence of two slopes at once before the lens. If the aperture were 1½ *d* there would be alternations of haziness with these displacements of *r* seconds, the displacements themselves being not entirely free from haziness. With further increase of the size of the objective, displacements would for a time exist but become more and more hazy until at last they would cease, leaving the planet perfectly steady but blurred.

"Such is the effect of using different apertures. As a matter of fact we rarely have such simple conditions in actual experience. We have a given telescope and usually three series of air waves which may all be of different sizes. By a big diaphragm we can get rid of the blurring effect of the largest set. By medium and small diaphragms we can improve successively the bad effect of the other series but in doing so the light is enormously decreased. We may summarize this matter of aperture by saying that the smaller the aperture the more bodily motion and less confusion of detail; the larger the aperture, the less bodily motion and the more confusion of detail.

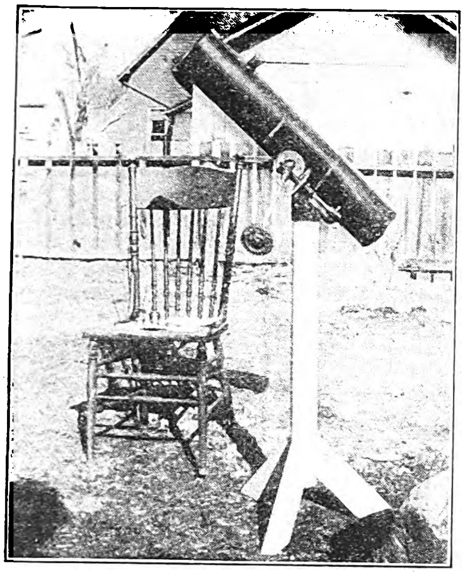
"Good seeing then, apart from transparency of the air, consists of two factors, steadiness and definition. In a given atmosphere these factors vary with the aperture, one being improved at the expense of the other; either one may come from a superior atmosphere.

"Aperture has another effect on the seeing which is of different kind, namely, physiological. It principally concerns observers of planetary detail. All the effects of this kind observed, vary with the size and brilliancy of the pencil of light entering the eye. The first imperfections noticed are motes which float about and persist in coming upon the planet which is under examination. They can also be seen against a clear blue sky.

"Perhaps the most harmful imperfection in the eye is the lack of homogeneity within the more dense transmitting media, either the lens or the membranes; probably the



An easily made observatory



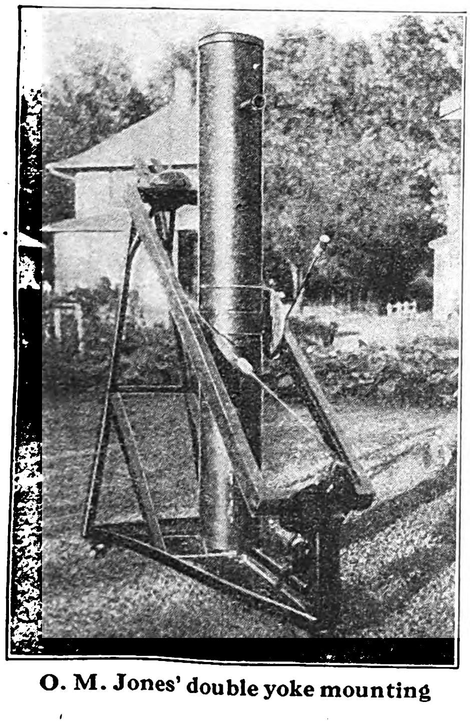
Arthur B. Flagg's trim reflector

former. Under proper conditions the lens (presumably) displays irregular circles and radial lines, the whole resembling a spiderweb structure. Under actual tests this structure is so very prominent that we wonder why the eye is able to give such good definition as it does. No optician could ever sell a lens so badly made, except for the coarsest usage; in proportion to its size it has the imperfection one finds in the lens of a bull's eye lantern."

Professor Douglass next describes methods of examining one's own eyes, but this is too long to quote here.

"High powers greatly reduce contrast," he continues. "When one changes from a low to a high power the light parts of the planet become correspondingly fainter but the dark parts seem to become lighter.

"The eye has considerable power of adapting itself to contrast occurring in different intensities of light in a manner entirely independent of the size of the pupil. This has often been exemplified in the experience of visitors looking at Mars, when the emergent pencil was much smaller than the pupil of the eye; at first they see nothing but a glare of light but after looking some-



O. M. Jones' double yoke mounting

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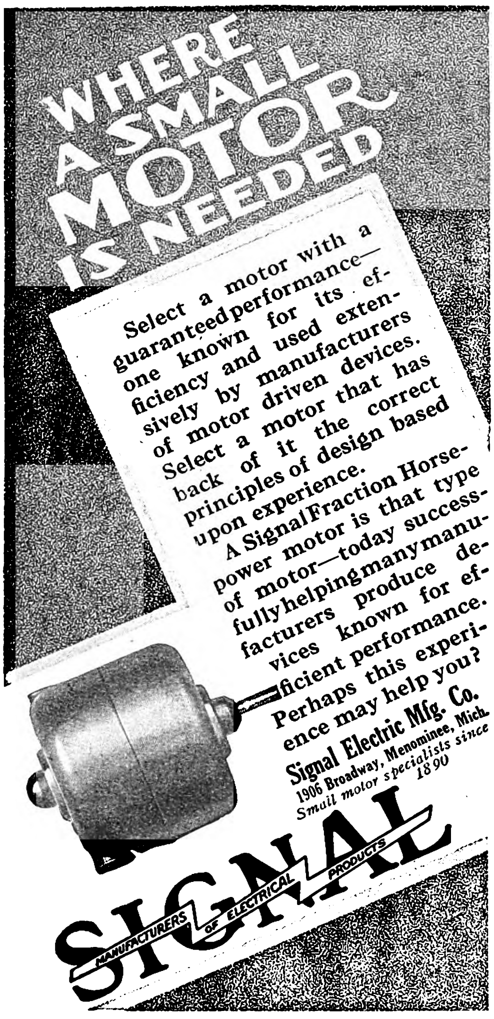
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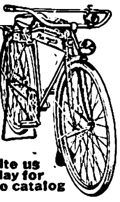

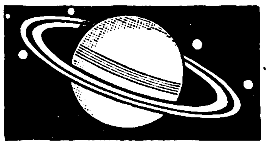

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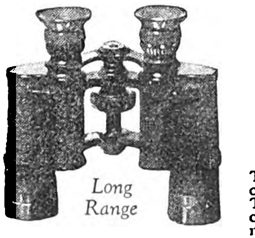

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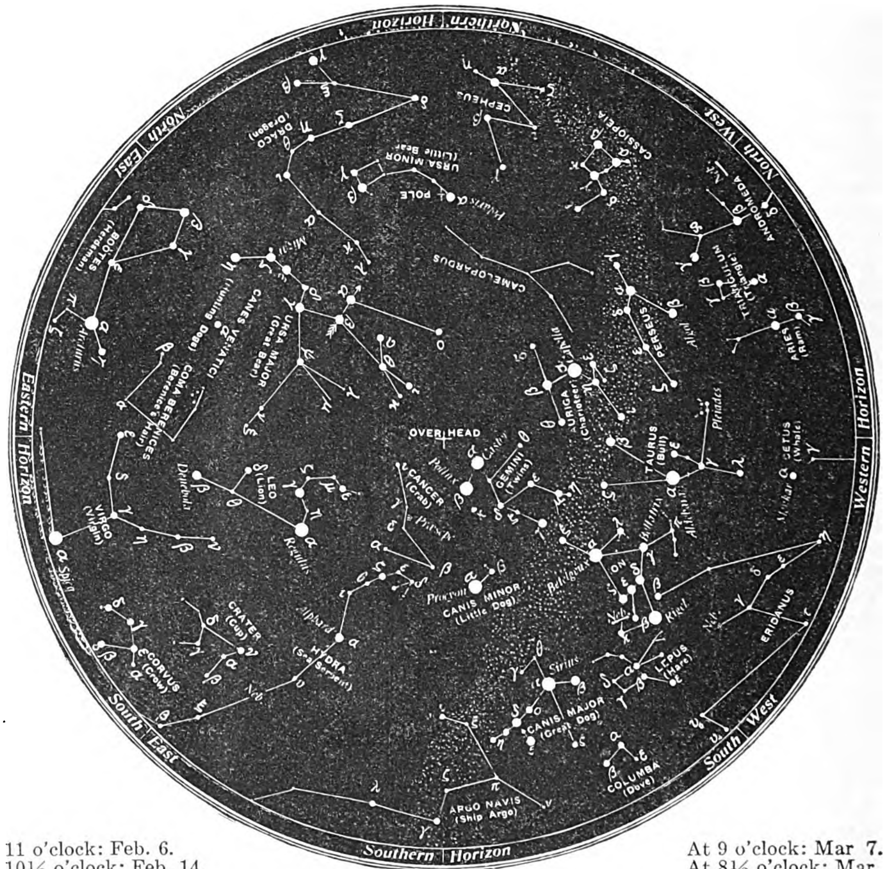
times for 12 to 15 minutes the glare diminishes and markings begin to appear. This is a certain power of adaptation which I have never seen mentioned before. After much practice that first glare becomes less and less noticeable and the eye becomes more sensitive to the particular range of contrast sought. That, in fact, is the training required by the eye to discern planetary detail, and for different planetary bodies which present different degrees of contrast and different intensities of light the training has to a certain extent to be undergone afresh in each case."

FROM Professor Douglass' article the reader will have gathered some of the basic principles of good seeing and bad. It is quite natural that the beginner should assume that magnifying power, or rather actual *seeing* power, should be increased simply by increasing the aperture of the instrument used. The matter is not, however, so simple as that; it involves a number of variable factors, variable not only from night to night but from place to place. At best any telescope is a compromise—a compromise between a number of these factors. The most elementary point for the very beginner to grasp is that mere magnifying power does not necessarily guarantee good seeing. On many occasions one can crowd on higher magnification by means of higher powered eyepieces and actually see less than with a low power. Fully to understand the considerations Professor Douglass discusses naturally requires years of patient observation under a wide variety of circumstances.—*A.G.I., Tel. Ed.*

The Heavens in February

By PROF. HENRY NORRIS RUSSELL, Ph.D.


Northern Horizon
North East
North West
Eastern Horizon
Western Horizon
South East
South West
Southern Horizon
DRACO (Dragon)
CEPHEUS
CASSIOPEIA
URSA MINOR (Little Bear)
Polaris
POLE
BOÖTES (Herdsman)
Arcturus
Mizar
CAMELOPARDUS
ANDROMEDA
TRIANGULUM (Triangle)
ARIES (Ram)
CANES VENATICI (Hunting Dogs)
URSA MAJOR (Great Bear)
PERSEUS
Algol
COMA BERENICES (Berenice's Hair)
Capella
AURIGA (Charioteer)
Pleiades
OVERHEAD
Castor
Pollux
GEMINI (Twins)
TAURUS (Bull)
CETUS (Whale)
Menkar
Aldebaran
Denebola
LEO (Lion)
CANCER (Crab)
Praesepe
Regulus
VIRGO (Virgin)
Spica
Procyon
CANIS MINOR (Little Dog)
Betelgeuze
Bellatrix
ORION
Neb.
Rigel
ERIDANUS
CRATER (Cup)
Alphard
HYDRA (Sea Serpent)
CORVUS (Crow)
Sirius
LEPUS (Hare)
CANIS MAJOR (Great Dog)
COLUMBA (Dove)
ARGO NAVIS (Ship Argo)

At 11 o'clock: Feb. 6.
At 10½ o'clock: Feb. 14.
At 10 o'clock: Feb. 21
At 9½ o'clock: March 1
At 9 o'clock: Mar 7.
At 8½ o'clock: Mar. 15.
At 8 o'clock: Mar. 22.

NIGHT SKY: FEBRUARY AND MARCH

MERCURY is a morning star and is best seen about the 15th when he is 26° from the sun and rises at 5:40 A.M. He remains visible low in the dawn till the end of the month. Venus is in conjunction with the sun on the 6th but she will not come into sight in the evening sky until next month. Mars is still unfavorably placed, rising about 6 A.M. and is too low for telescopic observation of any profit. Jupiter is in quadrature on the 26th and comes to the meridian at 6 P.M. He is in Taurus, north of Aldebaran, which he greatly outshines. Saturn is a morning star, rising between 4 and 5 A.M. Uranus is an evening star and sets about 9 P.M. in the middle of the month. Neptune is in opposition on the 21st, at which time he is in Leo in 10° 18′ R.A. and 11° 18′ north declination, 3¼ degrees east and one degree south of the bright star Regulus. He is invisible to the naked eye, and the observer with a small telescope can detect him only by his motion, comparing sketches of the sky made on successive nights.

The moon is in her first quarter at noon on the 6th; full at 4 A.M. on the 13th; in her last quarter at the same hour on the 20th; and new at 9 A.M. on the 28th. She is nearest the earth on the 12th and farthest off on the 24th. During the month she is in conjunction with Uranus on the 3rd, Jupiter on the 7th, Neptune on the 13th, Saturn on the 23rd, Mercury on the 26th, Mars a few hours later, and Venus on the 28th.

Chemistry in Industry

(*Continued from page* 157)

dissolved, and by the agency of rains, rivers, and ocean currents will also be distributed, but more slowly. The energy left in my body, after death degraded to heat, will quickly leave it and form part of the energy of the universe. This I believe to be the true resurrection of the dead, and the life everlasting. I believe in God, but like the God of St. Paul's Greeks, it is an unknown God, as in our present state of development we are incapable of understanding Him."

Ultra-violet Rays Said to Improve Flour

ACCORDING to the *American Miller*, at least one German flour mill has become convinced that treatment of flour by ultra-violet rays produces a superior product. In this mill, flour is exposed to ultra-violet rays to produce a low-cost food which abounds in the antirachitic vitamin D. Other changes occur simultaneously with this treatment and give better baking qualities and a more wholesome taste. Compared to milk, on the basis of food value, flour and flour products are said to have the advantage of greater constancy and much better keeping quality.

"All the Gold in the World" Is Not So Much

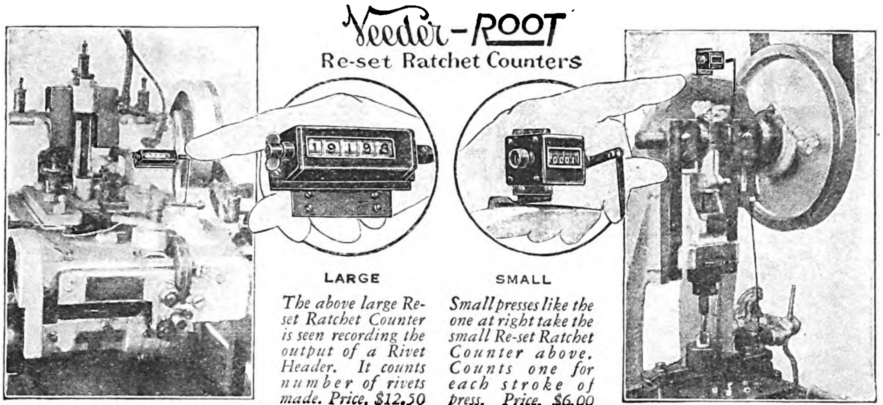
SINCE the discovery of America, world production of gold has only slightly exceeded a billion ounces, approximately 1,003,500,000 ounces being indicated by study of available records, says Scott Turner, Director, United States Bureau of Mines. More than half of the grand total of gold production for the past 435 years, or 516,273,000 ounces, was produced in the first 27 years of the present century. Of the cumulative world production of gold since 1492, 467,000,000 ounces are estimated to exist in the form of monetary stocks, while 536,563,329 ounces represent the balance of gold lost or absorbed in other than monetary uses.

The scarcity of gold may be illustrated by the fact that if the entire world production since the discovery of America were cast into a cube its edges would measure only 38.5 feet.

Rare Earths in Glass Produce Remarkable Effects

MOTORISTS may have noticed the glass tank atop the gasoline pumps in the service stations and observed that this glass if often tinted. Contrary to popular belief, this is not merely a decorative idea, but it represents a scientific effort to minimize the decomposing action of sunlight on the gasoline that stands in the glass tank. It has been found that certain elements, particularly the rare earths, impart a delicate tint to glass which filters out those rays of the sun which tend to "crack" the gasoline. Many other interesting discoveries have been made lately regarding the effect of these substances in glass; for example, a trace of neodymium in the glass of one's spectacles should partially correct color blindness.

Professor Weidert, of the Kaiser Wilhelm Institute for Silicate Research of Berlin, and director of the technical optics laboratory of the Berlin Technical High School, recently discussed the use of the rare earth elements as components of glass. He



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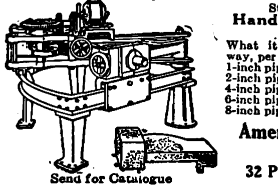

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pointed out that one gram of neodymium or praseodymium cost 20 marks before the war, but is now much cheaper. Didymium glass was used during the war for secret optical telegraphy. Glass containing cerium was used in spectacles to cut out ultra-violet light, and zirconium was used in the production of cloudy opal glass. Neodymium glass is especially suitable, by insertion before mercury vapor lamps, for the production of monochromatic light. Neodymium makes red or green appear sharper; it may, therefore, be used to correct incomplete color-blindness.

Recently, neodymium and praseodymium have been applied extensively in the manufacture of art glasses. In these, the color depends on the thickness of the glass, so that parts of varying thickness show a changing play of colors; and the glass is, therefore, used in the production of artificial gems. The color also depends on that of the incident light; for example, praseodymium glass is green in daylight and colorless in candlelight.

Impregnated Hemp More Durable

A RUSSIAN chemist named Pissarew, of the Institute for Textile Research, has obtained a patent on a method of impregnating hemp by means of which, it is claimed, the durability and mechanical properties are improved very substantially. The tensile strength is increased by 50 percent, and eight years at least are added to the useful life of the hemp fibers.

The method is particularly suited for cordage, fish nets, and water hose. The impregnating substance, which is called "Naphtiol" is quite cheap, the cost of production being estimated at only about 20 rubles per 100 kilograms when manufactured on a small scale. It is obtained from residual products from the refining of petroleum. The impregnating process can be carried out in the same way as ordinary impregnation with tar.

New Borate Mineral Is Finding Commercial Use

MINERS, prospectors, and mineralogists have so thoroughly searched every nook and cranny of the earth's upper crust that nowadays new minerals are seldom found, or where they are discovered, are apt to be rare, and to exist in small quantities of no particular commercial importance. Nevertheless, a new boron-containing mineral, discovered within the last five years, has been found in such quantities as to render its commercial exploitation possible, according to the Pacific Experiment Station of the United States Bureau of Mines.

The new mineral, which has been variously called Razorite or Kernite, is found in the Mojave desert of California, at depths some 600 to 800 feet below the present surface of the ground. The pure mineral is colorless, transparent, and occurs in lamellar or columnar form. It contains the oxide of boron and of sodium, together with some water, and in places is of high purity, but differs markedly in physical properties from the ordinary borax of commerce.

Its constitution has been of great interest to the chemist, who has hitherto known only the normal crystallized sodium borate, which contains ten molecular proportions of water to one of borate, and the octahedral sodium borate, with five molecular proportions of water. Both of these forms are readily soluble in water, the former being the sort found in nature as the result of the the natural evaporation of alkaline lakes. The octahedral form is unstable with respect to water at ordinary temperatures, and is not found in nature, but can be prepared in the laboratory by crystallization above 142 degrees, Fahrenheit. Chemists have not succeeded in preparing the new mineral form in the laboratory, for although it contains from three and one half to four molecular proportions of water, it is dissolved in water only with considerable difficulty. It seems probable that the material is a product of volcanic activity.

One of the larger uses for the borate is in the manufacture of certain special glass, and for glazing sanitary ware.

"Tin" Cans Made of Aluminum in Norway

THE use of aluminum cans in place of the conventional "tin" variety has possibilities of revolutionizing Norway's canning industry, according to a report from Oslo to the United States Department of Commerce. At present the experiment is limited to canned fish, 50,000 aluminum cans having been ordered for this purpose, but there is reason to believe that it will be extended.

The Norsk Aluminum Company, Hoyanger, Norway, is backing the experimentation. This firm is making plans to install rolling equipment for the special gage sheets that are required. While it is admitted that the most serious objection is the price of the new container, it is pointed out that the expense of the printed label may be done away with, as the aluminum can may be attractively embossed. The light weight, and consequent lowering of shipping costs, is said to be another advantage. Then, too, the empty cans, being pure metal, have considerable reclamation value.

It would appear that the low cost of electric energy in Norway would make for cheaper aluminum, since the production of this metal is an electrolytic process in which the cost of power is a major factor.

New Freezing Mixture

EVERYONE who has made ice cream is familiar with the rock-salt-ice freezing mixture used. When a lower temperature is desired for use in the chemical laboratory, chemists have long used a mixture consisting of one part ammonium nitrate, one part sodium carbonate, and one part water. Although this mixture permits a temperature drop of 31 degrees, centigrade, it has the disadvantages that it is expensive and the ammonium nitrate is comparatively difficult to obtain. A mixture frequently used as a substitute, consisting of ammonium chloride, potassium nitrate, sodium sulfate, and water, gives a temperature drop of only 25 degrees, centigrade. Furthermore, the price of this mixture is relatively high.

German patent 463,792, granted to W. Kasch of Berlin-Wilmersdorf, describes a mixture of ammonium chloride, sodium carbonate, and water, which is obtainable at only one fourth the price of the first named mixture and gives a temperature drop of 31 degrees; furthermore the material is easily obtainable. The best proportions in which this new mixture may be used are 100 parts ammonium chloride, 150 parts sodium carbonate, and 300 parts water.

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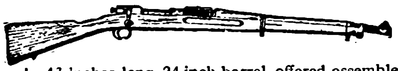

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(*Continued from page* 152)

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"This Aviation Business"

ERNEST W. Dichman, formerly of the Army Air Corps and now chief engineer of the Fairchild Airplane Manufacturing Company, has produced one of the best books on aviation for the lay reader that we have ever seen; "This Aviation Business" (Brentano's, New York).

The chapter entitled "The Period of Evolution" gives the right historical background. "Notable Flights and their Significance," is a thoughtful review of the solid achievement which has accompanied the adventurous flights of the past. "Commercial Development" and "Popular Enthusiasm after May, 1927" bring the reader completely up-to-date in the history of American commercial aviation.

The author is not entirely satisfied with the safety of aviation, and points out that "there is an unfortunate tendency to jump at each of the newly announced inventions as the cure for all the ills of aviation." He says, further: "The actual facts are these: There have been many all-metal airplanes catch fire and burn. Several three-motored airplanes have had forced landings. Pilots have been lost using the radio beacon. The efficacy of the Handley Page slot still remains to be proved. The N.A.C.A. cowl is still in the experimental stage, and the autogyro needs ten years' work before it will be developed to any degree of satisfaction." It is good to hear a conservative note from time to time.

At the present time great numbers of young men are seeking to enter aviation in any capacity. While aviation will grow rapidly and steadily, it is impossible that it should absorb indefinite numbers of young men. In "Aviation as a Career," the author voices a sound warning to aviation aspirants and at the same time gives an authoritative guide to training and prospects in the industry.

The author's style is really surprisingly good, particularly for an engineer, and we cannot resist quoting the following striking passage "A young man came to see me the other day. His ostensible purpose was to discuss some aviation ideas. His real purpose may be summed up by his question 'How does one git into this aviation game anyhow? This is the coming thing and I want to git in on the ground floor.' This young man happened to be a farmer. His hands and face plainly showed the marks of honest toil. He was just itching to get away from the monotony of the farm and into the air. This sort of experience, with suitable variations, is repeated on an average of once a week. Druggists, bank clerks, draftsmen, mechanics, young men of almost every calling are anxious to give up their jobs and learn to fly. One garage owner with a comfortable business was ready to sell out and take up flying. The boy who delivers my laundry recently announced that he was quitting his job to begin a course in flying at a local field."

Lieutenant Dichman first of all discusses the question of age for the would-be pilot.

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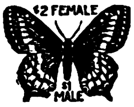

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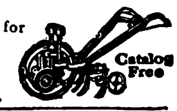

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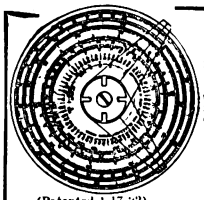

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For the young man of moderate means, the author advises application for admission to the Army Air Corps Flying School. If he has the necessary physical and mental qualifications he may be admitted as a flying cadet. He then receives $75 a month in addition to board, clothes, and shelter. "He will be made to do a number of things which he does not like, which will be good for him. However, he will certainly be taught to fly or gently but firmly told that he does not possess sufficient natural aptitude and be discharged."

The course of instruction lasts one year and is thorough. Time in the air amounts to about 300 hours. He may then remain in the Army or if he chooses to enter civil life, he will find many opportunities open to him. He may become a general utility pilot with some operating firm. He may do photographic work, cotton dusting, et cetera.

It is difficult to break-in with the transport companies and an apprenticeship stage as flying mechanic or assistant pilot is necessary, at 150 to 175 dollars a month. After this, he may become a regular transport pilot, and earn between 5000 and 6000 dollars a year. The author advises great caution in selecting a private school (for the man who does not get into the Army flying school) both as regards the amount of fees to be paid and the competency of the school selected.

The author covers with similar accuracy other careers in aviation—sales, drafting, engineering, operations, and so on. We advise every young man with aviation aspirations, or his parents, for that matter, to read, learn, and inwardly digest this chapter.

Aviation is passing through a period of financial depression, and the public which has financed aviation on such a generous scale is the sufferer. The following words of warning should have been written a year or so ago: "The entire nation has taken hold of the aviation idea. The tales of fortunes made in gold or oil are recalled. The automobile industry is drawn upon heavily to supply inspiration. If you had invested 100 dollars in the original Ford company you can figure out how many millions you would be worth to-day. Every investor in aviation securities considers himself a potential Rockefeller or Ford. There has been money made in aviation. There will be more money made in it. But there has been and will be a great deal of money lost in aeronautical ventures." Analysis of passenger transport is particularly pessimistic from the financial point of view.

Nevertheless, the author forecasts a great future for the industry. Central and South America will be brought close to the United States. San Francisco will be as close to New York as St. Louis is now by rail. "I confidently expect the presidential candidate of 1936 to use the airplane a great deal in his traveling."

The final note: "Aviation is becoming a real business."

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THE full title, which well describes this book, is "A History of Science and its Relations with Philosophy and Religion." Philosophy digs deeper than science as such, yet the two are really parts of a greater whole which most thinking people aspire to comprehend. This work is for the seasoned reader who may already have read some such book as the famous "Story of Philosophy" by Will Durant, or done equivalent thinking. In scope it extends from ancient to modern science and philosophic thought.

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By Burton Peter Thom, M.D.

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By R. V. D. Magoffin, Pres. Archeo. Inst. of Am., and Emily C. Davis, Archeological Staff Writer, Science Service

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

"Trademark Specialists" Repudiated

A BULLETIN regarding circulars recently issued by certain self-styled "trademark specialists," has been issued by the Committee on Trademarks and Unfair Competition of the Association of the Bar of the City of New York. This committee, under the chairmanship of Harry D. Nims, includes Henry T. Hornidge, Ellis W. Leavenworth, Alan N. Mann, Howard M. Morse, Orson D. Munn, A. Parker-Smith, James McKinley Rose, George W. Tucker, Wallace White, and William B. Whitney.

The bulletin follows, in full text:

The Association of the Bar of the City of New York has authorized the publication of this bulletin in order to inform the general public regarding certain fundamental principles of trademark law and to correct some erroneous conclusions or impressions which may have resulted from the recent activities of so-called Trademark Specialists who have been circularizing the business world.

1. The first person to use a trademark on merchandise acquires title thereto in the territory where his goods are marketed. Therefore the suggestion by these Trademark Specialists that the owner of a trademark is in danger of losing his mark by not having it registered according to their suggestions is entirely contrary to fact.

2. Registration in the United States Patent Office is not at all essential for the protection of vested trademark rights. It is desirable as being *prima facie* evidence of ownership (when secured under the 1905 Act), and for other practical and procedural reasons such as giving the registrant the right to use with his mark the phrase "Reg. U.S. Pat. Off." and the right to bring suit in the federal courts. The advertising Trademark Specialist in the cases investigated has exaggerated the importance of specific forms of registration and the language used is susceptible of a construction which might mislead the trademark owner as to the true situation.

3. As a rule no mistake fatal to common-law trademark rights can be made in obtaining a trademark registration, but it is usually advisable, because of the technical nature of the procedure and the probable need of overcoming Patent Office objections, that competent counsel should be entrusted with this work. The Specialist's warning that a single defect lurking in a registration may cause the loss of a mark and the good will of the business and similar expressions are obviously erroneous.

4. Vested trademark rights are recognized and protected by the courts in all the States irrespective of state or federal registration. Therefore the statement often found in some of these circulars and letters sent out by these self-styled Specialists that state registration is necessary in order adequately to protect trademark rights is not true. State registration is helpful only in exceptional cases and the trademark owner should not be burdened with the large expense involved in securing such registration except in unusual cases.

It is obvious, therefore, that the general public need not be disturbed or alarmed by the statements and veiled suggestions of disaster often found in circulars and letters which are constantly being received by trademark owners, circulated by persons and concerns thus soliciting use of their services in connection with such matters.

Rejection of Claims Due to Delayed Application

DELAY for nearly five years in making the application for reissue patent covering locomotive reversing-gear mechanism resulted in rejection of certain claims of the delayed application by the Commissioner of Patents *exparte* Henry Helmholtz *et al.* The decision was rendered on an appeal from the ruling of the examiners in chief, finally rejecting claims 10 to 16 of reissue patent Number 17483. The original patent Number 1208556 was granted December 12, 1916.

The applicants accounted for the delay by general statements that they were engaged in furtherance of the war aims of the Government and could not exploit and did not learn of the defects of the original patent until shortly before the filing of the application. This was held to be an insufficient special circumstance which would not excuse the delay in view of the fact that the patent was assigned three years after it was issued, and nearly two years before the reissue application to a corporation which furnished no excuse for its delay.

Invention Rights Barred by Disclosures of Prior Art

IT is the intention of the Patent Statute to reward invention, and not to reward diligence in unearthing prior patents which have not been turned into commercial success. A person is not entitled to the reward given inventive genius if his invention has already been disclosed to the public through the records of the Patent Office, even though the prior art device has not gone into extensive and successful commercial use, according to a decision of the Circuit Court of Appeals for the Tenth Circuit.

The case in question, W. H. Butcher Packing Company *versus* Cincinnati Butchers' Supply Company, was heard by Circuit Judges McDermott, Lewis and Phillips, on appeal from the District Court for the Western District of Oklahoma. The lower court had found infringement, awarded an injunction and directed an accounting, but the Court of Appeals reversed the decree, with instructions to dismiss the bill. The machines of both parties of the suit were found to lack novelty over the prior art, and therefore had no right to claim patent protection.

The plaintiff's patent for hog-dehairing machines, Number 1388898, issued in 1921 to Charles G. Schmidt and Oscar C. Schmidt, was held to be more like the prior art than the patent held by the defendant was like that of the plaintiff. Because of public use of the prior art machines, in which the invention had been disclosed, the later patentee has no grounds for demanding the rights of the inventor. Finding no infringement, and not passing upon the validity of the claims in suit, the court held it unnecessary to discuss presumptions, commercial success, or many other points ably briefed and argued. The decree was reversed and the bill dismissed.

Facsimile Signature Upheld

DESPITE its similarity to the opposer's trademark, the autograph-signature mark "E. W. Williams," has been upheld by the Assistant Commissioner of Patents on the grounds that a facsimile signature possesses such distinctiveness as not to be confused with marks otherwise portrayed. The ruling reversed the decision of the acting examiner of interferences, which had sustained the opposition to the registration of the signature. J. B. Williams Company, owner of the mark "Williams," had contested the registration of the facsimile mark, both marks being used for cream to be used after shaving.

In holding that there was no likelihood of confusion by the current use of the two trademarks on goods of the same descriptive properties, the Assistant Commissioner pointed out that in every branch of the law handwriting is considered distinctive. The distinctiveness, in such cases, is in the penmanship and the mark is not the mere name of an individual. According to the ruling, the mark "E. W. Williams," as written, bears no resemblence to the mark "Williams," despite the seeming evidence to the contrary.

Profits from Expired Patents

MORE and more holders of valuable patents and trademarks are realizing that the best insurance for profits during the post-patent period is in building recognition for the future by extensive advertising. When patents expire, the company which has established itself firmly in the field is at a distinct advantage over its competitors, even when the industry at large is free to make use of the invention. As many patent-holders have learned, this "head start" can be perpetuated and capitalized by the judicious use of display advertising.

A slightly different result, illustrating the same principle, was pointed out recently in *Engineering and Mining Journal:*

"Basic patents on a machine used extensively by a specific industry were owned by the ABC Corporation. The XYZ Company also made the machine, along with other products, paying the ABC people a royalty for every machine sold. The XYZ Company chose to stay in business without making a practical profit on this particular product. Why?

"Two years or so ago the patents expired. The expected happened. Dozens of manufacturers turned to making the machine. But instead of diminishing sales for the XYZ Company, there came increased sales, pyramiding profits, and leadership in the field. This leadership is being maintained today by the same formula that was used steadily for three years before industry-at-large was free to make the machine.

"During the three-year period from 1923 to 1926, when XYZ's profits were barely enough to pay royalties to the patent owners, XYZ advertised regularly in certain well-chosen periodicals, building recognition for the future, intrenching themselves in a strategic position for the post-patent period. After the patents expired, in 1926, pyramided effects of continuous advertising sent sales and profits constantly upward.

"Today a sustained advertising program of full and double pages, with pithy, factful copy, is keeping the XYZ Company in top place."

Mark Suggestive of Use Held Not Descriptive

ALTHOUGH the notation, "Detective Special," the word "Special" having been disclaimed, is obviously a recommendation of revolvers to detectives and suggestive of their use, it has been held that the notation is not so clearly descriptive as to justify the Patent Office in refusing registration. The applicant, Colt's Patent Fire Arms Manufacturing Company, had appealed to the Commissioner of Patents from the decision of the examiner of trademarks. In refusing registration, the examiner asserted that the mark is descriptive of the goods, offering in substantiation of his stand a reference from the applicant's catalog describing the revolver in question as "a snub-nosed Colt shooting the powerful .38 special cartridge, yet small enough to ride handily in the side pocket of coat or overcoat."

The Commissioner concluded that the revolver has no structural characteristics which make the weapon particularly suitable for use by a detective any more than for any other person. It was conceded that the mark would be interpreted in the nature of a recommendation of the revolvers to detectives, and would function, not descriptively as to the characteristics of the articles but suggestively as to their use.

Among the references cited by the applicant in defense of the mark were, "Hotel Special," for coffee; "Cow Boy Special," for overalls; "Miner's Special," for gloves; "Planter's Special," for feed for horses; and "Banker's Special," for revolvers, showing that it is the practice of the Patent Office to register marks of such character. Concerning the trademark, "Banker's Special," for revolvers, the Commissioner said, "I fail to see any distinction as to registrability between the two marks, and feel that either both should have been registered or else both should have been refused registration. The instant mark is regarded as not so clearly descriptive of the applicant's goods as to justify the Office in refusing its registration. The decision of the examiner of trademarks is reversed."

Why Spark Plugs Do Not Crack

"THOSE who drove automobiles a few years ago will recall vividly, among other troubles, the grief caused by cracked spark plugs," we are reminded by J. T. Pardee of the United States Geological Survey, in a recent issue of the *United States Daily*. "Today we have forgotten about spark plugs. They have ceased to be a source of trouble—no one ever hears of a cracked porcelain any more."

Explaining "Why spark plugs do not crack," Mr. Pardee describes the way this improvement was brought about, an incident which clearly illustrates the value of purely scientific research carried on for its own sake and without any immediate economic object in view.

"In June, 1926, in the course of field work for the Geological Survey, in Inyo County, California, Adolph Knopf, a geologist, saw an outcrop of rock that had been taken by one prospector for silver ore and by another for phosphate. It evidently was neither, and so far as its appearance indicated was merely one of the host of rocks that compose the bulk of the earth's crust.

"However, the geologist, recognizing the mass to be of an unusual character, stole time enough from the otherwise economic work assigned to him to gather specimens and to ascertain the facts of its occurrence. Later, at Washington, an examination of his collection showed that the rock was largely composed of a mineral called andalusite. Now at that time andalusite was not known to have any economic value. But, because of its scientific interest, a description of the occurrence was published in a scientific paper.

"Before that time the silicate minerals had been one of the many subjects of investigation by the geophysical laboratory, which had, among other things, determined what to the layman might appear to be a bit of perfectly useless information; namely, the amount of swelling and shrinking shown by andalusite and other minerals when they were heated and cooled; or, in scientific terms, their coefficients of expansion.

"The geologic paper and the results worked out by the physicists fell into the hands of engineers looking for substances with which to make spark-plug procelains that would not crack, and presto!—andalusite was the answer. The geologist's research had found the deposit, and the physicist's research had shown its suitability for the purpose sought.

"Again in the course of field work, this time in the Rochester district of Nevada, the same geologist discovered another scientifically interesting occurrence, a mass of the mineral dumortierite, which, in the course of events he described and for which the physical properties had been made known as before, with the result that the spark-plug makers were directed to a deposit even more valuable for their purpose than the andalusite.

"Today, as an indirect result of purely scientific, uneconomic investigations, we drive our automobiles with never a fear of a 'missing' plug."

Electroplating Process Claims Declared Patentable

FINDING nothing in the claims that limited them to any particular apparatus, the Board of Appeals of the Patent Office has reversed the action of the examiner who had rejected as unpatentable certain claims of a process for electroplating the interior of tubes. The process claims had been rejected as not being patentable over the apparatus claims which were allowed by the examiner. The allowed claims are included in patent Number 1733404 issued to Frank A. Fahrenwald, covering both process and apparatus for electroplating tubes.

The Board of Appeals held that the apparatus disclosed, when operated in the manner described, carries out operations

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co.; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

BRAKING DEVICE FOR AIRCRAFT—By which the speed may be smoothly checked in flight, and the craft automatically maintained with safety in a fore and aft balance, so that when landing it may be brought to rest in a relatively restricted area. Patent 1731735. Marion H. Aten.

Pertaining to Apparel

GARMENT—An article of wear convertible from a plain rectangular form to be used as a steamer rug, or given the form of a wrap with sleeves and a collar by the engagement of a minimum number of fasteners. Patent 1736594. Bessie J. Hart.

BUCKLE—Including a tubular body which is adapted to telescopically receive the free end of a belt, or one of a pair of members to be connected thereby, and permit a limited relative movement between said members. Patent 1737492. William H. Carroll.

Designs

DESIGN FOR A STOCKING—Patent 79876. Ruby Lefi.

DESIGN FOR A DRESS—Patent 79730. Dorothy Long.

DESIGN FOR A TEXTILE FABRIC OR SIMILAR ARTICLE—The inventor has been granted nine patents for ornamental designs for textile set forth in the process claims. This fact, however, is not sufficient reason for rejecting the claims as functional, the decision stated, when such process claims are not limited to any particular apparatus. In such cases it was held that process claims should be allowed, since the process form of claim may be more satisfactory than an apparatus claim.

The application disclosed a process by which a tube to be electroplated is mounted for rotation; the anode is shorter than the tube and is caused to be reciprocated to and fro lengthwise of the tube. The liquid is circulated through the tube. One of the claims stated: "The process of electroplating the interior of a tube which contains the step of electrolysing a solution of plating metal in contact with the entire tube interior as cathode, and simultaneously impressing upon the tube and anode two independent movements, one a gradual axial movement relative to each other and the other a gradual movement of rotation of the tube around the anode."

Garment Pressing Machine Patent Upheld by Court

INVENTION, and not mere double use, is involved in applying to a steam garment-pressing machine a suction drying device taken without substantial variation from another art, where the patentee was not only the first to make application of the old device to the new use and the first to show how it could be made, but he was also the first to perceive and show utility in making it. On these grounds, the Weinberger patent (Number 1193093) for a garment pressing machine has been sustained by the District Court of Delaware, which simultaneously declared invalid the Spencer patent (Number 1326982) covering a device substantially the same. These decisions terminated a suit brought for the alleged infringement of both patents, United States Hoffman Machinery Corporation *versus* Pantex Pressing Machine, Incorporated.

The Delaware court ruled also that although an examiner had rejected certain claims of a patent application which were subsequently allowed by examiners-in-chief on appeal, a court may hold the patent invalid on the same prior art considered by the Patent Office.

It was held that the placing of old elements in juxtaposition without a new function or effect is not combination, yet when elements are so united that by their joint action on their common object they perform additional functions and accomplish additional results, the union is a true combination, and whether they coact successively or simultaneously is of no importance. Also, according to this court, the substitution of one element or device for another which performs the same function in substantially the same way and accomplishes substantially the same result, even if the substituted part performs the function better, is within the capacity of one skilled in the art and is not a patentable invention.

Fur Company Denied Use of Name "Hudson"

UPHOLDING the rights of the historic firm known as the Hudson's Bay Company, chartered by King Charles II in 1670 under the title, "The Governor and Company of Adventurers of England

fabrics. Patents 79749, 79750, 79751, 79752, 79753, 79754, 79755, 79756, 79757. Frieda B. Paisner.

Design for a Dress — Patent 79887 Dorothy Long.

Electrical Devices

Alarm Apparatus—An electric burglar and fire alarm which normally utilizes the house lighting current for actuating an alarm when the surreptitious opening of a door or window is effected or when a fire occurs in the building. Patent 1732276. John A. Morrison.

Indicating Apparatus—For indicating, annunciating or displaying indicia bearing elements, which are displayed and concealed successively in numerical order, as the result of actuation of a single controlling device, including a source of electrical energy. Patent 1733817. Joseph S. Moranor.

Coin-Controlled Circuit Closer—Which automatically controlls an electric device, such as a fan arranged within a public toilet having a hinged door, upon the insertion of a coin in a coin slot and the closing of the door. Patent 1734838. Arthur W. Tucker.

Automatic Switch—A safety switch for a motor driving a given piece of machinery, which stops the operation of the machinery in case of an accident, but does not stop the running of the motor. Patent 1735761. James E. Huey.

Television Apparatus—A system employing a square scanning beam upon a photo-electric cell controlled by two rotating spherical surfaces, the axis of which are disposed at right angles to each other. Patent 1735553. Samuel T. Syphrit.

Electric Advertising Device—Wherein round or other shaped articles are provided with a magnetic member which co-acts with means forming a field whereby as the field is energized the article is moved about without apparent cause. Patent 1736613. Guy McGoshen.

Of General Interest

Submarine Safety Device—Including a marking buoy controlled from the interior of a submerged vessel, and a cable attached thereto which will draw upwardly a normally collapsed hose, through which the crew of the disabled vessel may be rescued. Patent 1734864. Willy Krause.

Holding Means for Vanity Cases—The holding structure for the removable plates being swingably connected to the casing and constructed to hold any kind of powder, rouge and like renewals which may be applied without the use of tools. Patent 1734860. William G. Kendall.

Skylight—Which is fireproof, and comprises a metalic frame structure made of separable members so that the skylight can be disassembled and shipped in knock-down condition, and secured without the use of solder, bolts or other fastening elements. Patent 1734840. Sidney Volk.

Photograph Exhibitor—Comprising a cabinet having a plurality of supports for the mounting of photographs on one or both sides, the supports being movable in the order of book pages thereby successively displaying the pictures to view, without injury by handling. Patent 1734790. Helmuth F. Bandt.

Shaving Brush—Wherein the handle and brush element are separable, the brush consisting of a flexible bristle carrying strip helically wound and detachably held within the handle so that after use the bristles may be thoroughly sterelized. Patent 1734873. William M. Neissl.

Combined Arm Rest and Prop—Which may be readily adjusted for use as an arm rest or a prop, and will serve advantageously on a com-

Trading Into Hudson's Bay," the District Court of Minnesota has ruled that no other firm dealing in furs and blankets can do business under a firm name containing the words "Hudson," or "Hudson Bay." The above firm had opposed an application of the "Hudson Bay Fur Company," for permission to continue its established business under the revised name, "Hudson Furriers, Incorporated."

The Minnesota court ruled that the defendant, by improperly adopting the name "Hudson Bay Fur Company," had been in error, and despite the fact that large sums had been spent in advertising the improperly acquired name, it should discontinue the use of the word "Hudson."

The court said: "If defendant had never used the name 'Hudson Bay Fur Company,' the wrong and deception, if any, involved in now using the name proposed (Hudson Furriers, Incorporated) would be much less than it would be under conditions as they actually exist. The application of the defendant seems like an effort to see how far it will be permitted to go, without incurring the penalties of the law, along the lines on which it should never have entered at all.

"The world is wide, and available and good names for defendant's business are many. It has a great range of selection without trespassing upon the rights of plaintiff, and without, by a possibility, deceiving the public. Some such name should be chosen. In the face of the decree which has been entered in this case, the defendant has continued to use and advertise under the prescribed name for quite too long a time. The matter should now be promptly closed, and changed conditions, conforming thoroughly to the spirit of the decree, should be inaugurated without delay."

Examiner Upheld in Ordering Drawings Corrected or Withdrawn

WHEN drawings submitted with an application for patent are lacking in conventional symbols specified by the Rules of Practice for all applications involving electrical systems, the examiner is justified in ordering the drawings corrected or withdrawn. This decision was made by the Commissioner of Patents, acting on a petition from an order from a patent examiner.

Although the art generally may use different symbols in illustrations, uniformity is declared to be necessary in patent applications in order to facilitate clearness and accuracy on the part of the examiners. For many years a chart for the guidance of draftsmen as to the use of symbols in connection with wiring diagrams have appeared in the Rules of Practice. This chart has been modified from time to time as the practice adopted by engineers and others skilled in the arts has changed or advanced. The application's drawing (*ex parte* Rodman), the examiner's requirement, and the applicant's petition were submitted to each of the five principal examiners in charge of the respective divisions of electricity, for comment. At least four of them strongly supported the requirement of the examiner, in the interest of clearness and accuracy. This action of the examining staff and the Commissioner of Patents emphasizes the importance of having applications and drawings prepared by attorneys and draftsmen thoroughly familiar with the Rules of Practice as revised to date.

bination folding chair and cot in connection with one of the sections. Patent 1736569. Arthur F. Bailly.

Method of Welding Copper-Boiler Ends—Whereby an extra-thickened portion presenting an internal bead at a point where the head joins the shell is caused to fuse and extend inwardly, presenting a strong structure, which is water and steam tight. Patent 1733922. Albert H. Trageser and Louis Hassinger.

Holding Ring for Compact Plates—Comprising an annular tubular ring structure wherein one or more corrugations are provided, whereby different shaped compact plates may be properly engaged and held resiliently and removably in place. Patent 1734859. William G. Kendall.

Tray—A serving tray consisting of two parts, a frame and an article holding plate, the plate resting in contact with the frame and handles which hold it from slipping, yet may be easily removed for interchange or cleaning. Patent 1733838. Malcolm Steiner.

Brush—A hair brush of the type which includes a handle and a detachably associated bristle carrying section which may be easily disassociated to permit of a thorough cleansing and sterilizing of the parts. Patent 1735802. Rocco Statuto.

Bottle Crate—Particularly designed for transporting milk bottles, including nonmetallic vertically arranged partitions of a size and spaced in such manner as to reduce chipping and breakage, and minimize noise in transportation. Patent 1735772. John F. Maurer, Jr.

Ventilator—Particularly adapted for location in the ceiling of a room, for transforming horizontal circular motion into vertical circular motion, giving a maximum air space from a minimum area occupied by the device. Patent 1735760. James R. Howard.

Traps—For rodents, including a box of tapered construction, a door mounted for up and down sliding movement within channels, and a bait holder and latch rod, the disengagement of the bait automatically closing the trap door. Patent 1735786. Sherman S. Pearl.

Wheelbarrow—In which an auxiliary rear wheel is provided for relieving the operator of a portion of the load, but is adjustable for support at various heights without the necessity of releasing the grip on the handles. Patent 1735527. John Cwik.

Shield for Cooking Stoves—Readily adjustable, and whereby the cook is protected against the fumes and heat rising from the stove and food, yet permitted a clear view of the food, and in no way interrupted with the manipulation thereof. Patent 1735806. James F. Struble.

Safety Razor—Wherein a hollow handle is provided which constitutes a container for the remaining parts so that when not in use they may be arranged into a small compact package. Patent 1735751. Thomas C. Green.

Adjustable Chair Seat—Which can be satisfactorily used in connection with lunch counters or the like, and is characterized by means permitting of quick and convenient adjustment to afford maximum clearance between the seat and the counter. Patent 1735304. George B. Travis.

Record Binder—Of the loose-leaf type, which will be of all metal construction, extremely durable and efficient in use, yet will permit of light-weight construction of the parts. Patent 1736711. Ernest W. Jackson.

Container Cover—Serving as a sealing for preventing leakage of the contents or excluding air therefrom and including a compartment for holding a direction-bearing pamphlet in such manner that it will be displayed when the cover is removed. Patent 1736286. Clen S. Humphrey.

Visible-Card File Cabinet—In which each drawer is hinged at its inner end to a latch member adapted to normally prevent the drawer from being entirely withdrawn from the cabinet, and to support the drawer depending if desired. Patent 1736655. Lugi Lombardini.

Loose-Leaf Binder—Comprising a binding member in the form of a strap which extends through slots in the aligned perforations of a plurality of sheets and is fastened to prevent accidental movement of the sheets. Patent 1735031. Royden E. Beebe, Jr.

Bedcover Folding Device—Which functions on any conventional form of bed, to render available as bed covering the entire length of the blanket and other coverings, by eliminating the necessity of tucking covers beneath the mattress foot. Patent 1736212. Benjamin A. Moeller.

Coupling Device—For connecting necklace or locket chains, including a pair of rotatable notched elements connected for movement in opposite directions, the notched portions receiving and completely embracing an article to be coupled. Patent 1737481. Michael Rabb.

Inscription Device—For sand blasting letters or other configurations upon tomb stones, whereby special designs may be set up and pressed into a prepared coating for cutting out, the letters being more accurate than when cut by hand. Patent 1737500. George B. Johnson.

Umbrella—A collapsible umbrella, including channel shaped members one of which is slidable within the other, and pivoted ribs, the parts being arranged so that it can be carried in a hand bag. Patent 1737464. Henry R. Lillich and Carter Smith.

Playing Cards—Of what may be termed the standard type, with the suits so marked with distinguishing elements that one of the suits may be told from another, at a glance as they are fanned in the player's hand. Patent 1737478. Jesse E. Simmons.

Directory Board—Primarily adaptable to city maps, enabling a stranger to quickly locate a desired street or place, the function being electrically performed by pressing a button, the device may also serve as an advertising medium. Patent 1737520. Thomas P. Richardson, Jr.

Valve for Fuel-Storage Tanks—For trapping and preventing water which has seeped into gasoline or kerosene storage tanks from being sucked into the pump, and also functioning to warn the pump operator should water have gotten into his tank. Patent 1737529. John H. Viele.

Hardware and Tools

Pipe-Reaming Attachment for Pipe Threading Tools—By which reaming the pipe for removal of burrs is accomplished simultaneously with, and by operation of the threading tool, thus upon completion of threading the pipe is devoid of interior burrs and ready for installation. Patent 1731727. Max Richman and Harry H. Leon.

Bending Tool—Particularly adapted for use by workers on building construction jobs, for the purpose of carrying out clip bending operations in conjunction with structural elements to support the latter in readiness for application thereto of other structural material. Patent 1736585. Fred R. Fehlhaber.

Gauge for Applying Hinges—By virtue of which inserted leaf hinges, where it is necessary to cut an angular groove, may be rapidly applied with accuracy, and without requiring the mechanic to resort to unnecessary measurements. Patent 1736709. Ernest Flagg.

Supporting Device for Rails—Comprising a base or wheeled truck, having U-forms constructed of metal mounted thereon, for holding the side rails of a ladder or scaffold, and threaded studs for securing the rails in fixed position. Patent 1736501. John J. Macklem.

Carpenter's Level—In which the number of bulbs usually employed is reduced by combining with the straight edge a circular bulb allowing a reading to be conveniently taken, whether disposed vertically or horizontally. Patent 1736502. Robert B. Maddox.

Heating and Lighting

Marine Signal Light—A portable signal light adapted for marking the location of buoys, dories, channel stakes, fishing gear, etc. The portable nature of the device makes it useful generally where a signal light is needed. Patent 1735797. Louis T. Scott.

Automatic Control Apparatus for Gas Burners—Which can be set to any required opening by hand and is subsequently controlled by means of a thermostat for the purpose of keeping the temperature of an oven or its equivalent substantially constant. Patent 1736649. James Dolphin.

Damper Control—A special operating element for the damper control of heating or ventilating pipes and means for locking the damper in any adjusted position, rattling due to draft through the pipe being prevented. Patent 1735034. Frank H. Bryant.

Machines and Mechanical Devices

Belt Tightener—Automatically operated for maintaining the constant engagement of a belt with the drive pulley and a variable engagement with the driven pulley, so that as the tightner moves toward the driven pulley the frictional engagement is increased. Patent 1737467. Paul E. Mahaffey.

Washing Machine—Including inner and outer casings of the reciprocating types, with cleaning solution inlets and outlets, wherein clothing is subjected to the washing process in an easy manner, and in less time than is usually required. Patent 1737480. Max Troy.

Concrete Mixer—And transporting tank, which operated in one direction will mix the sand and cement, and in another position will propel the mixture to a discharge point, adding the water immediately before the discharge of the concrete. Patent 1737522. Carlyle H. Scott.

Combined Display and Vending Machine—A coin operated machine which prominently and attractively displays the merchandise which it handles, is adapted to handle a wide variety, yet permit the selection of any particular article, which will be automatically dispensed. Patent 1737499. Robert C. Hardman.

Fruit - Pitting Machine — Particularly adapted for removing the pits from dates by an intermittent motion, means being provided for holding the fruit, and positioning the pit within the path of a knife for longitudinally slitting the fruit and ejecting the pit. Patent 1734010. Anthony Gotelli.

Paint Roller—For applying paint to collapsible tubes, at the same time preventing injury and correcting irregularities in the tube to a certain extent, while applying the paint in a properly coated form. Patent 1733893. Frank J. Lynch.

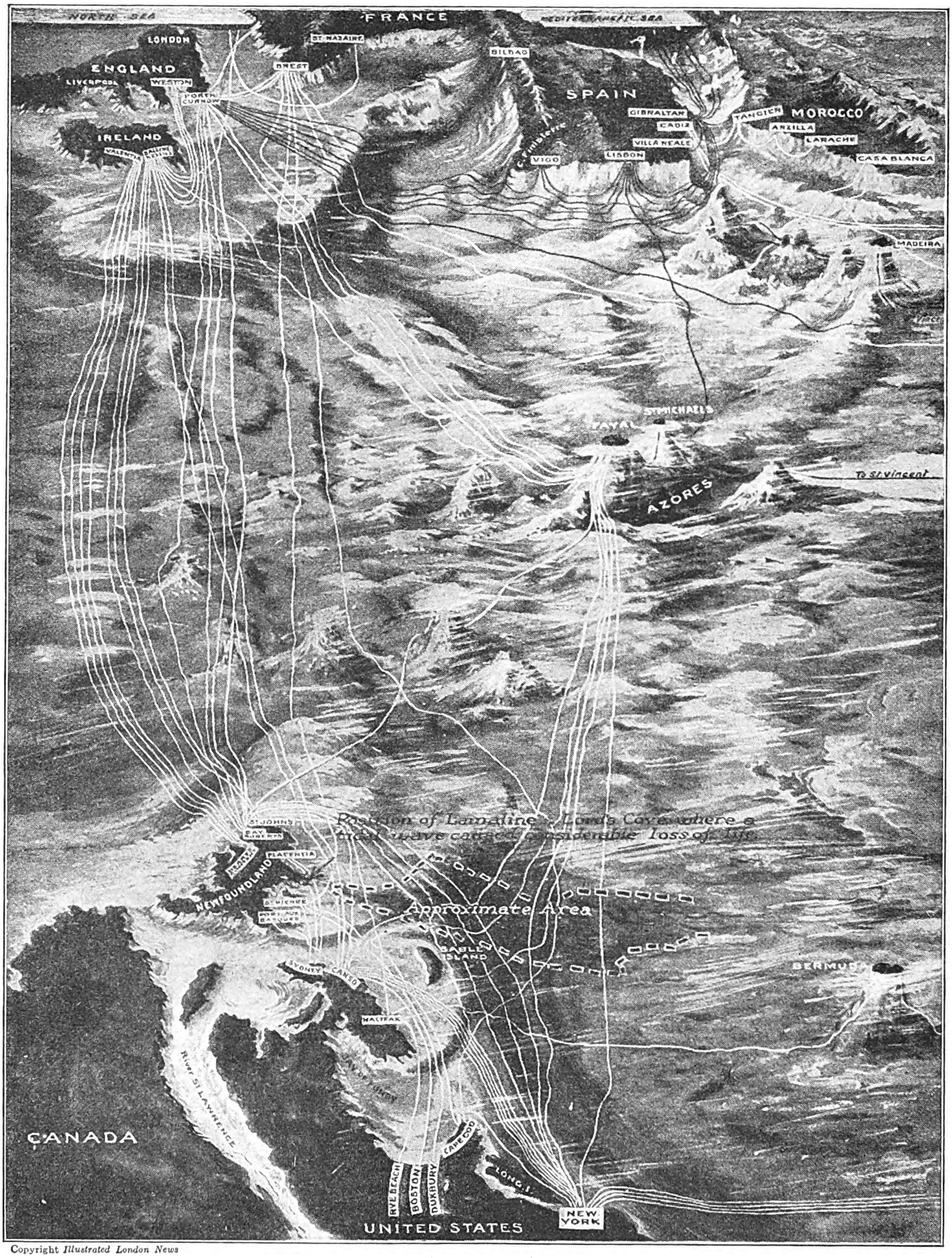
Atomizer—By which a thorough atomizing and intimate mixing of liquid fuels, such as crude oil or other hydrocarbons, and air will be effected, and ejected at a high velocity thereby obtaining a highly combustible mixture. Patent 1733413. Oscar Kay.

Combination Bailer, Dump and Pump—Characterized by features of construction and operation by which the device may be readily converted to adapt it for carrying out bailing, dumping and pumping operations in sinking well holes. Patent 1733837. Harry J. Steinberger and Harr A. Miller.

Stock-Feeding Means—For machines effecting dual operations upon stock, the stock being fed to one part of the machine, operated upon, and then returned to another part of the machine for a subsequent operation. Patent 1734868. David E. Milne.

Prince Louis-Victor De Broglie

TO Louis-Victor de Broglie, brilliant French physicist, younger brother of the X-ray physicist Duc Maurice de Broglie, is due the credit for first suggesting the new concept of the wave atom. Since his first publication of this revolutionary concept, it has been widely and frequently discussed throughout the world of science. Other capable workers, notably Schrödinger of Germany, G. P. Thomson of Scotland, (temporarily lecturer at Cornell University), Rupp of Germany, and Davisson and Germer of America, have taken it up and extended it until there is now a large literature, mostly abstruse, about the wave atom. For his original suggestion de Broglie has just been awarded the 1929 Nobel Physics Prize. What de Broglie did was to synthesize brilliantly some of the main concepts of physics which previously seemed contradictory. His hypothesis, as stated by the American physicist Heyl, "was that every mass-particle was enveloped and surrounded by a group of waves traveling with the particle as a sort of body-guard." Thus electrons, the fundamental basis of matter, have some of the qualities of particles and some of the qualities of light; matter becomes more shadowy, less material, and light more material, suggesting a kind of "merger" of previous concepts. The scientist de Broglie is also a nobleman. He was born in 1892. His great grandfather served in the War of the American Revolution as Gen. Lafayette's chief lieutenant.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SPAIN
C. Finisterre
VIGO
LISBON
GIBRALTAR
CADIZ
VILLA REALE
TANGIER
MOROCCO
ANZILLA
LARACHE
CASA BLANCA
MADEIRA
ST. MICHAELS
FAYAL
AZORES
To St. Vincent
ST. JOHNS
BAY ROBERTS
PLACENTIA
NEWFOUNDLAND
ST. PIERRE
PORT AUX BASQUES
Position of Lamaline & Lord's Cove where a tidal wave caused considerable loss of life.
Approximate Area
SABLE ISLAND
SYDNEY
CANSO
HALIFAX
BERMUDA
River St. Lawrence
CANADA
RYE BEACH
BOSTON
DUXBURY
CAPE COD
LONG I.
NEW YORK
UNITED STATES

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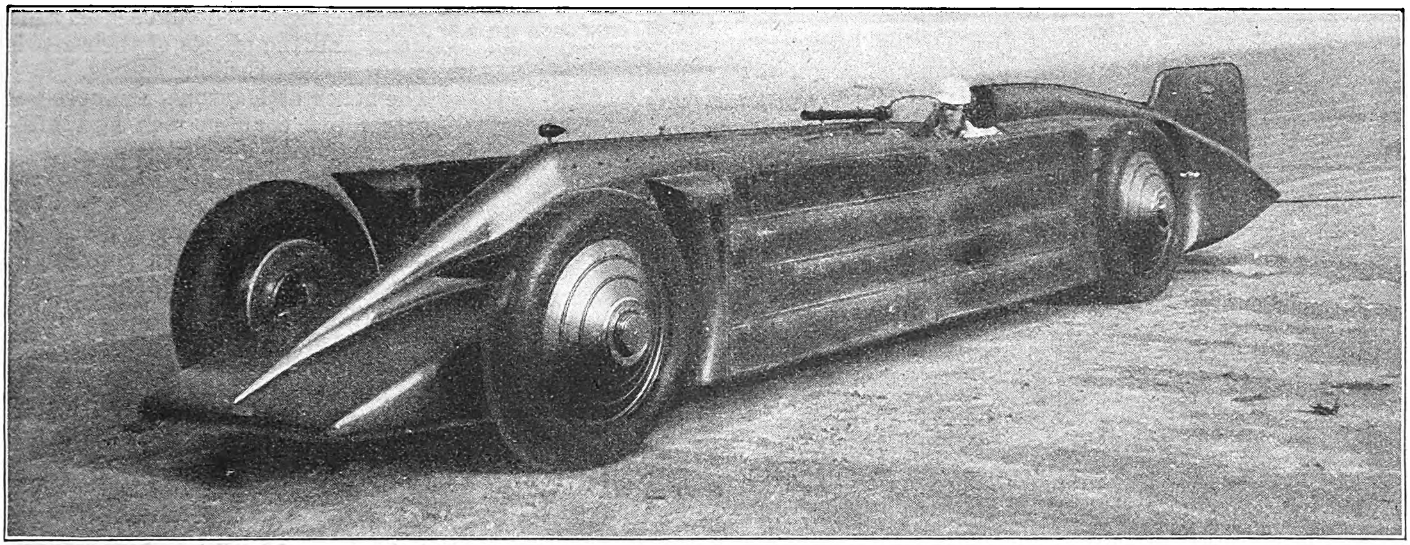
Submarine Cables and Area of Recent Earthquake

NEWSPAPER readers who were justly not satisfied with current, hasty explanations of the Newfoundland submarine earthquake will take interest in accurate data, necessarily delayed but dependable, communicated to the British scientific journal *Nature* by the noted Scottish geologist J. W. Gregory. The cable companies located 23 breaks in 11 cables. Plotting these accurately on a map, Professor Gregory saw that they were not haphazard but occurred in two north and south rows averaging 115 miles apart. New soundings between these rows showed that the sea bed had there actually dropped as much as 1710 feet, creating a great submarine trough. This is a new extension of the trough already existing between Newfoundland and Canada. Doubtless the rows of cable breaks mark two geologic subsidence faults.



PRESENT HOLDER OF THE WORLD'S SPEED RECORD

Designed and constructed abroad for the purpose of establishing a new world's record on the beach at Daytona, Florida, the *Golden Arrow* fulfilled its mission by raising the recognized speed record to 231 miles an hour. Sir Henry Segrave is shown in his famous car

400 Miles an Hour?

Far Greater Speeds Than Any Yet Achieved on Land Are Predicted by Sir Henry Segrave

By G. H. DACY

AUTOMOTIVE racing cars which will travel so fast that the human eye will be unable to record their passage are mechanical eventualities — speedsters on land which will outrival the swiftest aircraft that have been designed for cruising among the clouds.

That, at least, is the prediction of Sir Henry Segrave, owner and driver of the world's fleetest automobile, the spectacular *Golden Arrow* which was powered to attain a maximum speed of four miles a minute and which was timed at Daytona Beach at the unparalleled velocity of 231 miles an hour.

"What limit automotive speed?" was the question which the writer put to Major Segrave during a recent interview.

"THERE is practically no limit to the motor racing speeds which will be attained eventually," he replied, "provided that suitable speedways are available."

"Five hundred miles an hour?"

"That would make an astonishing lead for your story, now wouldn't it," Sir Henry countered, " 'Segrave says speed of 500 miles an hour possible.' I will not, however, qualify my statement by stipulating any limit to the future motor racing speeds. I am sure that the existing records are far below the marks which will be registered in the years to come."

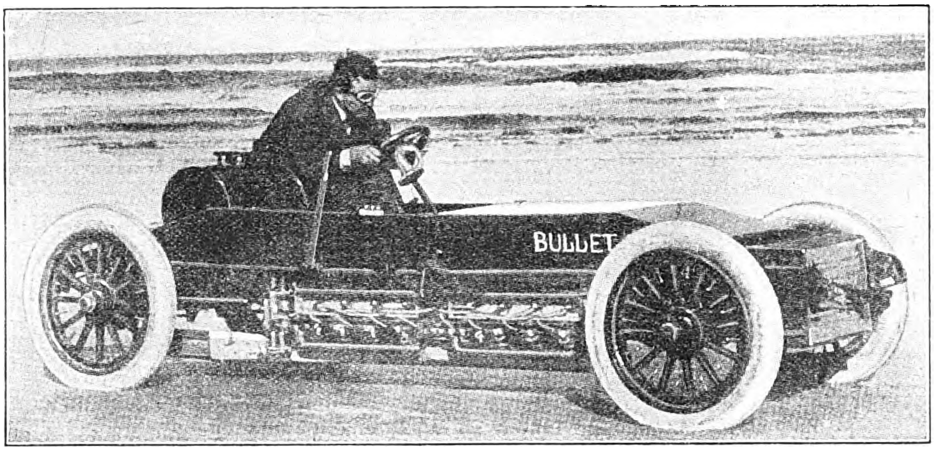
"Master all phases of aerodynamic resistance," continued the former Ace, "as this is the salient factor which must be conquered in the consummation of thrilling flights in automotive vehicles on land, and our racing records will get better and better year by year. Improving the mechanics of motor cars for the attainment of ever-increasing speeds is easily possible. Even today, experimenters are able to build automotive power plants which will develop such amazing speeds that there are no speedways safe for the testing of such machines at peak velocities. We can now build machinery qualified to turn at more revolutions per minute than such mechanical parts ever moved previously.

"Among other problems which must be solved before future cars are perfected and raced, at speeds faster than the velocity of the most devastating hurricane, are those which may appear to be insurmountable but which can be answered if enough technical research and money are devoted to such purposes. One need is the provision of either a natural or artificial speedway which will permit of time-trials at speeds of five miles a minute and faster. Such a course must be both smooth and compact. Daytona Beach, for example, would have to be lenthened considerably and measurably improved for such amazing trials against time. Car design must be improved so that air resistance is reduced to the minimum. Tires, either of rubber or some better material, will have to be constructed which will resist the disruptive action and tremendous heat of terrific speeds."

SIR HENRY SEGRAVE

To most of us who drive automobiles, and feel as though we are flying when we travel at the rate of a mile a minute, the predictions of the famous English aviator and sportsman sound almost incredible. Yet a review of the records in racing automobiles against time from the dawn of the sport in this country up to the writing of this article endorses Sir Henry's presages. Scan the ever-mounting records at Daytona Beach, the Indianapolis Speedway, and other national and international rendezvous of racing if you doubt this.

A certain W. J. Morgan, who chaperoned the first American bicycle racing team to Europe, is really the father of automotive time-trials in these United States. Mr. Morgan gained the cooperative aid of W. K. Vanderbilt, A. F. Vanderbilt, Howard Gould, and John Jacob Astor and introduced motor racing at Ormond and Daytona Beaches, Florida. The historic Vanderbilt cup races were a



ESTABLISHING A RECORD IN 1903

Alec Winton driving the *Bullet* at the record speed of 69.18 miles per hour. This achievement, made at Daytona Beach in 1903, stimulated great interest in automobile racing

result of those early efforts to establish record speeds on "cushions of air."

Henry Ford, who was then an ambitious mechanic endowed with meager financial assets but aflame with the automobile racing urge, eventually came to Ormond with his homespun racer, notable *999*. Mr. Ford had expended most of his funds in the building and equipping of his "gasoline chariot." He was unknown in motoring circles. It was with great difficulty that he procured on credit fuel, oil, and other supplies for his racing machine. He never established any remarkable records at Daytona Beach although the story goes that in one of his speed trials, Mr. Ford equaled the one-mile time record of 39 seconds made in 1904 by Alfred Vanderbilt driving a Mercedes—a velocity equivalent to 91.8 miles an hour. In this feat, the body of *999* failed and Mr. Ford was forced temporarily from the racing game.

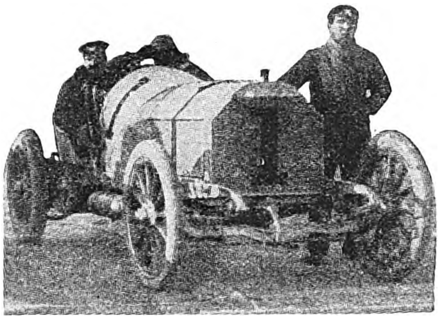
VICTOR DEMOGOET, a French driver of a Deracq car, two years later increased the Daytona speed mark to two miles a minute by covering that distance in 58 4-5 seconds. Several years later, Frank Mariott piloted his Stanley Steamer over the same course at the gait of one mile in 28 1-5 seconds.

"Speed, speed, and more speed," was the demand of the rapidly developing automobile industry. Cars were shipped from all parts of America and Europe to the Florida beaches where drivers dared death in exciting efforts to shave fractions of a second from time marks. Some of the pilots risked their lives in pre-sunrise races against time. Roaring, gas-actuated vehicles of wood and steel hurtled through space, challenging the wind's maximum velocity and the efforts of their rivals to surpass their thrilling speeds.

The beach at Daytona, composed of disintegrated coquina rock and ordinary sand, wave-rolled and water-packed, defies duplication as a natural motorway. It is so compact when the tide is out that race horses develop pavement soreness when run there. Early attempts to popularize horse-racing on that beach failed because all the equine sprinters soon became crippled due to the hard track. Rubber tires have absorbed the concussions which wrecked four-legged horsepower and as a result the endless story of speed conquests is being written in serial form.

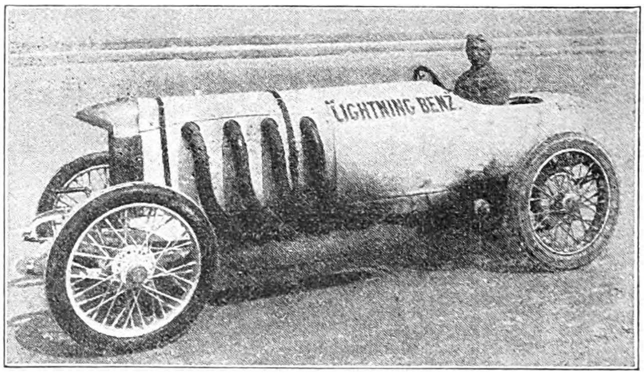
Ralph De Palma piloting a Packard in 1919 drove 10 miles in four minutes 9.31 seconds and subsequently lowered the mile mark from a standing start to 38.8 seconds. The following year, Tommy Milton driving a Duesenberg did even better by negotiating one mile in 23.07 seconds, five miles in two minutes 0.4 seconds, and one half a mile in 11.57 seconds. Milton's fastest speed was at the rate of 156.4 miles an hour. Subsequently, Joan Lacoste, a venturesome woman driver, drove a Miller at a gait of 144.65 miles per hour which still stands as the speed record established by her sex.

It was Sig Haugdahl crouched low at the wheel of his *Wisconsin Special* who ushered in the new era of speed at Daytona Beach. Haugdahl was timed in 1922 by officials of the International Motor Contest Association at the then almost unbelievable speed of 180.27 miles per hour, slightly better than



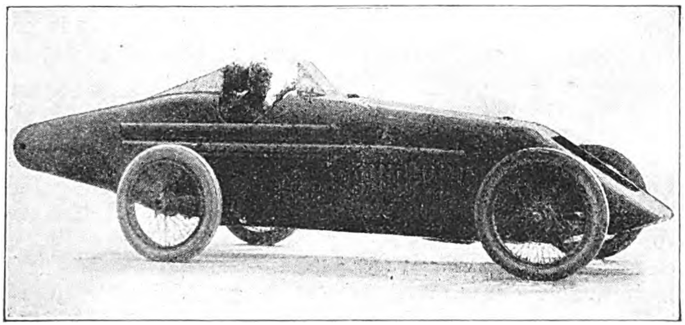
AN EARLY MERCEDES

With this car, Alfred K. Vanderbilt established a new record in 1904, by traveling a mile in only 39 seconds



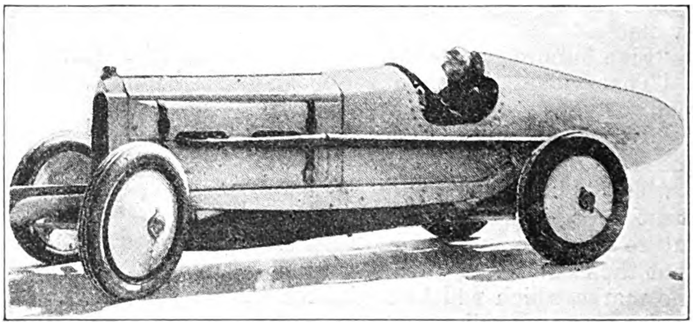
BARNEY OLDFIELD

Driving *Lightning Benz* in a competitive race with Alfred K. Vanderbilt, the famous Barney Oldfield won one of the first of his many racing victories



TOMMY MILTON IN A DUESENBERG

In 1919, Tommy Milton introduced a new era of speed, when he drove this Duesenberg 156.4 miles per hour on Daytona Beach



RALPH DE PALMA DRIVING A PACKARD

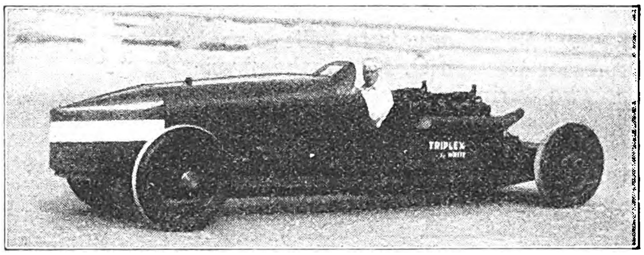
New records for various distances ranging from five to 20 miles were made in 1920 by Ralph de Palma, driving this Packard three miles a minute. A lull in racing records occurred until Major Segrave first visited Daytona Beach with his *Sunbeam Special.* A few days later, the former British birdman raced against electric timers at a speed of 203.79 miles per hour. He was the pathfinder among modern motorists who drive at velocities three times faster than express trains.

Then followed another Englishman, Captain Malcolm Campbell, winner of the Paris Grand Prix motor race over a cross-county course of 276 miles. Captain Campbell, seeking the crown worn by his countryman, unloaded his *Bluebird-Special,* tried out the course and shortly shattered the record by covering a carefully measured one-mile stretch at the terrific pace of 206.95 miles an hour. Shortly afterward, Ray Keech driving the White *Triplex* increased the time trial mark to 207.55 miles an hour. During one of these trials, the tachometer in the White car showed that the machine was traveling at a velocity of 253 miles an hour. Over the same course, Frank Lockhart drove to his death. Officials estimated his speed at 235 miles an hour when his tires exploded and the car dove 15 feet into the air and 50 feet out to sea.

TIMING DEVICE

Speed trials on the beach at Daytona are clocked with this electrical timer

During the 25 years from the Alfred Vanderbilt record of 91.8 miles an hour to the acceptance of Sir Henry Segrave's mark of 231 miles an hour, the speed of the finest racing automobile has been increased 139.2 miles an hour. If this achievement is duplicated during the next quarter century, it will mean that the champion racing driver of 1954 will set a record of at least 370.2 miles an hour, better than six miles a minute. Sir Henry, who knows more about the design, operation and, driving of high-speed motor cars—both from theoretical and practical standpoints—than any other living driver, believes that a speed of approximately 400 miles or faster will be a reality within perhaps the next decade.



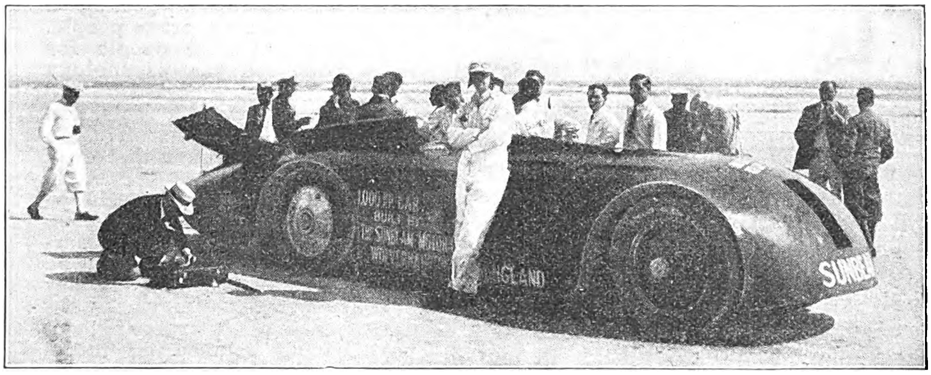
THE TRIPLEX

This ill-fated racer once placed the world's speed record at 207.55 miles an hour, with Ray Keech driving

SIR HENRY SEGRAVE maintains that with the eventual building of superhighways in the United States, and with future perfections of the ordinary motor car, American motorists will travel at speeds of from 100 to 150 miles an hour during their cross-country tours with as great safety as they now journey at 45 miles an hour. He says that at present there are ten makes of cars built in England which can do 100 miles an hour or better on present tracks and the finest roadways.

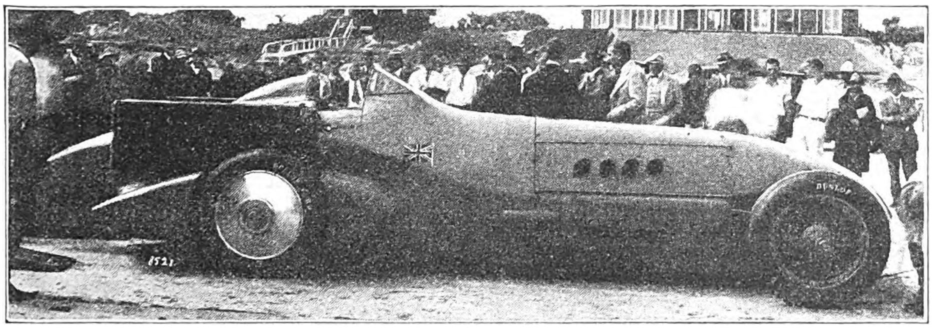
The motive power for potential passenger cars which in many respects will resemble the famous *Golden Arrow* is merely a matter of mathematics and is the easiest problem of all to solve in speeding up America's traffic streams. Both state and federal agencies have reacted favorably during recent months to higher speeds in the open country. California, for example, has abolished speed laws and leaves it to the individual driver to determine what speed is safe for his car and associated traffic. Research is ascertaining what special hazards are to be avoided at great vehicular speeds and thus is eliminating the dangers from future cross-country velocities of more than 100 miles an hour.

Sir Henry says that many improvements still remain to be made with regard to the aerodynamics of racing automobiles, as well as those of the passenger cars which eventually will be designed along similar lines. The future will see a much lighter-powered machine surpass the record of the *Golden Arrow* simply because experimenters will improve its aerodynamical features. Even today, the research experts of the National Advisory Committee on Aeronautics are experimenting in the wind tunnels at their Langley Field (Virginia) laboratories with velocities up to 1000 miles an hour. Their remarkable tests indicate future airplane and automobile speeds from three to five times greater than those which now prevail.



SEGRAVE'S *SUNBEAM*

For his first American tests, Segrave used the *Sunbeam,* shown at the right



CAPTAIN CAMPBELL'S *BLUEBIRD*, FORMER RECORD HOLDER

For a short time, this English car held the world's speed record, at 206.95 miles per hour

With the inevitable advances in road construction and in the mechanical perfection of automobiles, who can say what the harvest in the way of new speed records will be in the next quarter century?

OUR POINT OF VIEW

Science Awaits

WHETHER or not the general reading public is to believe that Professor Dayton C. Miller, the physicist who during several years past has been re-performing at Cleveland and Mount Wilson the famous Michelson-Morley ether-drift experiment and obtaining with uniform consistency indications of an actual ether drift and hence the existence of an ether, is out to "get" the Einstein theory of relativity which dispenses with an ether, seems to depend upon what it reads. If one could safely depend upon all he saw in the newspapers, and especially in newspaper headlines, Miller, driven by some animus, had about succeeded at last in hamstringing Einstein.

Quite a large section of the public has apparently become somewhat "steamed up" about these things and the Einstein—anti-Einstein battle has again taken on new life. We can think of no corner of science which seems to stir up as much high-pitched emotion as the Einstein theory. People for the most part are all for it or all against it; there is no middle course. It would seem that the most redoubtable defenders of the Einstein concepts come not from the ranks of the professional scientists but from the lay public; and likewise its most bitter and tenacious opponents.

One who goes habitually among professional scientists will not, however, meet with a comparable temper. There, instead of taking the matter in high gear, there is a marked disposition to take it in low. Perhaps scientists, or at least physicists and astronomers, the scientists most closely involved, realize a little more fully than others that the Einstein theory will not be settled finally one way or the other either by the research of any one man or two men, or even ten; or in one year, or two years, or ten years. Instead, a long slow pull is ahead and these men propose to take it in low gear. Animus, prejudice, personal feeling and, in short, any kind of emotion whatever is wholly contrary to the method of science. Let the layman if he wishes become overwrought about the reasonableness or unreasonableness, the demonstrability or sheer ridiculousness of bent space and similarly bizarre Einsteinian concepts; a good scientist will divest himself as completely as a Supreme Court Justice of every shred of such impediment.

Of all scientists there are two who give perhaps more clearly than any others the impression of living up to the scientific ideal—the search for truth unprejudiced—and these are Einstein and Miller. Let a world of blind admirers and enraged detesters of a theory beat the air with superheated syllables, Einstein serenely smokes his pipe and says "If Professor Miller's research is confirmed, my theory falls, that's all." And Miller, standing before his assembled peers in science, is almost apologetic about his findings but indicates that there they are. He has followed the lead of experiment, the only lead worth following. No wonder he receives a hearty handclasp from all men of science.

Rioting for Science

SINCE the world-famed trial of a Tennessee professor several years ago for teaching the theory of evolution, science has made great forward strides both in achievement and in the amount of serious interest it has aroused. But no one was surprised more than the scientists themselves at the scene enacted recently in the American Museum of Natural History, New York City, when a mob of 3500 to 4500 men, women, and children attempted to gain admission to a small hall in which was to be shown a moving picture concerning Einstein's theory of relativity.

Surging and seething around exhibits of the Alaskan Eskimo and the North Pacific Indian —canoes, totem poles, walrus tusk ornaments, kyaks — the swarming knowledge seekers were oblivious to these exhibits of which they already were informed and pressed on toward their objective — the higher knowledge of modern scientific theory. Theirs was no apathetic interest but a determination to learn. And while their rioting was undignified, perhaps, the mere fact that they did riot indicates that the popularization of science is now getting a stronger hold on average people. They *were* average people for they evidenced the psychology of the mob.

In the face of such facts, can skeptics continue to scoff? We think not. We believe that even the hard-shelled ones will begin to see the light, will begin to understand that despite dogma, superstition, and in-bred tradition, the appetite for scientific knowledge is becoming keener every day. SCIENTIFIC AMERICAN'S task of interpreting and popularizing science is, therefore, far from hopeless—except, of course, in the case of Voliva, dictator of Zion City, Illinois. We never hope to prove to his satisfaction that the earth is a sphere—but then, who wants to argue with him or his kind!

For misleading the public about the Einstein theory, first with regard to its alleged full acceptance by scientists and then with its alleged disproof by Miller, the popular writer is mainly to blame, for he too frequently presents snap judgments and half truths. Science itself takes neither course; it awaits. That is why this journal has published so little about the Einstein theory in recent years.

Bad Bargains

IN parts of the country where spring comes early, farmers and home gardeners are already buying seeds and doing their planting. In other sections, many thousands of people are poring over seed catalogs, fascinated by the size and colors of the fruits, flowers, and vegetables depicted there in all their glory.

Most of these people are experienced. For some of them, farming or gardening is a life work but for a lot of others these jobs constitute an avocation or a method of obtaining recreation and exercise. Yet despite their experience, many planters buy their seeds according to price. They are warned year after year to buy the very best seeds available and are reminded that cut prices indicate inferior seeds, the purchase of which is the poorest sort of economy. And yet many catalogs replete with alluring promises and splashes of color are published every year by unscrupulous dealers and have a wide circulation.

Therefore, for your own best interests, heed the perennial warning: "Don't buy bargain seeds!"

Increasing Game

A FEW years ago it was feared that the American buffalo, or bison, was doomed to extinction. Then the government took a hand and protected the few remaining specimens, with the result that herds are rapidly growing. Now comes the good news in an announcement of the Forest Service that large game animals, indigenous to America, are also showing an increase in numbers. To most people the figures, based on very careful estimates, will be surprising.

On December 31, 1928—the latest estimate available—deer on the broad expanses of our National Forests had shown an increase over the preceding year of 47,400, making a total of 748,000; elk increased from 74,200 to 78,-

200; and antelope from 7700 to 8500. On the date of estimate, black or brown bears totalled 52,200; grizzlies (including the Alaskan brown bear) totalled 3400; mountain goats, 19,300; and mountain sheep, 13,800.

These game animals have not been press-agented as much as our buffalo, to which a great deal of sentiment has been attached due to the important part it played in our history, but they are valuable nevertheless and certainly worth all the effort expended in their behalf. It is to the credit of the Forest Service, therefore, that it has undertaken to increase the supply of game animals—even to the extent of "planting" them in sections where they have been exterminated. And if it can devise means of increasing the number of moose, caribou, and mountain goats—the three important species which are hardly holding their own—the Forest Service will win the thanks not only of naturalists, nature lovers, and big game hunters but also of those sentimentalists who have a predilection for all early American things.

Our Limitation Conference Delegates

THE difficulties confronting the delegates attending the Conference on the Limitation of Naval Armament in session at London, are obvious to the most casual observer. It is never easy to reconcile the naturally ambitious aspirations of first-rate powers. The rôle of an envoy is always an unhappy one; if he abates too much of his country's claim he is assailed as unpatriotic; if he is too chauvinistic he prevents an international accord.

Our country has no traditional enemy or unsatisfied ambition. It is financially able to indulge in competitive naval building if that becomes necessary, but prefers to concentrate its energies in peaceful pursuits and well knows that its real interests will be furthered by an era of world peace. Nevertheless, the international situation is so complicated by the relations existing between other states, and Europe has such a heritage of conflicting ambitions, that our delegation will be taxed to find an agreement, satisfactory to all the powers, that will still safeguard our own legitimate interests.

Mr. Hoover has from the first been aware of these difficulties; his years abroad familiarized him with the unending struggle for foreign markets, scarcely suspected in some parts of our country; he knows that a desire for peace will not of itself keep a country out of war, and what he saw in Belgium under German control will not incline him to expose his country ever so remotely to such horrors. He has stated that he will not attempt to lead the world to disarmament by solitary example.

To confront and assist in overcoming these difficulties, Mr. Hoover has selected an extraordinarily strong delegation of civilians and has supplied them with able naval advisers. During the World War three of the civilian members—Mr. Stimson, Mr. Dawes, and Senator Reed—served in France in the American Expeditionary Force; Mr. Gibson served in the American Embassy at Paris; Mr. Morrow served on the Allied Maritime Transport Council. The presence of Senator Reed and Senator Robinson insures the Senate complete information on the proceedings, and the participation by Secretary Adams assures the country that the efficiency of the Department assigned to his care will not be unduly sacrificed. The following brief sketches of the personnel of the American delegation emphasize the careful selection exercised by our President, and we feel sure all Americans will wish them well in their efforts to find a proper solution to an ancient problem.

The Barjot Plan and a Greater North

TO the engineer and the practical man the Barjot power project described on page 196 will be seen to resolve itself directly into a question of economics and engineering installation. Its purely theoretical or scientific side is sound, being based on simple elementary physical laws; it takes advantage of a temperature difference. This, also, is the essence of a steam plant; heat is energy. In the Barjot scheme, however, the temperature difference is relatively small, but the volume of the "fuel" available is sufficient to compensate for it—far more than sufficient, in fact.

To some readers the apparent lowness or coldness of both of the temperatures involved in Dr. Barjot's plan, the low and the high, may seem to be an obstacle. It must, however, be remembered that the coldest arctic temperatures are not in actual fact low. What we human beings commonly think of as "low" and "high" temperatures have no such significance in science; they are merely relative to our own immediate criterion of hot and cold, the reports of our senses. Zero on our Fahrenheit scale is actually 459 degrees above zero on the absolute scale of temperature—two thirds of the way to the boiling point of water—and that is the only scale which has inherent sanction in fact. The rest are arbitrary; and misleading, also.

The Barjot plan bears close resemblance to the well known Claude-Boucherot plan for making use of the temperature difference between tropical sea water at the surface (80 degrees) and at the bottom (40 degrees). Both are fundamentally based on taking advantage of a temperature difference. Extensive application of the Claude-Boucherot plan would spread the industrial world from the temperate zones, where it is now centralized, to the tropics; the Barjot plan would spread it far toward the Arctic. In this connection one will recall the writings of the arctic explorer Stefansson, in which he has so often emphasized that the north will some day cease to be regarded as a vast arctic waste and become the object of a very active exploitation. Canadians should be especially interested in Dr. Barjot's article.

Mr. H. L. Stimson, the head of the American delegation, a New Yorker by birth, a graduate of Yale College and Harvard Law School, was a law partner of Elihu Root and, like him, served as Secretary of War before serving as Secretary of State. During the World War he served in France in the Field Artillery and earned his promotion to Colonel of the 31st Field Artillery in the field. He succeeded Leonard Wood as Governor General of the Philippines and carried on his work of rehabilitating the Philippine Government. Although a strong executive and frequently in conflict with Filipino politicians, Mr. Stimson quickly gained the confidence of the Filipino people and on his departure from Manila to become Secretary of State he was given a farewell ovation by the inhabitants of Manila.

Mr. Stimson belongs to that group of eastern Republicans most favorable to our entry into the World Court. There can be no doubt of Mr. Stimson's abilities to present America's just claims to parity; he is too wise to be imposed upon, and although this is his first large undertaking as Secretary of State, we venture the prophecy he will not let his natural desire to return home with an agreement lead him to make concessions that will be unacceptable to the Senate or the country.

Mr. Charles G. Dawes comes from the Middle West that boldly claims it represents the heart of America; he graduated in law only to become a successful banker and business man. He served on Pershing's staff during the World War and, as a member of the Liquidation Committee of the A. E. F., closed out the vast mass of unfinished business between the United States and France in one big bargain with the French in 1919. It was his spirited defense of the work of this committee before an investigating committee of Congress, that brought him nation-wide attention and added "Helenmaria" to the American vocabulary. He organized the Office of the Budget for President Harding, but soon turned over the job to General Lord and returned to his business.

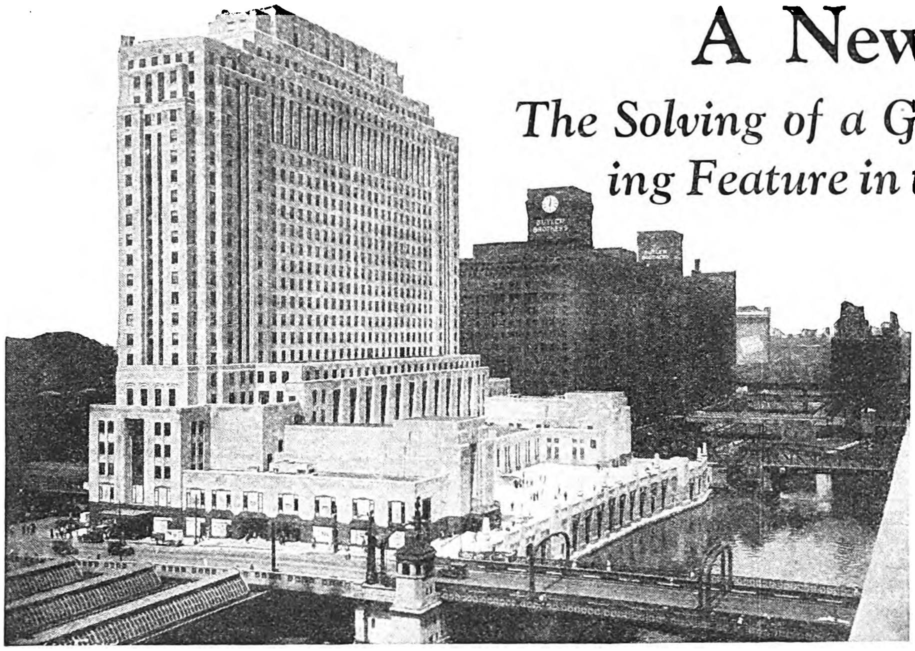
But for his loyalty to Governor Lowden, he would have been a more formidable candidate for the Republican nomination for the Presidency in

(*Please turn to page* 246)

A Newspaper in the

The Solving of a Great Railroad's Smoke ing Feature in the Creation of a Huge

By ALBERT A. HOPKINS



THE MONUMENTAL BUILDING

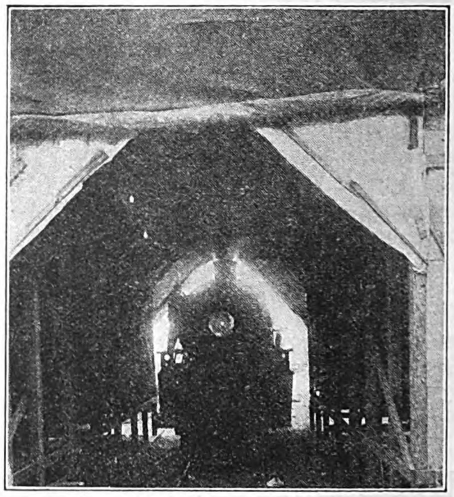
This huge building is built astride railroad terminal tracks. The smoke from the track area passes through vents into smoke chambers and is carried up a great internal chimney

CHICAGO needed to expand. That iron bound "Loop" held the business quarter in a vise. There was congestion and lack of space for growing industries. The freight tunnel helped to relieve the situation, but something more had to be done to give relief. What did Chicago do? They turned to their river, which was heretofore a hopeless nuisance upon which the city's back must be turned, and they found that it had other uses than as a receptacle for wastes and as a means of transportation of freight. The Wacker Drive development and the new Marshall Field Building on the main branch of the river, and the Union Station, the Civic Opera, and The Daily News buildings on the south branch all testify to the growing realization that the river is a civic asset of primary esthetic importance.

THE completion of the Daily News Building above the tracks of the Union Station group of roads and the rapid progress of work upon the Merchandise Mart above the Chicago & Northwestern tracks should serve to give a concrete object lesson relative to the hundreds of millions of dollars of value and income which railroad officials could produce for their stockholders by prompt action in making possible air-rights development above their terminal tracks. But what about the smoke? There did not seem to be much chance of electrification in the Chicago region, so this question became a very vital one.

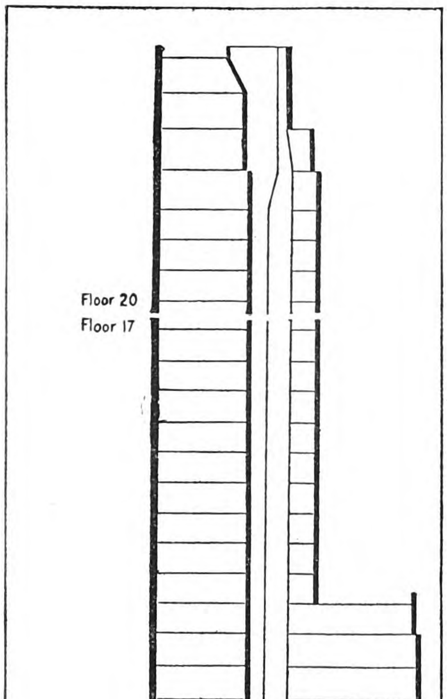
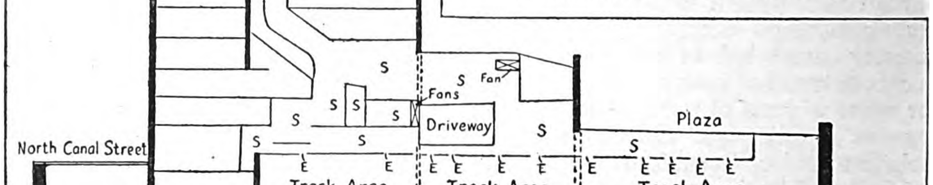
The smoke problem was attacked and solved in an interesting manner by Mr. Joshua D'Esposito, a consulting engineer. Today the Daily News Building is an accomplished fact, but only because of a new departure in the handling of smoke and gas discharges from locomotives. One admires the symmetry of the beautiful building but does not realize that hidden away from general view are certain chambers, passageways, and stacks which are the agencies of the smoke control system. The construction engineers understood the value of air-rights, New York furnishing an excellent example, but there the smoke problem has been solved by electrification. Smoke-handling tests in Chicago began early in 1917 in a temporary shack in the coach yard of the Pennsylvania Railroad. The experiments involved great labor and cost much money, but they were successful in the end.

An expansion chamber was constructed above the vents in the test shack. The engineers found a valuable fact in that the smoke in the chamber expanded. Expansion decreased its density, made it practically as light as air, and consequently added a safeguard against its dropping through the entrance passageways. The system was entirely successful. The Daily News Building was accordingly built directly over the tracks and the locomotives belch smoke and gas freely. These waste products pass through vents in the roof to the roomy



THE EXPERIMENTAL SHACK

Smoke is being discharged into chambers in a shack where the problem was solved

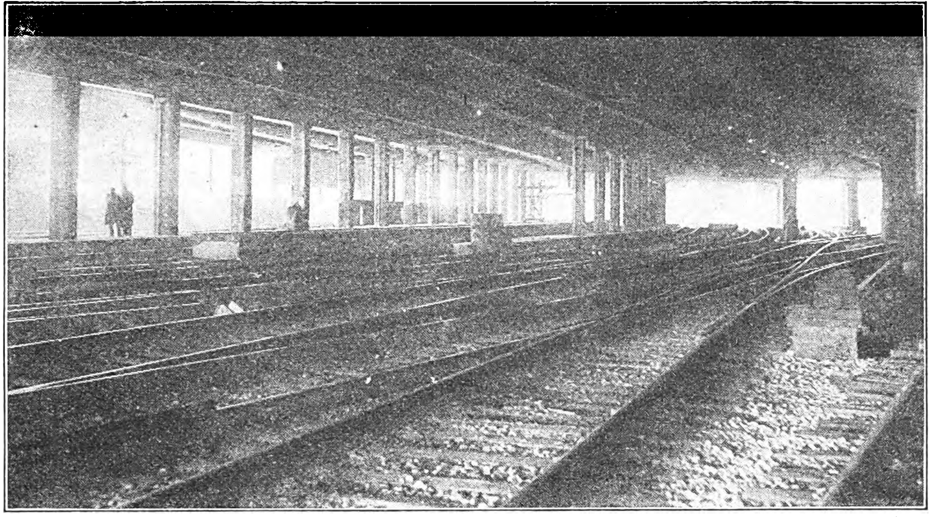



ELIMINATING THE SMOKE

The smoke is drawn from the expansion chambers into a smokestack that mounts through the 25 stories to the open air. The great bulk of the solids is stopped in smoke chambers

Making

Problem Was a Strik- Newspaper Plant



MAKING AIR-RIGHTS POSSIBLE

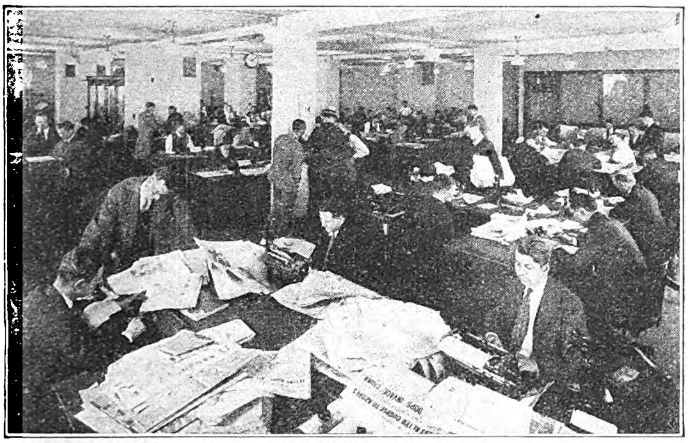
The Chicago Daily News Plaza viewed from below. The grooves in the ceiling are the smoke vents which allow the smoke from the C. M. & St. P. engines to pass into the numerous smoke chambers directly over the track area, an excellent utilization of air-rights

smoke chamber which is as wide and as long as the track area. To be precise, this chamber consists of several divisions, as partitions have been built in it. The smoke is drawn from the expansion rooms into smokestacks that mount, through the 25 stories of the building, to the open air. The great bulk of the solids in the smoke are stopped and remain in the smoke chamber, to be removed later. Smoke emitted 25 stories up is as nothing compared with the same smoke emitted at or near street levels.

We need say little of the architecture of the building itself; it really has to be seen to be appreciated. It is one of the finest buildings in America and directly across the river and facing it is the new Civic Opera House illustrated in our February issue. The plaza, the bridge, the clocktower are all beautiful features. A fleet of speed boats take the visitor or the commuter via the river to the Wrigley Building on Michigan Boulevard in a few minutes.

The *Chicago Daily News* is one of America's great dailies, and while visiting the building the writer was so struck with the newness and efficiency of the great plant that it was determined to make the latter part of this article a brief description of the work involved in turning out a newspaper.

The *Chicago Daily News* was built up by Melville E. Stone and Vincent F. Lawson. Mr. Stone was for many years manager of the Associated Press and with Mr. Lawson as president they helped to develop this great co-operative news gathering and distributing agency. A newspaper has been well defined as an organism with a synthetic soul. While habitually giving reliable information in the fullest measure, it must endeavor consistently to teach a sound philosophy of life. It must be fair, avoiding prejudice and prejudicial practices. In the broadest sense it must be a force on the side of human progress. The *Chicago Daily News* has always held public confidence. This is probably the reason why it has such a splendid building.

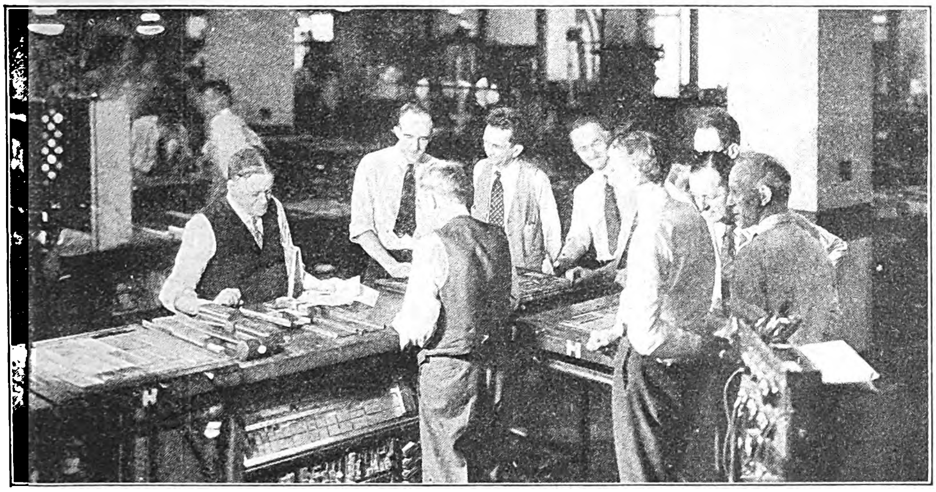


THE NEWSROOM AT WORK

In the foreground are the rewrite men. The city desk is shown at the right center and in the background are still other desks

THE BUSY "COPY" DESK

Reports of the doings of the teeming world, received by wire and written by the reportorial staff are all edited and head lined



WAITING FOR THE LAST LINE

The markets have closed and the editors have finished their work on the "Red Streak" edition. In a few seconds the closing quotations will be in type and then to press and the street. As this is an afternoon newspaper, great speed is necessary in handling financial news

The old building at 15 North Wells Street was a ramshackle affair endeared to all those who were brought up in its atmosphere. For many years the talk of a new building had been the subject of many a joke. Site after site was considered and rejected. The

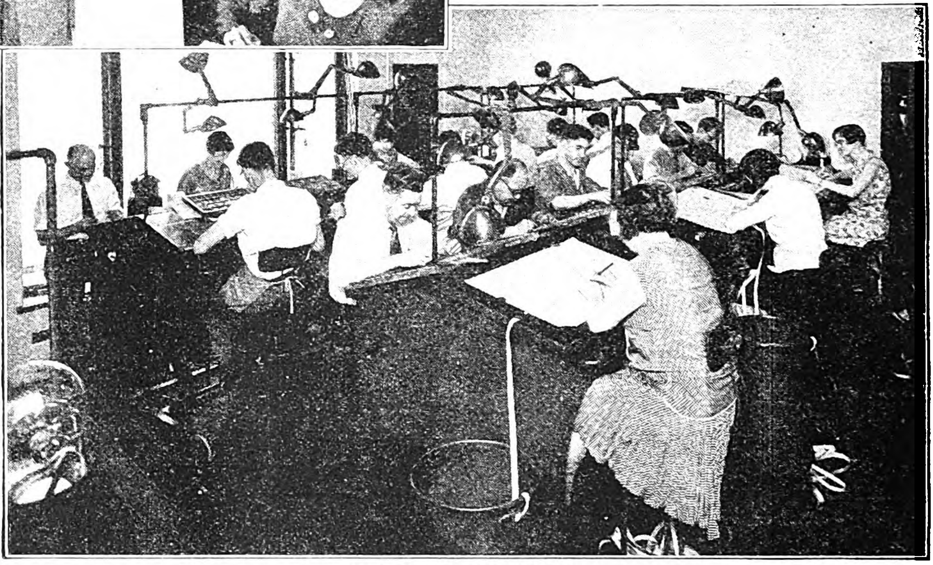
"WANT" ADS BY TELEPHONE
These alert girls take in "want" ads over the telephone for the classified advertising

development away from the "Loop," the construction of Wacker Drive, and the river straightening project all seemed to point to the necessity for a location where considerable space was available, yet one which was central enough for the receiving of news and for distribution of the printed newspapers. Therefore the site over the tracks next to the Union Station was finally selected.

A newspaper is an exceedingly complicated organization, particularly in the editorial end, and it requires great co-ordination. It will have besides the managing editor, an associate editor, news editor, art editor, editorial writer, literary editor, foreign news editor, the make-up editors, and special editors for sports, automobiles, aviation, financial, et cetera. These clever craftsmen all have their offices, but they lack the atmosphere of the newsroom, where are arranged the 45 desks of the city editor, the copy editor, telegraph and picture editors, the rewrite staff, and the reporters. A feature of the room is the specially designed copy desk which provides space for 10 copy editors and their chief. Of course there is ample telephone service as well as pneumatic tubes for routing communications. Copy boys, the descendants of the printer's devils of yore, are arranged along the north wall of the news room, where they can respond quickly to the calls of editors and reporters. Directly in front of their station is a slot in the floor through which copy is dropped to the composing room so that only a few seconds elapse from the time the copy is written until it reaches the battery of linotype machines.

The composing room is 200 feet long and 80 feet wide. Here is installed a battery of 54 latest model linotype machines, besides other composing equipment. The composing room includes an engraving department and a matrix department, to name only a few of them. The room where the market reports are compiled is the scene of a daily fight against time. The quotations are hand set by compositors receiving the dictation of girls who watch the swiftly moving tape. The entire composing room is floored with wooden blocks placed on end which rest rather than tire the feet. The ceiling is covered with soundproof material which eliminates sharp and metallic noises.

The photo-engraving department allows for speedy production of both line and half-tone cuts. The newspapers are printed from curved stereo-



THE "HI-LO" ROOM
Priceless seconds are saved by putting market quotations directly into type. The girls read aloud from the unwinding tape and the compositors set type by hand. It is a mad rush

AN EXPERT TOUCH
The foreman engraver has been putting finishing touches on plates since 1887

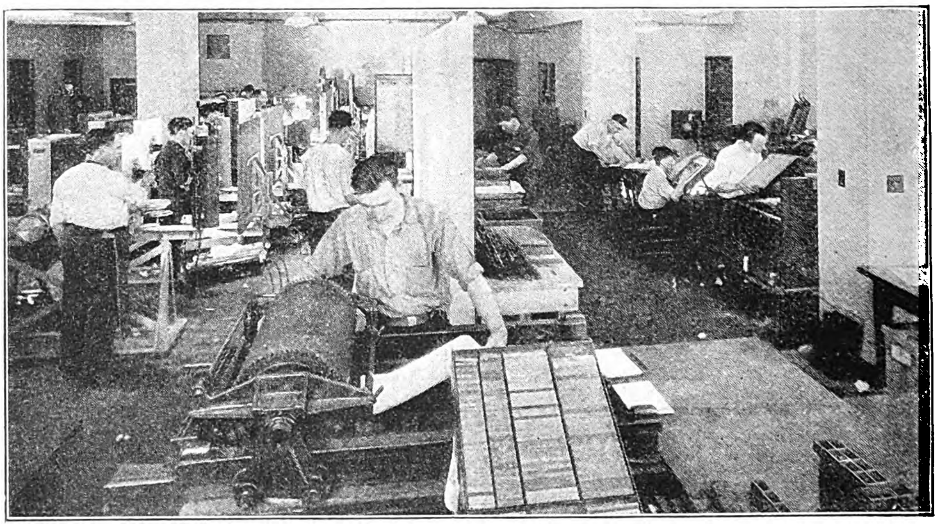
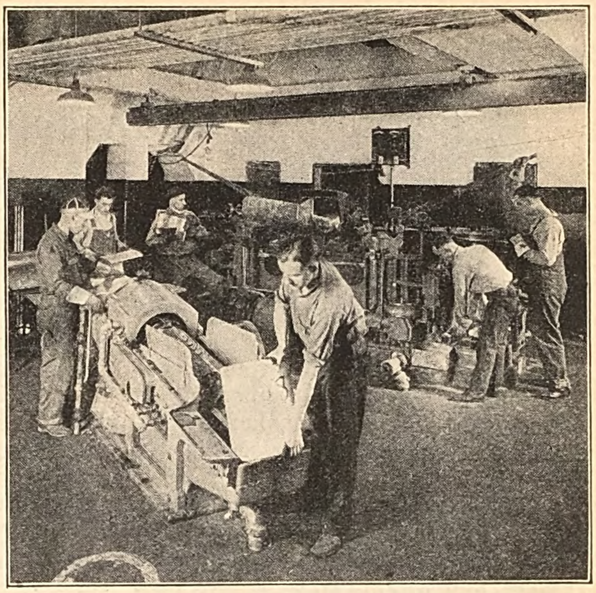


PHOTO-ENGRAVING
Photo-engravings, both line and half-tone, are important to the newspaper. Here the men are photographing, etching, and finishing. Newspaper cuts are made with incredible speed



THE STEREOTYPE FOUNDRY ➤

Here the semicircular plates for the great presses are cast in wonderful automatic machines

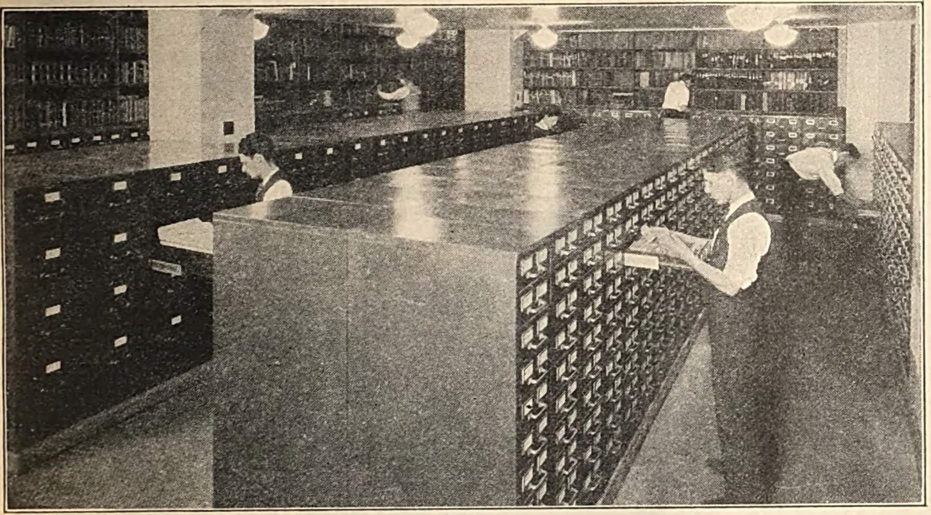
type plates which are made in the stereotype foundry. These plates go to the great presses which are of very special design. One would hardly expect any sentiment to prevail in the pressroom, but when the order for new presses was placed by the publisher, Mr. Walter A. Strong, he suggested that the old metal be used. Carrying out his wishes, R. Hoe and Company, builders of the new units, melted down the old iron castings and used the metal for the new presses and folders. The presses consist of 70 units. Each unit has a capacity of eight pages, and units may be made up in tandems of from two to 10, depending on the size of the paper to be printed. Presses are carefully insulated to avoid vibration. They are floated on a mat of cork which is laid on a concrete base and up the sides of the press pits.

A crane moves the rolls of paper from the hold of the vessel on which they are delivered and places them on a conveyor system which operates down a mammoth shaft to a point 40 feet below the surface of the river. As the paper reaches the bottom of the vertical shaft, it is rolled off on horizontal conveyors and travels under the Union Station property and the Chicago, Milwaukee & Pacific Railroad tracks until it is beneath the Daily News Building. Then it is automatically rolled off to a vertical lift where it ascends to storage space, or directly to the presses.

The paper in roll form is fastened on a roll in the press, its open end is smeared with glue, and as it is swung into place the open end flips over to the paper web going from the press and is automatically glued to it. The web from the old roll is broken and the new roll takes its place. It speeds through the press, being printed on both sides, and comes out on a folding machine where the individual papers are automatically cut apart, stacked and placed on the conveyor which brings them automatically to the binding machine which counts and binds them with wire into bundles of 25 or 50, depending on the size of the issues.

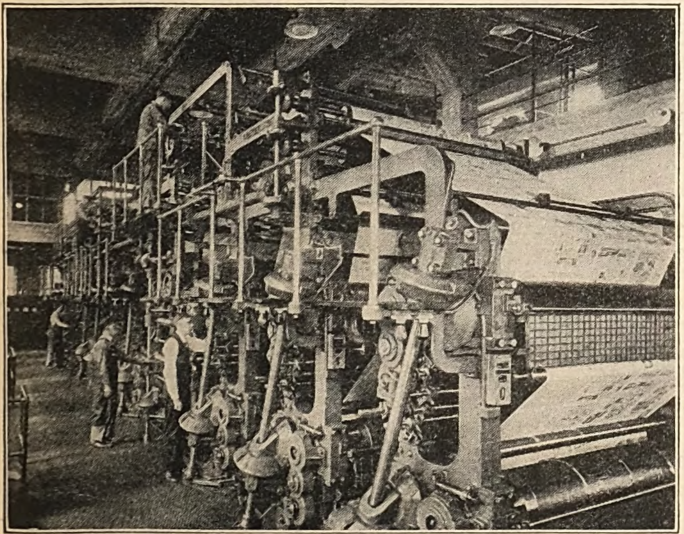
Some of the figures relating to the pressroom may be found interesting. The mechanical equipment cost approximately 3,000,000 dollars. For an 80-page paper, 2000 plates of type are cast in multiples for speed. Nine thousand pounds of ink are used daily and more than 100,000 pounds of melted metal are required each day.

Many of our pictures are self-explanatory, such as the morgue, receiving of classified advertising, et cetera. The *Daily News* equipment includes two airplanes and a fully equipped broadcasting studio, station WMAQ.



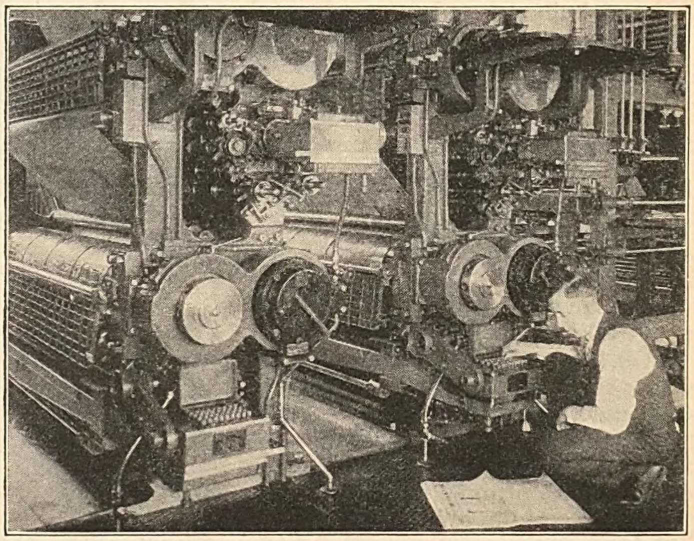
THE "MORGUE"

A million photographs, a million clippings, one hundred thousand negatives, form a part of the "morgue." It is easy to "look it up" here with such splendid modern equipment



CLICKING OFF THE "HOME" EDITION

The nine great presses have a capacity of 300,000 papers hourly. The complex machinery daily turns 300 tons of white paper into printed newspapers. They are the last word in printing machinery



A QUESTION OF INK

The proper distribution of ink is important. The superintendent of the pressroom is operating the ink-fountain supply regulator with a press-sheet before him to ensure even color distribution

Cameras, Airplanes, and a New Industry

The Story of an Inventor Who Developed a Hobby Into a Commercial Enterprise of International Standing

By MILTON WRIGHT

IN the history of American invention there are the names of plenty of poor boys who struggled over seemingly insurmountable obstacles to places of prominence. It almost would seem that lack of resources is one of the essentials of success.

Once in a great while, however, we find a man who lacks the advantage of having been born in humble circumstances, and who, in spite of that fact, makes an invention that founds a new industry. And when we do find such a man we have found one whose career it will be well worth while to study.

Consider Sherman Mills Fairchild. At 33 years of age he is one of the dominant figures in the aviation industry, being president of the Fairchild Aviation Corporation and a half-dozen subsidiary corporations, all bearing his name, as well as vice-president of the 200,000,000 dollar Aviation Corporation which he helped to organize. His companies control two airplane factories, one of which is said to be the largest exporter of cabin planes in America. Another of his companies makes all of the aerial cameras used by six governments, including our own. Another engages in making aerial photographs and surveys. And these, remember, are not enterprises that he bought an interest in, but enterprises that he founded himself and built up by hard work, business acumen, and perseverance.

"How did you come to start this gigantic business?" we asked him one day.

"IT probably was largely a matter of natural perversity," he replied. "My relations and friends thought I was just wasting my time on what they considered merely a hobby, so I just had to show them they were wrong."

"But how did you come to take up aircraft?"

"Oh, that was a matter of evolution. One thing led logically to another. Of course, we had to have our eyes open to see opportunites when they appeared, but then the aviation industry is full of opportunities."

"You started in aviation in the war, didn't you?"

"No, not exactly; let's say at the time of the war."

Elsewhere we learned that Fairchild had adopted several hobbies. One was interior decorating. Another was playing the piano. Today he has two pianos in his New York apartment and two in his country home at Centre Island. His favorite form of relaxation is playing duets with a certain well known composer and music publisher.

The one hobby that has determined his career—and affected, too, the development of aviation—is photography. Cameras are a means of achieving artistic effects, and Fairchild is artistic. Their use involves niceties and intricacies of mechanical operation, and Fairchild is mechanically inclined; in fact, he is a mechanical engineer.

When America entered the World War, he hurried to a recruiting office. However, the army surgeons who gave him a physical examination refused to let him into the army. They even told him that if he expected to be of any use to anybody, himself included, he had better start living in a high, dry climate. So Fairchild went to Arizona, while all the other fellows his age—he was 21 then—went to Europe.

MAPPING THE EARTH FROM THE SKY

Typical aerial survey map, useful for realty development, taxation, and similar purposes. *In the oval:* Sherman M. Fairchild

But you know what Emerson said about building a better mousetrap and the world beating a path to your door through the wilderness. Fairchild, in Arizona getting back his health, worked away with photography. More and more the war news featured airplanes. Not only were planes fighting one another and raiding enemy positions, but, what was more important, they were the eyes of the army.

Here was where Fairchild could help—aerial eyes for armies—cameras for use in airplanes. And cameras were his hobby. He went to work and soon obtained some remarkable effects in clear, sharp, long-range photographs. They came to the attention of army officials in Washington.

FAIRCHILD was getting results that the army couldn't get with the apparatus they were using, so they ordered him to Rochester, where the facilities of the Eastman laboratories were available. He evolved a camera that the army found ideally suited to its purpose. Today Fairchild cameras are standard equipment of the United States Army and Navy Air Corps, the Royal Canadian Air Forces, the Brazilian Navy, the Argentine Navy, and the Japanese Imperial Army Air Service. Our own Army Air Corps specifies that substantially all airplanes now being built must provide for the installation of Fairchild cameras.

"Just what did you do to perfect cameras for aerial use?" we asked Mr. Fairchild.

"Worked out the between-the-lens shutter," he replied. "If you will recall almost any picture of racing automobiles that you've looked at, you may remember how distorted the objects were and how uneven the illumination was. Those defects were due to the design of the shutter; you don't have them if the shutter is of the between-the-lens type, such as those used by the army.

"This kind of shutter, as we use it today, is adjustable to speeds of 1/50, 1/100, and 1/150 of a second. It is mounted in a metal cone attached to the camera body. The retard mechanism for varying the shutter speeds has to be positive in action and unaffected by changes in climate, for the army takes its pictures at high altitudes where the temperature is far below zero. We obtained a high efficiency in opening and closing the shutter by having the retard mechanism function only when the shutter leaves are wide open; it is released before the leaves begin to close."

"But how did you step from cameras to airplanes?"

"The planes came later. The army wanted cameras, and so we started making them. We're still making them, developing new models, of course, all the time, for the art of photography is one of constant progress and development. Some remarkable results are being obtained. Only recently Captain Stevens of the army took pictures at a distance of 227 miles. [See page 127, February.]

"RECENTLY we received an order from the army for a machine gun camera; it looks and is operated exactly like a Browning machine gun, only instead of shooting cartridges, it snaps pictures which show the accuracy of the aerial marksmen. [See page 482, December 1929. Editor.]

"To develop aerial cameras we had to use them, and, using them, w came to see what a wonderful field aerial photography was for commercial and industrial uses. Towns could be surveyed for tax purposes, geological formations could be studied for the location of oil wells or gold mines, power sites could be laid out, real-estate developments planned, and the like. The hardest thing in connection with this was educating the public. Nobody had ever used aerial photographic maps and it was an uphill job to put them over.

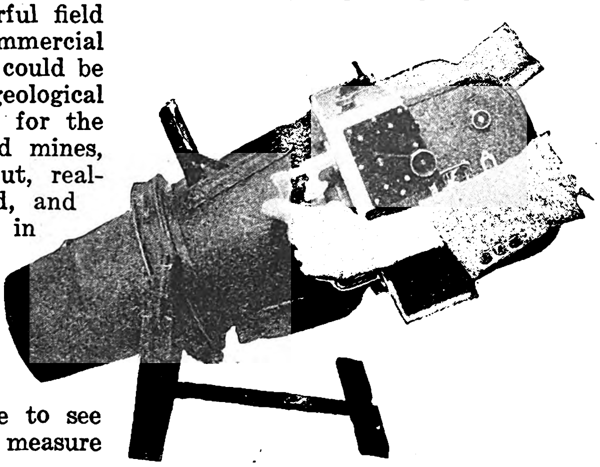
"As we did more and more aerial survey work we came to see that results depended in a measure upon the kind of airplane we used. A plane for photographic work ought to be stable and steady, comfortable, fast, and easily maneuverable. There was no plane that we considered ideal.

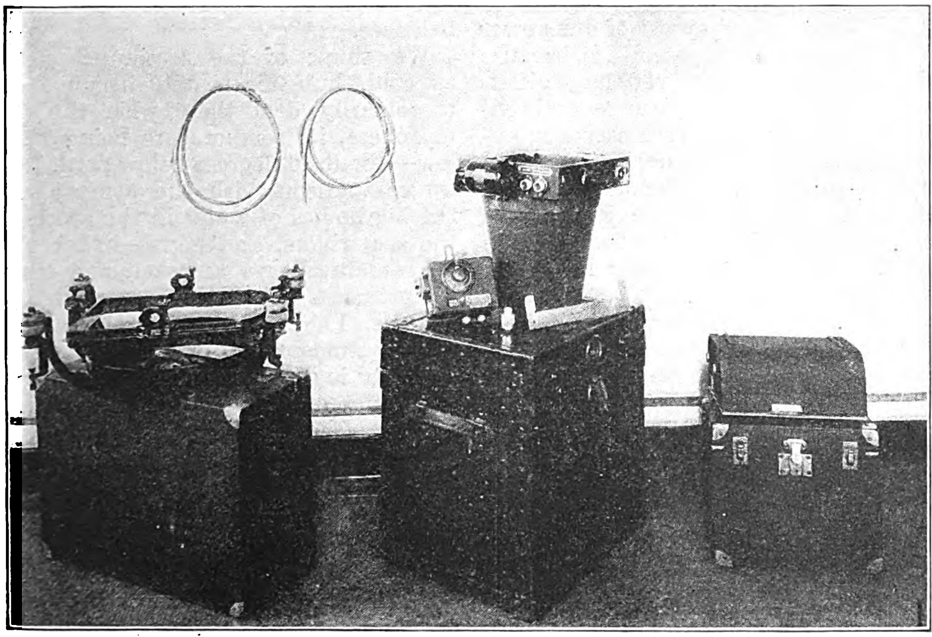
"We were down at Rio Janeiro equipping the Brazilian Navy with aerial cameras, when their officials asked us to get them a plane. This was our opportunity. We would sell them one that would incorporate our own ideas. We had another manufacturer make it for us. The Brazilian Navy liked it, but we could have done better if we had made it ourselves.

"We designed a new ship and built it. We entered it in the Ford reliability tour and it outperformed other ships in its class. Within a year we had sold several planes of that design to other companies who were engaged in the operation of aircraft or were manufacturing exclusively for the government."

"But how did you get a factory?"

"At first we rented the old Sperry Gyroscope plant at Farmingdale, Long Island. Later, as we grew, we bought land and began putting up factory buildings of our own. As business developed we kept adding to them."





EQUIPMENT FOR MAKING AERIAL SURVEYS

Aerial camera outfit, with swivel mount, intervalometer, and magazine containing 75 feet of film. *Above:* Camera assembled on swivel mount in position for mapping from high altitudes

MAKING AERIAL PHOTOGRAPHS

Photographic mapping from the cockpit of an airplane, with the camera in position

"But how did you come to go into a big combination of airplane companies?"

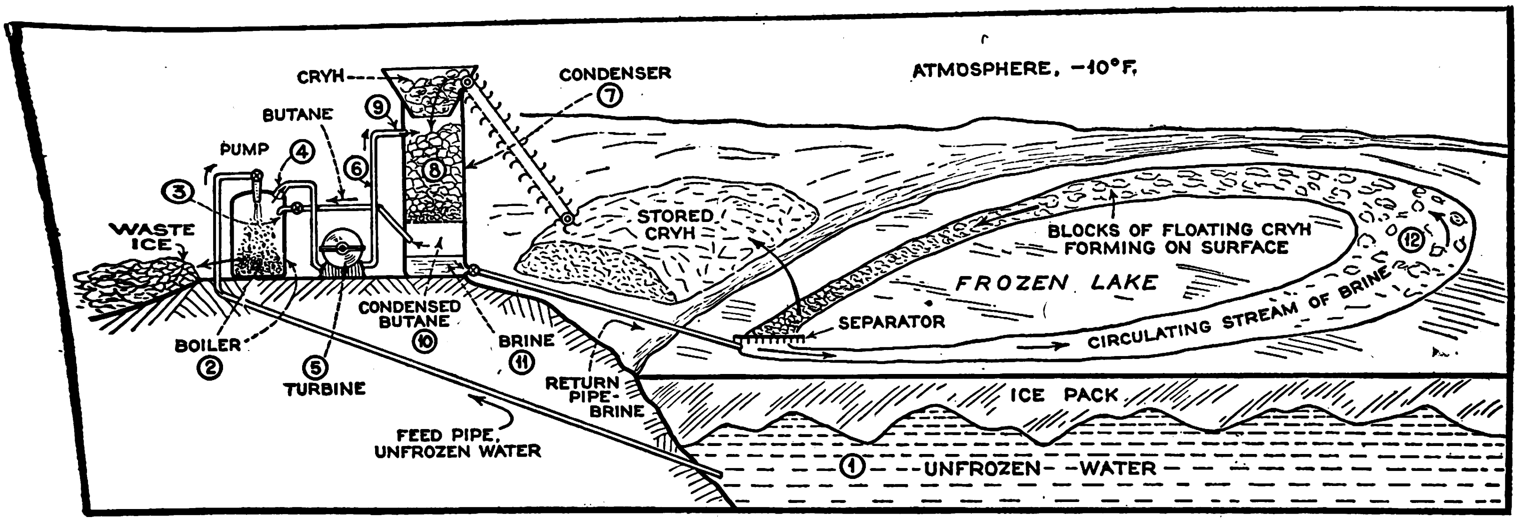
"This is the day of big combinations; especially is this true of the aviation industry. It is all very well for an inventor to start out in a small way and keep going by himself, but only up to a certain point.

"WITH the camera we had exclusive patent rights and the capital investment required was not enormous. When we got into airplane manufacturing, a small group of men was enough to provide all the funds necessary. Later, as we expanded, we enlarged our group of owners. Then came the day when we saw the need for a sort of 'General Motors' of the air. We organized the 200,000,000 dollar Aviation Corporation, with the Fairchild Aviation Corporation as its manufacturing unit. Other combinations were forming, and we had to do it, too, not only as a defensive measure, but as a means of contributing to the advancement of aviation."

"Do you still do much inventing yourself?"

"Not a great deal now; there are too many other things to do. I probably have had 50 or 60 patents issued in my name, but nowadays the design of airplanes and engines has become so highly specialized that we retain the best engineering talent we can find. The inventor may be all right for supplying fundamental ideas, but in a highly technical field like aerodynamics you want a highly trained specialist—a scientist.

"Then, too, you must remember that after you reach a certain stage of development, your job is not alone one of inventing, nor even of manufacturing. You must know the whole field in which you are operating, you must read in the activity of today the developments of tomorrow, and you must organize your forces accordingly."



A DIAGRAMMATIC LAYOUT OF THE PROJECTED INSTALLATION

The numbered details are listed in the text and will be better understood if left until their description is reached. It would be well, however, to take note of the main features, the feed pipe and the source of its supply beneath the ice, also the return pipe above it

Power from the Heat of Arctic Waters*

Energy Outrivaling That of the Niagaras May Be Recovered in the Far North. Will the Frozen Wastes Become an Unlimited Source of Wealth?

By **DR. H. BARJOT, H.M.R., University of Bordeaux**.†

POWER is synonymous with progress and civilization. History proves this assertion. The white man leads the world today because, through invention and the possession of a scientific mind, he has been able to harness coal, water power, and other sources of energy, and thus to adapt the forces of Nature to his own ends. Other races, unable to do the same thing, remain in a backward social condition.

Slavery was due to the lack of power. The Roman mill could be kept turning only by a human motor—by a slave who might even be blinded in order to increase the efficiency of that engine. The same cause, the lack of power, will account for the social inequality of the Middle Ages; only a comparatively small privileged class could live on the luxuries provided by the labors of all the common herd.

The invention of the steam engine, more than any other factor, has changed this situation, liberating man through the products of the machinery it drives, and enabling more people to devote time to intellectual and spiritual pursuits. The discovery of a new source of energy, more than any other fact or social theory, brings about human progress.

In the final analysis, power, whether it be provided by animals or engines, has its origin in the sun's heat. But heat can not be turned into power at will. True, the greatest law of thermodynamics, Carnot's Law, tells us that power is generated by a thermal machine only by a drop in temperature from high to low, just as water turns a wheel only when falling from a high level to a lower one. In more common language, "cold," a relative degree of cold, is as necessary as warmth for getting mechanical energy from heat.

WE now obtain most of our power from coal and petroleum, because their combustion gives very large differences of temperature. But several centuries hence when our reckless consumption of coal has totally depleted our fuel reserves, and no more heat is available through combustion, we shall have only natural differences in temperature left to use. The hoped-for release of "intra-atomic" energy now appears to be quite impossible, or at least difficult. So the problem of finding new sources of power amounts to finding temperature differences in nature, no matter how small they may be, provided the respective hot and cold sources have large enough values to make up in quantity what they lack in quality. That possibilities of this kind are more important than was previously suspected has been demonstrated by the well-known scientist Georges Claude who recently showed that a 100-horsepower turbine could be kept running with a temperature difference of only 18 degrees Fahrenheit, at Ougrée in Belgium. Thus this project has already entered on practical possibilities.

Such natural sources are rather rare but such a source, outstanding in total magnitude, exists throughout the year both in the arctic and the antarctic; it also occurs in sub-arctic regions in winter time. These immense sources of energy are the basis of our power process. This process has already been outlined before the French Academy of Sciences.

We think of the arctic primarily as cold, but this is only because we customarily deal there with the atmosphere, its temperature being very low—about 40 degrees below zero. But by comparison with the atmosphere the big bodies of water in the arctic—the sea, rivers, and lakes—under the ice remain always unfrozen and their temperature is therefore above 32 degrees. This, when compared with the arctic atmosphere, is warm. The anomaly is due to one of the physical properties of ice—it is a splendid insulator of heat. Thus it prevents the leakage of heat from the water beneath it to the much colder atmosphere; provided, of course, it is thick enough. One recalls the "igloo" of the Eskimo where, under cover of ice walls, comfortable refuge can be taken from the most intense cold.

The heat thus retained in unfrozen water is enormous; it corresponds, in fact, to the latent heat of solidification, and thus one cubic meter of water when freezing can liberate the same amount of heat as the combustion of two gallons of petroleum. Such a form of heat can be utilized in the arctic because the atmosphere is cold enough and because this cold makes available an immense amount of potential energy which can be utilized to generate power. It has been proved, in fact, that with a thermodynamic efficiency of only 4 percent—although theory allows double that amount for an atmospheric temperature of five degrees below the Fahrenheit zero—a volume of water obtained from beneath the ice pack can produce the same amount of mechanical power as an equal volume of water falling from more than 4000 feet. There is no Niagara which is as powerful as this one, and it is available in the arctic on the shore of any river or any lake. Since the energy can also be generated from sea water, power in this form appears to be as unlimited as the oceans.

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* See editorial on page 189
† See "Among Our Contributors," page 181

THE invention which we have had in mind during years, like all inventions, has required much developmental work. It has now reached the stage where it is suitable for practical application, through a simple and economical process. The apparatus will employ cold brine as a condenser, taking advantage of a well known property of a solution; namely, that when common salt is added to water the freezing point is considerably lowered, and the salted ice thus obtained—the so-called cryohydrate or "cryh"—is an effective refrigerating agent because its melting point is five degrees below the Fahrenheit zero. This substance, cryohydrate, is easily obtained in the arctic, simply by causing brine to freeze solid under normal weather conditions. It might therefore be said that the brine serves to collect the "cold" and concentrate it in tangible form.

Thus we would have the two differences in temperature required to generate power: First, the warm source, consisting of ordinary water, which freezes at 32 degrees. Second, the cold source, consisting of cryh which melts at a temperature of five degrees below zero. This standardized difference of temperature would bring about a flow of heat between the two sources, and a temperature difference is the fundamental and essential basis of a power plant.

A plant will preferably be installed on the shore of a lake or river, or by the sea. Unfrozen water, 1, (see diagram), pumped up through the ice pack will be directed into a boiler, 2, in same diagram. Here it will be mixed with a volatile liquid, 3. This volatile liquid, having low boiling point, will be caused to boil because it takes up the heat in the water. The volatile substance thus to be vaporized is one of the "light ends" produced in refining petroleum. These hydrocarbons of low boiling point possess the great advantage of being wholly insoluble in water, thus they can be mixed directly with it. This simple device provides an instant transfer of heat and permits the use of a simple and economical boiler. Normal butane, which boils at 30 degrees Fahrenheit under a pressure of 25 inches of mercury, would be particularly suitable for such a purpose. Because it would be condensed and used over and over again its cost would not be a large factor, especially since this petroleum by-product is very cheap, being wasted at present for lack of a market.

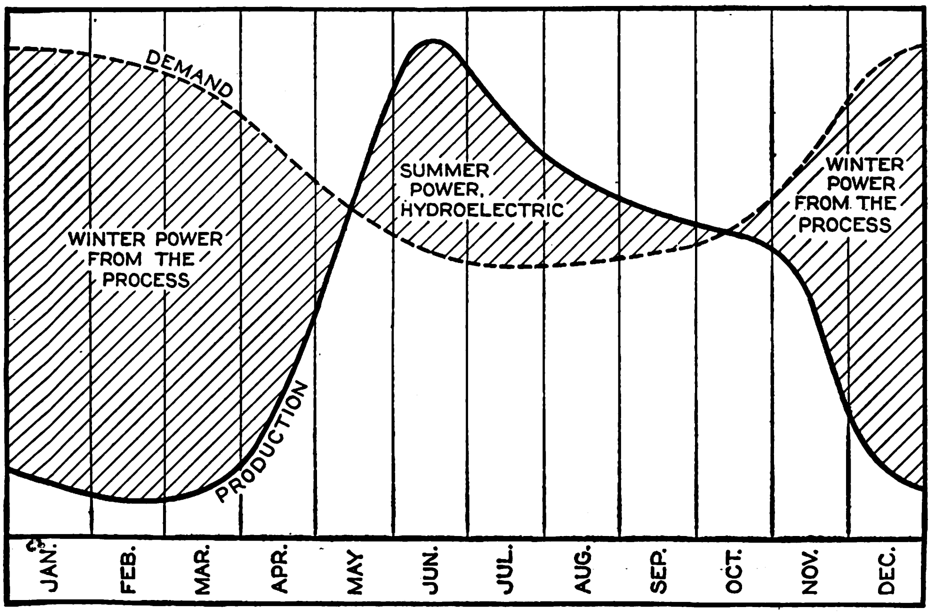
The butane vapor, 4, obtained as described, passes through standard low-pressure turbines, 5, and is exhausted, 6, into a condenser, 7. The condenser contains salt water ice ("cryh," 8) whose temperature is always below zero. The arriving vapor, 9, comes in contact with this sub-zero ice and is rapidly condensed or liquefied at low pressure (about 10 inches of mercury), meanwhile melting the ice.

The condensed butane, 10, and the melted brine, 11, collect at the bottom and since these two do not mix they are easily separated on a basis of their differing density. Both are used over and over again; the butane is sent back to the boiler, and the brine is caused to resolidify or freeze, 12, by action of the extreme cold of the arctic atmosphere.

If we look at the matter broadly we see that the production of power by a transfer of heat energy from unfrozen water to a chill atmosphere is theoretically unlimited, but that in practice it depends upon the capacity of the transfer agent employed. The price of that material is consequently the crucial matter, and this is why the use of cheap brine is extremely advantageous. Common salt is a very cheap material, but here is does not even have to be purchased, for a brine can easily be produced in the arctic from sea water. For example, this would be the case were a plant to be built near the shore of Hudson Bay. Repeated freezings acting on an isolated quantity of sea water will, as is well known to arctic explorers, concentrate it as efficiently as evaporation. Pure water freezes first and automatically separates from the remaining liquid, and a concentrated brine is finally yielded. This operation would be carried on automatically in the boiler of the plant if it were fed with sea water. Here the large amounts of brine needed would be obtained as a by-product.

THE manufacture of cryh from brine is equally a simple operation, requiring no very special plant. Since the plant is working on the shore of a lake, for example, the natural ice sheet on that lake offers a ready-made smooth surface of large area over which the brine is poured. This liquid will spread over an immense area, will thus be brought into contact with the cold atmosphere, and will freeze rapidly. Mechanical scrapers moving on tracks will automatically clear up the brine and regularly supply the plant with cryh.

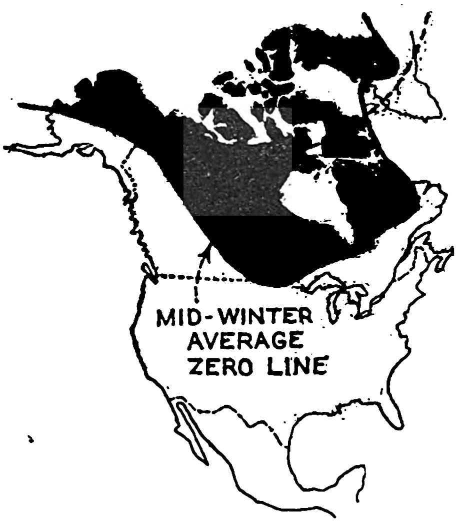
The capacity of the plant depends only upon the area of the cold surface just described; the use of brine as a medium permits the employment of an immense surface at low cost. A system of tubes to accomplish the same purpose would prove to be highly expensive; it has been proved by actual test that a simple tank having a volume of only 400 cubic feet, filled with cryh, would be equivalent to 300,000 lineal feet of one-inch tubing. Furthermore



WINTER POWER WOULD COMPLEMENT EXISTING SUMMER POWER

In the north, stream-flow in winter shrinks to a very low minimum. Hydro-electric plants are based on that minimum rather than a maximum. Winter power would compensate this the use of an open-air ice sheet would provide a better condensing process because there would be no added surfaces to delay the exchange of temperature.

Another great advantage of this cryh condensing process is the ease of obtaining a storage plant. The production of power is practical and economical only when that production is regular, and particularly when the peak load is being supplied. In our process an accumulation of cryh is equivalent to an accumulation of power. Let us suppose, for example, that a lake of brine having an area of one square mile is frozen to a depth of six inches; such an amount of cryh will enable a 75,000-horsepower plant to run during 24 hours at a 100-percent load factor. Thus the cryh, more easily produced in large amounts during the coldest spells and particularly at night time, has only to be stored up against the peak load and the occasional warm days that occur in the arctic, even in mid-winter. The storage would require no very special construction—nothing like the expensive dams of a hydro-electric storage plant.



THE NEW NORTH

The black region is suitable for the Barjot power plan. It has many lakes and streams

In general, plants which utilize the process described will be very economical, having no elaborate costly construction comparable to the big dams required where the energy in falling water is recovered. The "boiler" and "condenser" are simply rooms in a concrete building; the turbines are standard low-pressure turbines; pumping unfrozen water from beneath the ice presents no difficulties; the brine is cheap and can be produced at the site for many plants. The capital investment will be low; an estimate for a large plant gave less than 35 dollars per horsepower installed, while hydro-electric plants involve a cost of about 200 dollars per horsepower.

The practical advantages will be obvious if we draw a comparison with the Claude process of harnessing the temperature variations of the oceans. The expensive pipe 3000 feet in length there required for obtaining cold water from the depths of the sea is not required in the type of plant at present under discussion. Here water has merely to be pumped up through an ice pack ten feet in maximum thickness. Furthermore this process makes use of the latent heat of freezing which, for the same mass of water, is 80 times as great as the specific heat used in the other process.

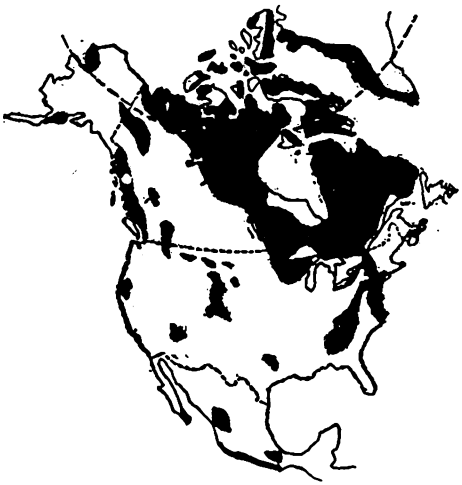
The region in Canada extending from Labrador to Alaska, all along the arctic coast and around Hudson Bay, is known as "the richest repository of base and precious metal in the world." The "pre-Cambrian Shield" or "Canadian Shield," more than 2,000,000 square miles in area, contains a wide range of minerals. Its southern extension in the United States, less than 5 percent of the total, has provided the Lake Superior iron mines and the Michigan copper mines which have played so large a part in America's pre-eminence in the mining industry. The largest part of the minerals of the Canadian Shield lie in the Great North, in that great region long regarded as a frozen waste. Among the potentialities of greatest known importance are the enormous deposits of native copper in the Coppermine River basin, situated under the Arctic Circle and recently estimated as a billion tons, and that fabulous reserve of iron ore at the recently discovered Belcher Islands in Hudson Bay.

An extreme degree of cold and the lack of power have thus far prevented the exploitation of this wealth. A hard winter lasting about nine months freezes the streams, which can not therefore be harnessed hydro-electrically to advantage. These lands may now be regarded in a new light—as the lands of power. Fiords, rivers, and lakes are innumerable in that region and the process can therefore be carried out virtually anywhere. The present trend of settlement northward will be accelerated and a new part of the world opened to exploitation. Cheap metals should become available, due to a great industry wholly contingent on the vast new source of energy.

The process would be applicable not merely to the far northern fringe of Canada but to areas much to the south of this. It is well known that the great hydro-electric plants of central Canada are seriously hampered by the severe winters, and that most of them are reduced to a low capacity. The Saskatchewan Power Commission recently decided on the impossibility of making profitable use of the existing power, because in this province "the variation in the flow of the river is as much as 100 times greater in summer when the demand is light than in winter when the demand is heavy, the variation being all the way between the maximum flow of 188,546 cubic feet per second to a minimum of only 850 cubic feet per second." (reports Sask. Power Com., *Power Age*, January, 1929). This is due to the fact that water is immobilized in solid form in winter.

Unfortunately this shrinkage occurs during the very season of the greatest demand and requires the provision of steam stand-by plants. It is, however, illogical to burn coal when so much heat is already contained in any nearby lake or river. Again let us remember that unfrozen water can give more power in freezing than if falling through a head of 4000 feet. This "winter white coal" is largely available in central Canada because of its intense cold, and therefore the winter power plants utilizing the process at times of peak will fit admirably into the existing seasonal "valley," supplementing the hydro-electric installations.

The energy obtained during the cold months would be so abundant and cheap that it could even be used economically for electric heating purposes. What a curious paradox: the colder the winter the more efficient the process and the more heat! King Zero will be forced to destroy himself. The present handicap to the settlement of the arctic will be removed. The American continent, granted by the accidents of Nature a Far North which it now turns out is really a land of power, will become a center of civilization.

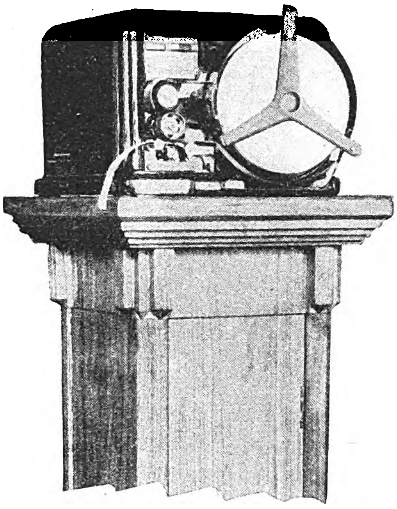


THE CANADIAN SHIELD

This area of pre-Cambrian rocks is a rich source of metals, but much power is needed

Finally, mankind has now the safe assurance that there is in the polar regions a source of power which will never be depleted; and which, incidentally, it will no doubt become steadily easier to transmit to greater and greater distances because the distance to which electrical energy can be transmitted is increasing every day.

High-Speed Tickers to Serve Brokers



NO LONGER A DOME

The old familiar dome of the stock ticker is going out of style. This is the new one

MUCH of the chaos—and many of the losses—incident to the recent stock crash was due to the tardiness of the stock ticker, the type used having been in service for 10 to 15 years. Trading off "the floor" was largely guess-work for brokers dependent upon the tickers, because by the time quotations reached them, many wild fluctuations had taken place.

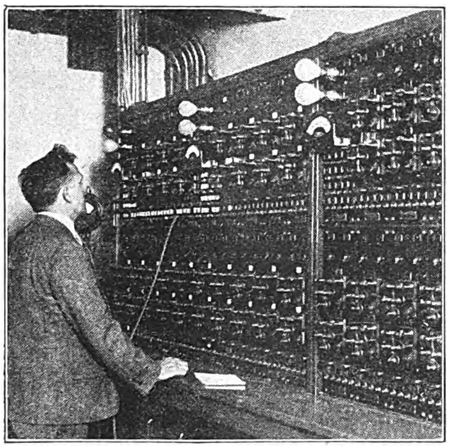
The recent announcement by the Western Union Telegraph Company that they are beginning installation of new high-speed stock tickers throughout the country will, to a large extent, prevent a recurrence of this situation in the future. Design and development of this high-speed ticker occupied practically three years' time and was a result of the combined efforts of ticker and printing telegraph engineers of the Western Union, the New York Stock Exchange, and the Teletype Corporation of Chicago.

WHILE this new ticker is a cumulative result of developments and improvements rather than any startling new invention, it is based upon principles which enable it to operate at practically twice the speed of the old tickers. It requires only one main line wire instead of two as formerly used.

With the old style ticker a considerable amount of power must be supplied over the telegraph signal wires and a considerable time is required to rotate the typewheel from one printing position to another, since the alternating current impulses which control this rotation cannot be sent at a speed greater than ordinary automatic signaling speed. The new high-speed ticker development, therefore, took place along the lines of reducing the operation to one-wire control, reducing the amount of signaling current required, furnishing a local source of power at the ticker, and a change of code which would not require so many transmitted impulses to control the position of the typewheel.

The new ticker operates on a start-stop principle similar to the well-known Simplex printers which are coming into general use as a part of telegraph equipment. A local source of power is supplied by having a small electric motor which furnishes the driving means for rotating all the moving elements in the ticker and performing the operations of shifting, printing, rotating the typewheel, et cetera.

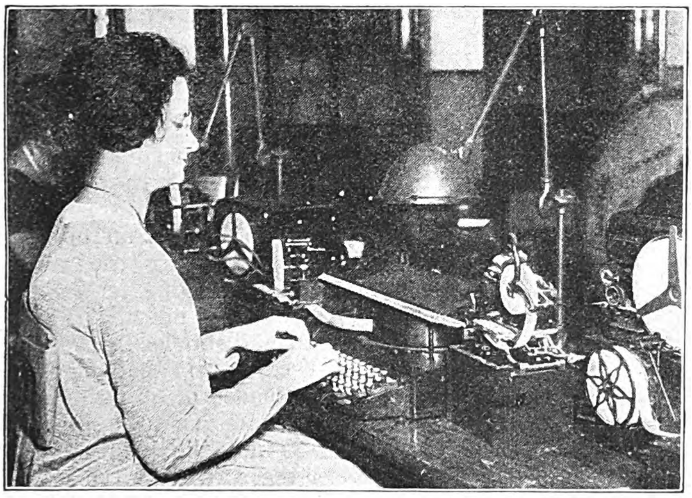
Instead of the step-by-step code which averaged 16 current units for each character printed, a permutation code is used which, with start and stop impulses added for each character, makes a total of eight current unit impulses for each character. There is only one magnet in the new ticker whereas there are four in the old. One important feature in the design is the fact that one character is really "stored" in the ticker mechanism and is being printed while the selection impulses for the next following character are being received and stored.



TICKER CIRCUIT BOARD

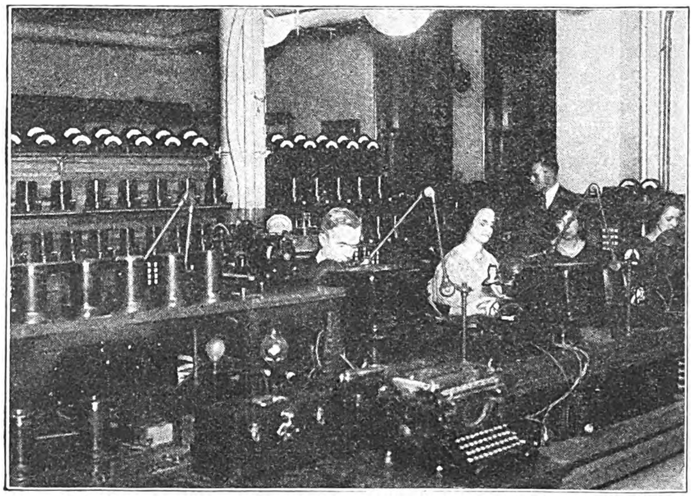
A section of the ticker circuit board controlling ticker circuits serving New York

The 4,500,000-dollar program involving nationwide installation of the high speed stock tickers required construction of 5000 miles of new city-to-city wires, mapping of numerous curcuit changes and wire installations in 350 cities all over the country and in parts of Canada, and an enormous amount of other preparatory work. To prevent discrimination, the new tickers will be operated at the same speed as the old ones until all the old tickers in the country have been replaced. Some 3000 new tickers will be installed on Western Union circuits in New York City, in about four months. At least six months more will be necessary to rush work to completion in the balance of the country.



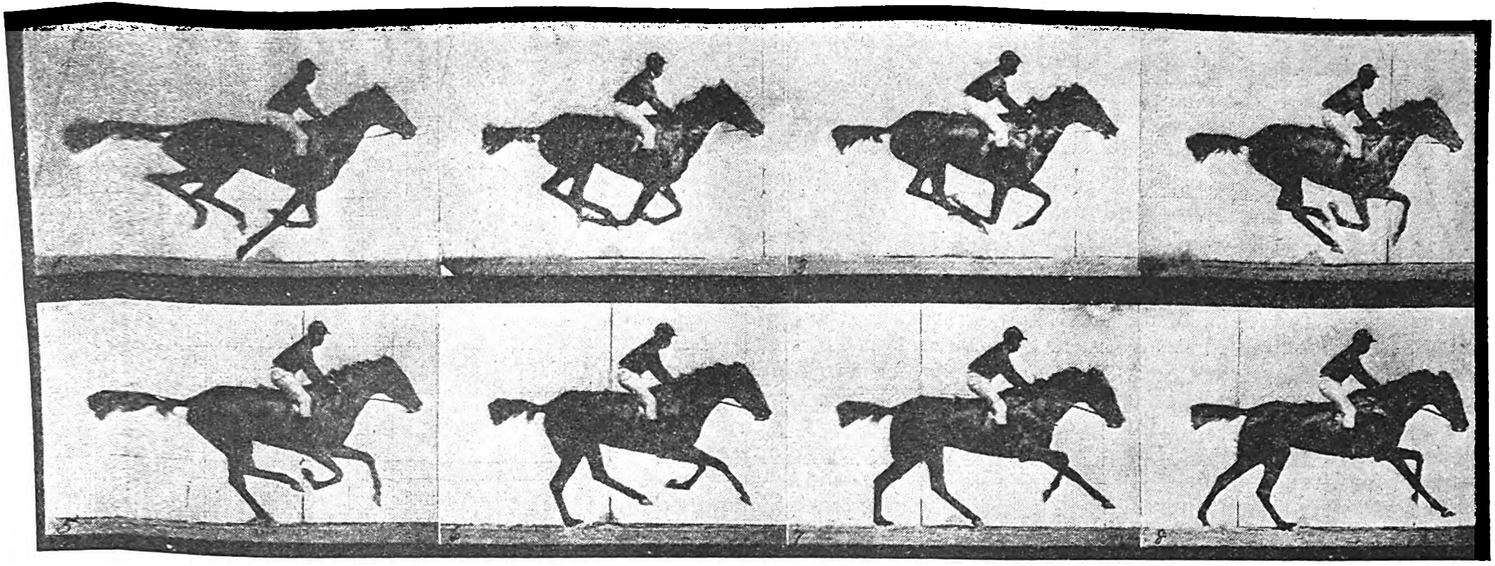
QUOTATIONS BY WIRE

An operator sending quotations from the new high-speed ticker sending station of Western Union at 40 Broad Street, New York



SERVING THE COUNTRY'S BROKERS

General view of the sending apparatus. In background a man watches a distributor receive impulses from the operating table



THE FIRST "MOVING PICTURES," REPRODUCED FROM THE ORIGINAL

"Animal Locomotion" is the title of the large volume in the possession of the editor, from which this page was reproduced. The same work is described on the fly leaf as "An Electro-photographic Investigation of Consecutive Phases of Animal Locomotion, 1872-1885, by Eadweard Muybridge, Published under the Auspices of the University of Pennsylvania," in 1887. See the text of the article

Our Eyes and the Movies

How the Laboratory Psychologist Explains by Means of Physiological Optics Some of the Phenomena of Moving Pictures

By DONALD A. LAIRD, Ph.D., Sci.D.

Director, Colgate Psychological Laboratory

An argument that could not be answered, and a rich man's natural inquisitiveness marked the birth of the movies. Now one out of five in the United States is a movie addict, according to compilations made by the industry, public schools are using movies for educational purposes, salesman are using them to supplement their sales talks, and when Walter Gifford, president of the American Telephone and Telegraph Company, cannot be at a banquet to make a speech in person, he makes a "talkie" of himself appropriate for the occasion and is represented in proxy by an operator of a projecting machine.

All this resulted from the bet of a wealthy sportsman and philanthropist 50 years ago, and on the application of some dry-as-dust discoveries and laws scientists unearthed nearly a century ago. Out of these origins has come the celluloid ribbon which claims 25,000,000 of us as well-nigh incurable movie addicts and touches closely the lives of as many more.

Science has accomplished so much that concerns moving pictures in the last century that we have developed a nonchalant, matter-of-fact attitude toward these achievements. We are content simply to enjoy the beauty or amusement rather than trying inquisitively to find out "what makes it go."

While hundreds of men who labored through two centuries have made essential contributions to the development of the motion picture, it is generally recognized that the first actual pictures were taken at Palo Alto, California, on the stock farm of Leland Stanford, in 1878 and 1879. Stanford turned his vast resources and ingenuity to settling some arguments on which wagers had been laid about how horses ran.

Eadweard J. Muybridge, sometimes known as Edward James Muggeridge, and John D. Isaacs, worked with Mr. Stanford in arranging a battery of 24 cameras so that a moving object, such as a racehorse or a human being walking, would expose each plate in serial order and would leave behind a photographic record of each of 24 closely timed phases of his movements.

While the investigation was planned primarily to settle arguments about racehorses, the developed negatives upset many conventional ideas about pole vaulting, sprinting, and even pleasure walking; the human brain and eye, apparently, had not in the past really analyzed motion itself but had reacted to a composite, and at best a rather hazy, picture. From this crude start, experimental work continued.

When we see, the light which enters the eye produces the sensations of vision by changing the chemical constitution of the sensitive retinal coating of the inner surface of the eyeball. The chemical changes do not cease immediately when the light is cut off. Everyone has seen the after-effects of this persistent chemical reaction when looking at the light in his bedroom just before turning it off for the night. The light is extinguished, but a weak image of it persists in the eye and remains, no matter what direction the eye turns. The same after-image is seen when riding at night and looking directly into the headlights of an approaching automobile; after the automobile has passed, the persistent image which is caused by the lag of the chemical reaction is seen dancing around like a firefly.

When a very strong light is used, these after-images last longest. So in experiments to reduce the flicker in movies it was found that, by substituting an arc light for the old carbon-filament bulb, the pictures could be made bright enough so that the chemical change of the first picture persisted in the eye while the cut-off blade of the shutter was hiding the second picture which was being jerked into place. But that was not all. Flicker still persisted and movies in the early professional exhibition hall flickered much as the blades of an electric fan do as they are coming to a stop. Of course it was not the blades or the pictures on the screen that flickered, but the overlapping chemical changes in the retina of the eye.

Ordinary visual impressions last in

the retina for about three thousandths of a second after they are cut off. The stronger impressions from a bright movie screen will last longer, but not enough to eliminate flicker. So "Talbot's Law" was called upon. This is a law from pure science but it solved the critical problem of movie projection.

Talbot's Law states that in rotating a disk made up of sectors of black and white, flicker decreases as the speed of rotation increases, with the intensity of illumination, and with the number of interruptions. The speed of films could not be increased practically and economically and the intensity of lighting of the pictures had been increased as far as seemed possible. So why not interrupt the light more? That is what they did. One shutter had to be used to hide the motion of the new picture being hauled into place, so another, and usually smaller, blade was added. Its function was to pass its shadow across the screen while the picture was being shown. Adding this second shadow diminished the flicker. Instead of interrupting the light on the screen just once for each picture, a second and sometimes a third interruption is now added. Paradoxical as it may seem, flicker disappears. Doubling or tripling the number of times the light is broken lessens the brightness of the picture seen by the eye, as predicted by Talbot's Law, but substitutes steady fusion of after-images and does away with flicker. Only when the machine is running too slowly or when the light is momentarily weakened does flicker appear.

IN the home projection of movies flicker may appear, due to several causes. If the home projector is moved a distance from the screen so that the size of the picture is increased, the intensity of illumination of the screen is decreased and may be reduced to a point where the after-images are too weak to carry over the darkened intervals on the screen. The motor may also be running slowly, due to lack of oiling. If the room is not darkened flicker will be difficult to avoid because the after-images fuse most readily when the general illumination is least.

While the home projector should be placed as close to the screen as possible in order to obtain the brightest picture that is consistent with adequate size, the spectators should sit as far from the screen as possible. When the spectators sit at a considerable distance from the screen the image of the picture is focused on the central region of the retina, but if they sit close to the screen the corners of the picture are focused on the peripheral or marginal portions of the retina. This marginal retina is especially sensitive to flicker. Thus, by sitting close to the screen one sees the central part of the picture fusing perfectly but the corners of the picture present an annoying amount of flicker.

When a common cotton screen is used the spectators should sit directly in front of the screen, because it reflects the maximum light directly backward. In moving picture theaters mirror or ribbed screens are used which reflect the rays to the spectators at the sides of the stage. Most screens used for home projection do not do this.

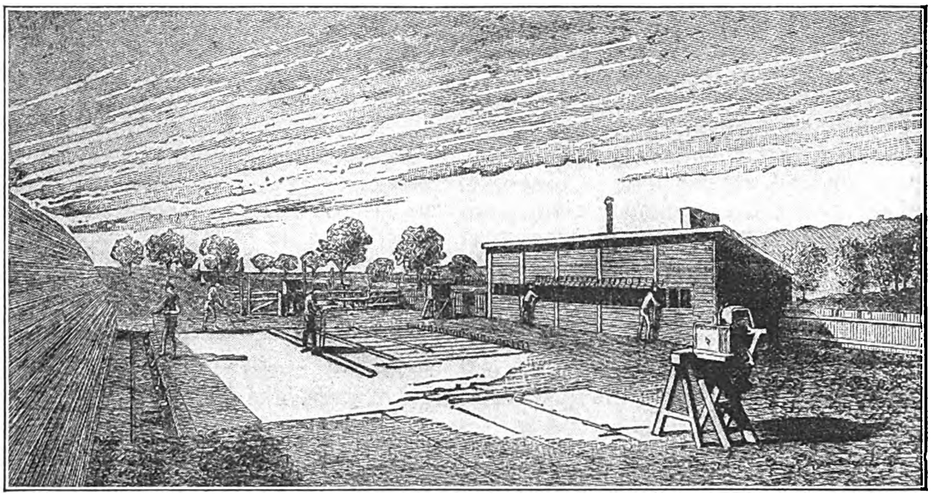
There are always a few persons whose eyes are irritated by the movies. This is due to individual peculiarities in the critical flicker threshold, and is not a defect of movie projection but a human idiosyncracy.

The fusion replaces flicker quickest when the predominating color is bluish, but the light of the carbon arc or incandescent bulb used in projecting the pictures has an excess of red and yellow rays and a deficiency of blue rays. In some professional machines lenses are used having a bluish cast. These filter out the excess of red and yellow and consequently give a smoother picture with the best fusion in the intermittent images. Some of the patented ribbed and mirror screens are so constructed that reds and yellows are absorbed to some extent, thus giving the screen and the picture it reflects a slight bluish cast. In home projection it will help if the cotton screen is thoroughly blued by the laundress. In the more skillfully designed moving picture theaters the lights that are kept on in the auditorium during the projection of a picture have bluish reflectors or filters in order to give this color help to fusion.

Do movies harm the eyes? Many people think so. A few years ago a responsible public health official made this prediction: "Motion pictures will be extinct in ten years. The public realization that they are ruining eyesight will lead to a demand that they be abolished. Within ten years I predict that there will be no more motion picture shows in America. By that time they will be barred as a pernicious evil to health."

Some people undoubtedly do experience eye strain at the movies, but this is usually the result of their eyes having defects which they have not discovered and had corrected. Or they may habitually sit too close to the screen or too far to one side. As a matter of fact actual measurements have shown that viewing a movie projected with ordinary care is less fatiguing to the eyes than ordinary reading for the same length of time. Theoretically the movies should be fatiguing, but practically they are not. There is one type of scene, however, which may readily be very fatiguing to the eyes. This is where counter-motion is shown, as in a parade where trained marchers are in military formation and the jerky movements of their legs are in the immediate foreground. This produces jerky and irritating sensations.

MOVIES seem to be peculiarly a human institution, animals indicating little, if any, interest in them. Not only household pets but primates which have been experimented upon show no interest in movies and are more likely to look away from the screen than at the screen. This is likely due to the eyes of animals not having the photochemical changes that make it possible to fuse the pictures. Dogs are interested in their own images in mirrors and in lithographic sheets portraying other dogs, but they do not look at dogs in movies. Probably this is because the movie screen looks to them as the slowly whirling blades of an electric fan look to us. It has been experimentally demonstrated that some animals, such as the parrot, do have after-images, but it would appear that their after-images do not follow the same time course that ours do.



THE EQUIPMENT USED BY EADWEARD MUYBRIDGE

From the SCIENTIFIC AMERICAN Supplement, February 5, 1887. "On the left," reads the legend, "is the reflecting screen against which the animal appeared *en silhouette*. On the right is the series of photographic apparatus of which each one took an image of the animal"

The Romance of Steel

Most of Us Take the Metal Iron Too Often for Granted. Were Iron Newly Discovered, Its Unusual Qualities Would Cause It to be Regarded as a Remarkable Element

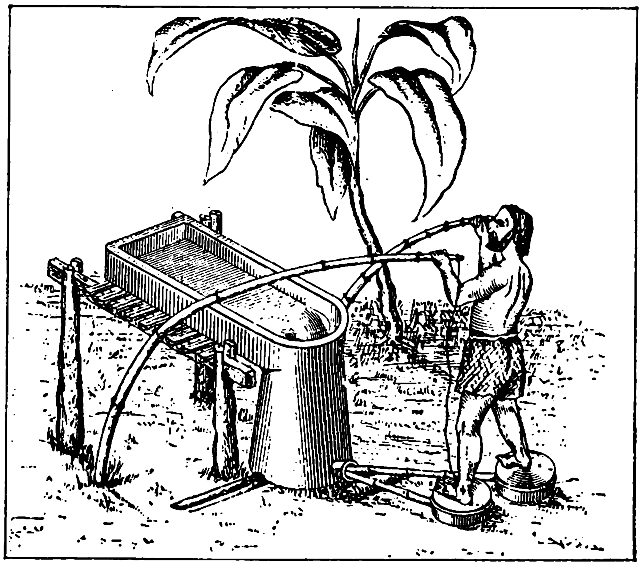
By MARTIN MEYER, Ph.D.
Assistant Professor of Chemistry, College of the City of New York

MANY thousands of years ago men were savage aborigines roaming about clothed in the skins of animals than which they were little better. Their chief cause of concern and object in life was to secure food enough to prolong their miserable existence. Surrounded by beasts of a ferocity unknown in modern times, their only weapons were crudely fabricated from wood, stone, bone, and later bronze and the softer metals. Then one day one of their comrades discovered that a rusty earth could be treated with fire to produce a material, iron, which could be fashioned into implements of an efficiency immeasurably greater than those of the time. It was one of the most important discoveries that the human race has ever made, ranking second only to the discovery of fire itself; so important, in fact, that the subsequent period is known as the Iron Age.

THE Iron Age endured from this dim dawn of humanity down to only 80 years ago, when mankind entered another epoch which might quite as rightfully be designated the Age of Steel. The date is fixed by the discovery of the Bessemer process for the manufacture of steel in 1855, and the importance by the events that have since transpired. As great an improvement over wood and stone as is iron, just so much greater is steel over all other metals.

The manufacture of steel is based upon the fact that iron possesses the peculiar and almost unique property of dissolving the element carbon, and thereby acquires some startling new properties which are further enhanced by the addition of other materials. While this was known long before 1855 and the perfection of Bessemer's process, it was not until then that steel began to be produced in the quantities that it is today.

The metals form an interesting group of elements. They are all relatively hard, strong, heavy materials, usually (except copper and gold) of a silvery appearance, and have what is commonly called a "metallic luster." They have an infinite number of uses, many of which are familiar to everyone. Copper is used for electric wires because of the cheaper metals it is the best electrical conductor, nickel for plating because it takes a high polish, aluminum for airships because it is light and strong—each metal has uses which depend upon its properties. This is what makes steel the valuable material that it is. Cheapest of all metals, composed mainly of iron to an extent always greater than 90 percent by weight, it is nevertheless not one metal, but many, because the nature and the amount of the other 10 percent makes an infinite difference in the material.



PRIMITIVE IRON SMELTING

The bellows are worked by the artisan's feet. The discovery of iron smelting was made in Africa by the negro

As steel, iron is the Proteus of the metals. Considering iron only from the standpoint of the carbon it contains, one finds at least three different and easily distinguishable varieties. When it has about 4 percent of carbon, which is about all it will hold, down to 2 percent it goes by the name of cast iron. This metal is hard, easily cast in molds since, like water, it expands on solidifying (a most unusual property) and takes a sharp impression of the mold. But it is quite brittle, so that it may be shattered easily, even by a blow from a hammer. Stoves are made of cast iron and one frequently breaks parts simply by dropping them.

When iron is given from 2 percent to 0.2 percent of carbon we have steel with somewhat contrasting properties. Not as hard as cast iron it is infinitely stronger, though normally it does not cast as well. Steel can be made with a tensile strength of more than 200,000 pounds per square inch; that is, so strong that a rope of only one such strand would suffice to lift a locomotive.

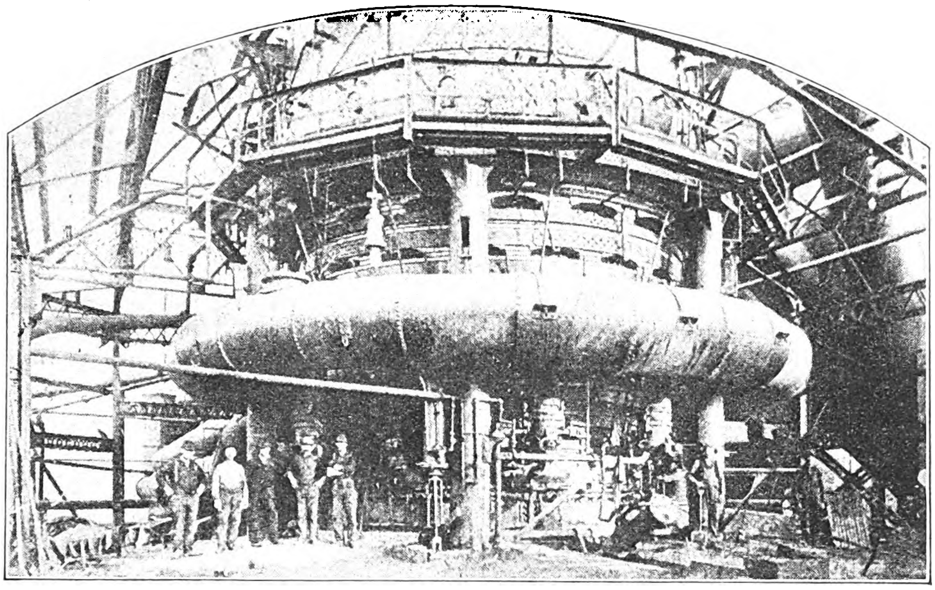
With less than 0.2 percent of carbon iron is called wrought iron, a material which is still softer than steel but quite tenacious and has many uses.

It is, however, the strength of steel which is proverbial and which makes the modern world the land of miracles that it is. Without steel there would be no railroads, no large bridges, no Woolworth and no Chrysler Building, and practically none of the wonderful machinery by which manufacturing operations are conducted.

THAT, however, would not be a great loss, for without steel there would not be nearly as much to manufacture, to say nothing of the countless smaller but equally indispensable things which are dependent upon this interesting material.

But the properties of steel may be still further and more widely modified by the addition of smaller amounts of other substances. Normally iron is magnetic but loses its magnetism slowly, and strongly resists attempts to change the polarity of its magnetization rapidly. After the addition of tungsten and small amounts of chromium it may be magnetized and will retain the magnetism practically forever, the so-called "permanent magnets," while on the other hand, if it contains silicon it may be magnetized in one direction, demagnetized, and magnetized in the opposite direction a hundred times a second with only a very slight loss, known as hysteresis or magnetic lag. Ordinarily steel rusts quite readily, but by the addition of silicon in large quantities one obtains Duriron which resists corrosion of even the strongest acids, while the addition of chromium yields the "stainless steels" which are used in cutlery.

For all these reasons and many more, our modern civilization is dependent upon steel, and to call this the Age of Steel is merely stating a fact.



THE BASE OF A MODERN BLAST FURNACE

Such a furnace is charged with ore, coke, and limestone (as flux) and is kept running continuously for years. Air under pressure enters from the large horizontal, circular tube

From whence comes this interesting material? Like the other metals it is derived from ores or earthy materials found in the ground, of which there are extensive deposits in the United States on the shores of the Great Lakes and in other places, in Spain, Germany, France, Russia, and in other countries. A new deposit has been found at Koolan Island in the Yampi Sound, a little dot in the wastes of the Southern Pacific Ocean. It is said to consist of more than 100,000,000 tons of the highest grade ore, with more under the ocean bed, and this will doubtless influence the future of the British Empire. Large deposits have also only recently been discovered at Kursk in Russia.

The most desired ores of iron are three in number—limonite, haematite, and magnetite. The last is the most valuable but also the rarest of the three, for it contains when pure about 75 percent of iron. It is the "lodestone" of the ancients, of which one rock was said to be so highly-magnetic that it drew the nails from passing ships and unfortunate sailors had to swim for their lives. Like the report of Mark Twain's death, this is doubtless considerably exaggerated, but magnetite is highly magnetic for a nonmetal, or even a metal other than iron itself.

THE ores are oxides, that is, compounds of iron and oxygen, and to obtain the iron one must remove the oxygen. The first operation in the manufacture of steel is smelting. This is conducted in a blast furnace and results in the production of cast iron. A blast furnace is a huge circular building about 100 feet high and 30 feet in diameter, having the general shape of two truncated cones placed base to base. Ore, coke, and limestone are charged into the top of the blast furnace, air is blown in to burn the coke, which removes the oxygen from the ore, and liquid iron at a temperature of 2200°, Fahrenheit, is tapped out of the furnace every few hours. If the ore were pure oxide of iron, only carbon would be necessary to remove the oxygen, but as would be expected of a material dug from the earth, it may also contain sand or limestone, although nearly always it does contain sand. This would clog up the furnace and make difficulty in the smelting operations. So lime is added as a flux, and it combines with the sand to form an easily melted slag that is also tapped off from the bottom of the furnace. This slag is very similar in appearance to a poor grade of glass, and when ground finds some application as an abrasive or cutting or polishing material.

The design, operation, and improvements of blast furnaces form interesting stories in themselves. Today they are almost always entirely mechanical in operation. Years ago they had to be charged by hand. Men climbed to the top of the structure, opened the door of the fiery inferno to drop in the charge, then jumped back to avoid the rush of flame which always followed. Sometimes they did not jump quickly enough and paid for their lack of agility with their lives.

The iron from the blast furnace has been made in contact with coke which is almost pure carbon, and therefore contains about all the carbon it can hold, about 4 percent. It is "pig iron" and the problem of making steel is that of reducing this carbon content to the desired 2 percent or less. The oldest method of accomplishing this purpose is by the open hearth process, which consists simply in melting the pig iron in large shallow beds lined with iron ore. The oxygen in the ore combines with the carbon of the iron and we get more iron out of the furnace than we actually put in.

Pig iron, however, also contains all of the impurities which were present in the original coke and ore—usually silicon, manganese, phosphorus, and sulfur—and these, especially the last two, give a steel with undesirable properties as it is likely to be brittle either when hot or when cold. During the World War this became a very serious problem, for it was found that the amount of sulfur in the coke which was being made was increasing. Special precautions must be taken at this point to remove them, and the furnace is always lined with either a basic or an acid lining, depending upon the chemical nature of the impurities. The lining usually takes the form of a sand or limestone layer. This is slowly eaten away in successive operations and has to be replaced at intervals. Finally the furnace is tapped and the liquid steel runs in thick fiery streams into ladles where alloying materials are added if special steels are required. More than 17 other metals are added to steel to confer upon it different properties for particular purposes.

From the ladles the steel may be cast into ingots which, in turn, go to the rolling mills to be rolled, hammered, cut, slotted, and shaped into rails, sheets, beams, and an almost infinite number of other things. By perfect marvels of mechanical ingenuity this tough and hard material is handled as easily as one may fashion butter.

ABOUT 1854 it occurred to Henry Bessemer that, since the problem of making steel from cast iron was simply one of removing carbon, this could be done most simply by burning it out with the oxygen of the air. He built a large egg-shaped machine into which he placed molten pig iron and proceeded to blow air through it. The idea worked so well that it failed. As the carbon is removed from the iron its melting point rises. In this case the air removed the carbon so rapidly that the temperature could not keep the iron liquid. It solidified and ruined the expensive machine. But eventually Bessemer solved the problem by blowing the air upon the iron instead of through it.

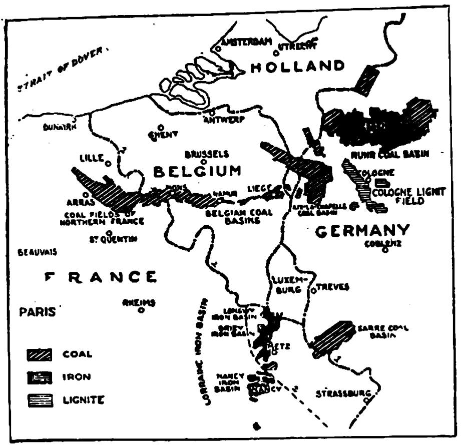
The idea was really conceived by Kelly, while Mushet and others improved it, but chiefly it was Bessemer who made it practicable. It was certainly he who received the rewards, for probably no great invention was so quickly and largely rewarded. It is estimated that before his death in 1898 Bessemer had received upwards of 5,000,000 dollars as the proceeds of this one discovery. Although he made other inventions in his life, none was of any importance in comparison with this.

The idea eventually revolutionized the steel industry. At first it resulted in the production of steel at a price with which no other method could compete. Now when the price differential has been largely overcome, it still holds this advantage: large Bessemer "converters," as they are called, hold only 25 tons of steel, while an open hearth furnace may hold 200, but the latter takes eight hours for one run while a "converter" turns out its charge every 15 minutes. It furnishes a better feed for a rolling mill for it is cheaper to handle a steady small stream of material than a large quantity at infrequent intervals. In a large modern mill the ore is never allowed to cool down from the time it enters the blast furnace until it comes out as the product.

A DESCRIPTION of each step in the process reads like a novel, and no one who has had the privilege of visiting a steel plant will ever forget the experience. The magnitude of the operations, the temperature of the furnaces and the molten metal, the noise of the mills, and the bare-shouldered workmen, like gnomes, controlling the work, combine to form a spectacle as impressive in its way as a Niagara or a Mammoth Cave. For many purposes, steel is manufactured in other ways, by the Duplex and Triplex processes, in crucible furnaces, and day by day more is being made by electricity.

Since Bessemer's invention the industry has grown by leaps and bounds until it is the most important in the world. Today it controls even matters of a political nature, for the principal problem in Europe's political tangle is no longer to maintain a "balance of power" but to maintain that which today is, from a national standpoint, infinitely more important, a "balance of steel." The world's production has risen from only a few thousand tons in Bessemer's day to over 76,000,000 in 1913 and around 100,000,000 today, valued at current market prices at about 36 dollars per ton.

From the figures of cast iron and steel production and cost, students of business foresee the course of commerce and stock speculators forecast the trend of the market. Quite remarkable correlations have been shown between carefully prepared analyses and actual subsequent facts.



IRON MEANS POWER

The iron ores between the present boundary (1) and the old one (2) have passed from German hands to the French

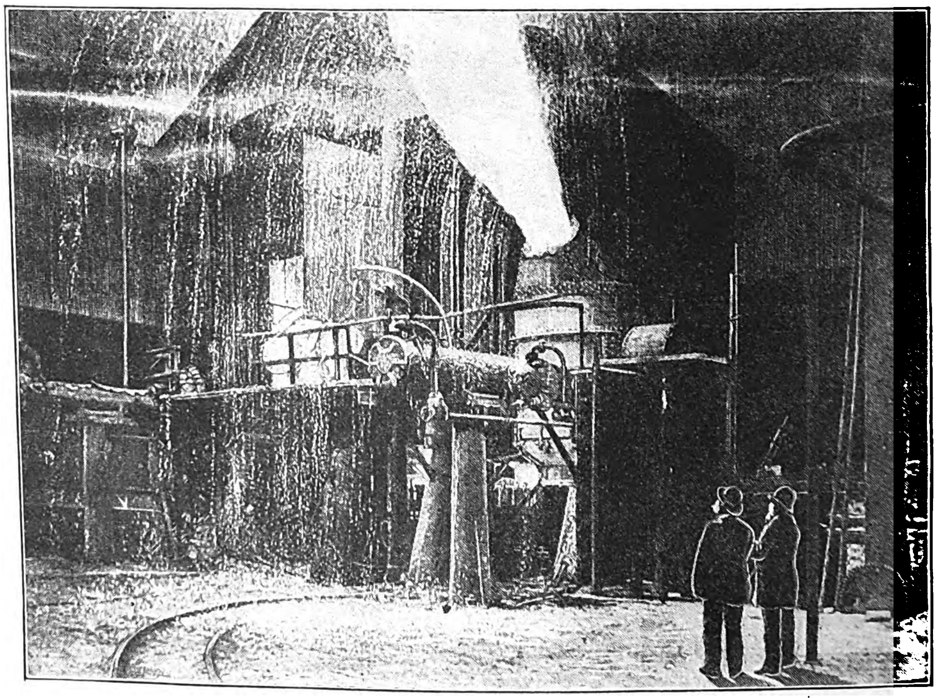
It is more than an interesting comment on the effect of modern science on modern life to trace the influence of steel production upon the course of current history. The greatest body of iron ore in Europe was shared prior to the war by France, Germany, and Luxemburg, and before the war Germany produced more steel than did the other three great steel producing nations of the old world, England, France, and Belgium combined, while the United States produced about the same total quantity, around 40 percent of the world's annual supply.

In the modern world steel production is the keystone to all else; steel means power and commercial preeminence. To it Germany owed her commercial supremacy and to her commercial supremacy she owed the war. By the Versailles Treaty France hoped to destroy that supremacy forever, for she thereby got Lorraine and the main portion of Germany's western ore deposits. But that has not solved the problem nor won the economic battle for France, even though she has won the war, for she did not win the coal.

In the natural course of economic events ore must go to coal to be smelted and not the reverse, as we see in our own country. Our great deposits of iron ore are on the banks of the Great Lakes but the center of the steel industry is with the coal in Pennsylvania. Coal is light and bulky, and expensive to ship, while ore is heavy and compact. France did not get the Ruhr coal deposits, and only a small part of the Sarre, although she has made heroic efforts to maintain control of them, so the actual ownership of the ore means little. Realizing the economics of the situation it is doubtful whether England could be brought to look with any degree of sympathy upon French desires for these coal deposits regardless of the other issues which might be raised to enhance the French ambition, and this is the problem which will remain for solution for some time to come. The recent formation of the European steel *cartel* or trust will write a new chapter and perhaps a whole volume in this story. In the meantime our own production has been mounting. Since 1916 we have produced more than 50 percent of the supply of the entire world. For us from that standpoint the future seems secure.

What Is Your Opinion?

This article is one of a series. All are elementary and deal largely with the romance of chemistry. Whether several more articles of this series will be published or not will depend entirely on the number of votes received from individual readers. A post card will suffice. —The Editor.



A BESSEMER CONVERTER IN ACTION

To make steel from iron, some of the carbon is burned out, either in the Bessemer converter or by the "open hearth" process. Today about three fourths of the steel is made by the latter process yielding a better product, and one fourth is made by the Bessemer process.

An Experiment in Suspended Gravitation

We May Reason Out One Kind of an Answer to a Question in Physics and Arrive at an Opposite Answer By Actual Experiment. Experiment Wins

By R. W. WOOD, LL.D.
Professor of Experimental Physics at Johns Hopkins University
Corresponding Editor, SCIENTIFIC AMERICAN

IF a bottle of water is allowed to fall, and a large air bubble is released at the moment at which the bottle is dropped, will the bubble rise in the water?

Having received an incorrect answer in a surprisingly large number of cases, it seemed of interest to devise an experiment which would demonstrate the abolition of hydrostatic pressure in falling water, and the consequent disappearance of buoyancy.

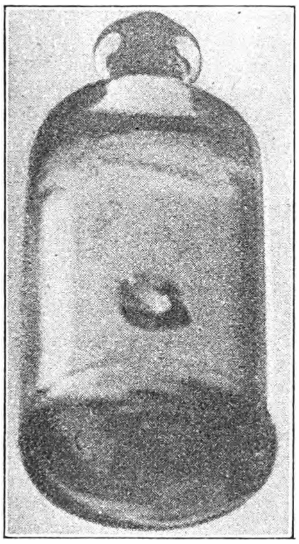
Everyone is familiar with the circumstance that in an elevator a suitcase held in the hand feels much lighter at the moment at which the cage commences to descend, and much heavier at the moment at which the descent is being arrested. If the supporting cable breaks and the car falls freely the suitcase weighs nothing at all and feels as light as a feather—although this observation has not been put on record, so far as I know, by the victim of any elevator accident. The experiment can be tried on a smaller scale by jumping from a height of five or six feet.

THIS suspension of gravitation occurs also within the interior of bodies shot up into the air, and the error made by Jules Verne in his "Trip to the Moon," in having gravitation disappear within the projectile *only* at the moment when it passed the center of gravity of the earth-moon system, has surprised many of his readers.

From these considerations it is clear that the hydrostatic pressure of water, which obviously depends upon its weight, disappears also when the mass of water is rising or falling freely in the air (neglecting a small effect due to air resistance, which prevents a "free fall").

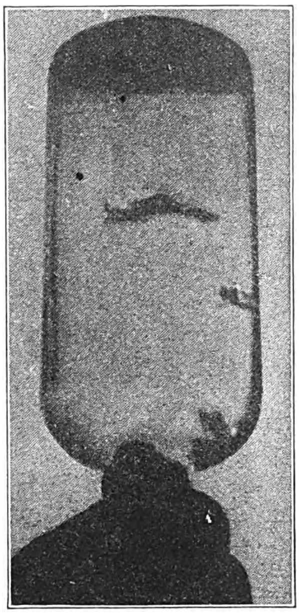
A parachute jumper could try some amusing experiments with a corked bottle of water containing a small quantity of air. If at the moment of jumping he inverted the bottle, the air bubble would remain for a few seconds at the bottom, and then rise slowly as the air resistance reduced his acceleration. As soon as he reached his final "terminal velocity," which is something like 120 miles an hour for the human body in a horizontal position and in air, there would be no further acceleration, and his velocity would remain constant until he opened his parachute. During the time of fall at constant velocity the air bubble would rise with its customary velocity.

Possibly some of our air service men who think nothing of dropping a thousand feet or so before opening their parachutes may be willing to try the experiment and report on it. I should also like to suggest that a moving picture of the earth, taken with the machine pointing straight down, during a free fall of several thousand feet, would be of considerable interest. It could easily be done with one of the lighter cameras operated by a spring drive, or perhaps even with a standard machine, although the latter might give more trouble later, in making the landing.



THE EXPERIMENT

Above is the bubble almost stationary in the falling bottle and virtually spherical in form. Below is a bubble made by simply inverting the bottle in the hands. Note its rather peculiar mushroom shape



The stationary bubble in the bottle can be observed, however, in a far less hazardous manner. After giving some thought to the problem of how to drop a bottle and release an air bubble at the bottom at the same moment, it occurred to me to toss the bottle into the air. After some little practice I learned how to do this in such a way as to bring the bubble to the center of the bottle at the moment at which it could most clearly be seen, namely, at the top of its flight when it is moving slowly.

If the bottle is properly thrown to a height of a foot or two above the head, we see the large silvery bubble poised at the center, almost spherical in form. If, however, we invert the bottle by a quick turn of the wrist, the bubble rises rapidly in a much flattened form having a mushroom shape. The two conditions are illustrated by photographs, taken with a shutter speed of 1-500 second with the sky as a background. The bottle was tossed up with one hand and the shutter sprung with the other.

THE best method of observing the suspended bubble is to stand facing the light, holding the bottle, cork down, loosely in the palm of the right hand at an angle of about 45 degrees, the arm hanging by the side. The bubble should be about the size of a peanut.

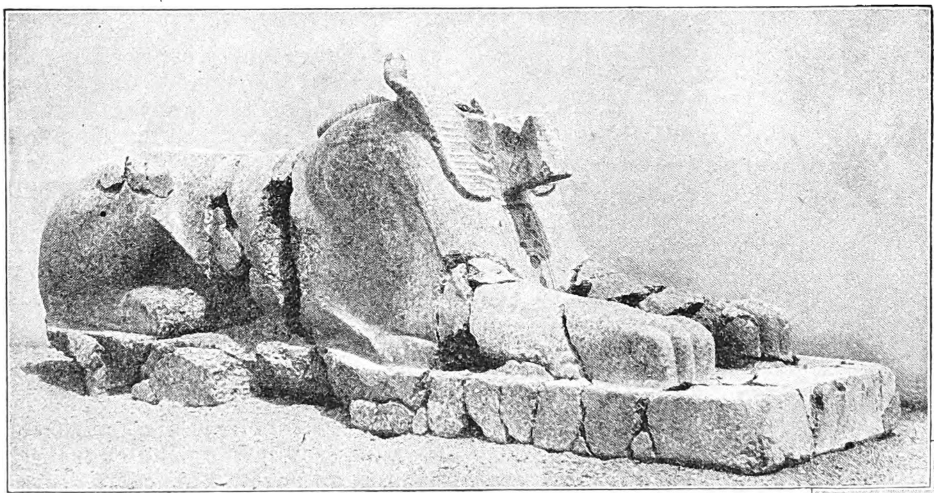
The bottle is now tossed up by a free upward swing of the arm, in such a way that it turns slowly and assumes an upright position at the top of its flight. The first attempt will probably result in a double somersault, but with a little practice the toss can be properly made. The best result is obtained by letting the bottle slide off the palm of its own accord, by straightening the fingers at the proper moment. If the bubble rises rather rapidly, as is sometimes the case, it is due to currents set up in the bottle by an incorrect release. However, a little actual practice will have more value than many words.

An Archeologist-Detective at Work

With Only a Vague Clue as a Starting Point, Queen Meryet-Amun's Tomb Was Unearthed

THE annual report of the Metropolitan Museum's excavations at Thebes is, as usual, written by Mr. Herbert E. Winlock, who has that rare ability of making archeology real and vibrant to the lay reader. It will be remembered that the stories of the expeditions in the last two years, presented in the SCIENTIFIC AMERICAN, have been very largely devoted to an account of the discovery of statues and sphinxes broken up and buried near Deir el Bahri. We have already related how Queen Hat-shepsut usurped the throne during the youth of King Thut-mose III and built a temple to justify her usurpation. When she died in 1479 B.C. the young king tried to expunge all memory of her by destroying inscriptions, statues, et cetera. Mr. Winlock says:

"To finish clearing away what still remained of Naville's debris [See SCIENTIFIC AMERICAN for June, 1929, page 522] and to expose the rest of the quarry was the task on which we spent the first part of the past season. Meantime, while the men were digging, we went back to the slow, laborious grind of sorting out and fitting together the fragments found during the previous years."



All photographs courtesy Metropolitan Museum of Art

Detective work by the expedition, on statues and sphinxes found at Deir el Bahri before the discovery of the tomb of Queen Meryet-Amun, brought other surprising results. The torso of one statue dug up by the expedition only a year or two ago at Deir el Bahri was found to fit a head taken by German Egyptologists to Berlin in 1843-45. The same situation existed in regard to a granite sphinx. The Metropolitan's expedition also discovered fragments of a statue of Queen Hat-shepsut, the torso of which was taken to Holland in 1869 by Prince Henry, High Admiral of the Netherlands Fleet. Negotiations are now afoot for the reuniting of these statues.

The next interesting feature which Mr. Winlock describes is the Osiride statue of Hat-shepsut referred to in our issue of June, 1929, page 524. Mr. Winlock continues:

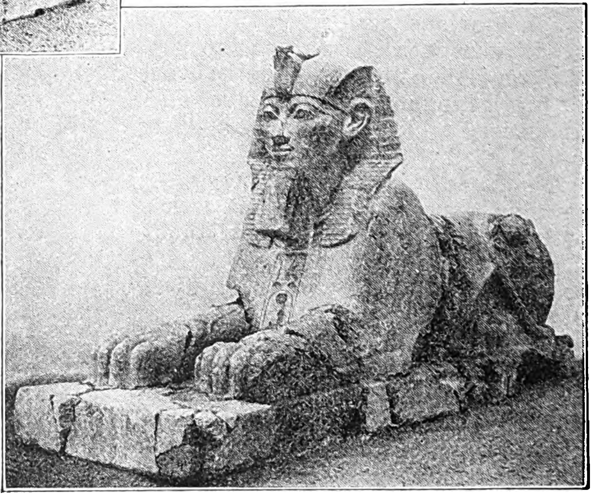
"For another piece of architectural sculpture—this time of gigantic size—the problem of location was solved last season and the actual reconstruction is now practically completed. We have unearthed fragments of two enormous Osiride statues and had been able to demonstrate that they had originally stood at the far ends of the two lowest porches of the temple."

The great story in the report on the 1928-1929 Egyptian Expedition is the finding of the tomb of Queen Meryet-Amun. After the search for statue fragments in the quarry and in the hole filled up by Thut-mose III, there was left only one more place where the archeologists believed that there was any likelihood of finds. On the hillside to the north of the temple there was a postern gate through which all sorts of rubbish and sweepings had been carried out in ancient times and dumped on the hillside. On it they noticed two chip heaps weathered during centuries and almost hidden by drift sand and fallen rock. Mr. Winlock says:

"We could see that the chip was shale from the lowest strata of the cliff and that it lay much higher up the slope than any natural agency could have carried it. Of course it was possible that we were dealing with heaps of shale dug out in leveling the temple courts below, but it was hard to see why the quarry chip from there should have been carried so far uphill—and across a ravine, at that. On the other hand it was equally possible that what we had were heaps of chip from the tunneling of some undiscovered tomb or tombs in the shale strata, and it was on this that we pinned our hopes.

"Naville had started to dig just outside of the temple wall—we had an old photograph showing some of his men working there—but he soon abandoned the place and covered the lower part of the slope with one of his inevitable dumps.

"AMONG the commonest questions put by the layman to the excavator is 'And how do you know where to dig?' If these words chance to fall under the eye of anyone who has wondered about it, an answer has been given for a typical case. In fact, the digging which took up the second half of our season involved finding the answers to so many of the everyday problems of excavation that it may be worth while telling the tale as we lived it on the spot. It had the usual delays and disappointments, the invariable surprise when the find was actually made, the laborious groping after the explanation of what had been found, and finally the arrival at a conclusion that seemed to fit the facts discovered. If the reader finds the tale involved in the telling he will get a very fair idea of the way things generally happen in the field."



THE SPHINX'S HEAD IS FOUND

The head was found in Berlin and the body was found in Egypt. They were pieced together; result, a perfect statue

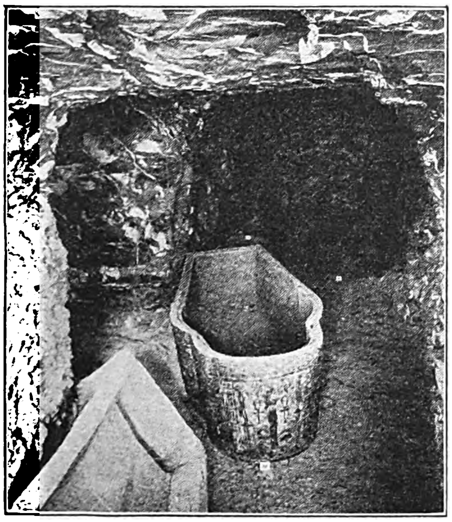
The remainder of Mr. Winlock's story must be somewhat abridged, although we shall not depart from his own words.

“The gang of workmen was started at the foot of the hill. On February 23—six weeks after we had started—the men found a rough hole in the rock. They cleared out an irregular, jagged opening, and, when they were about waist deep, brought to light some rather carelessly laid brickwork. As a matter of routine we put guards on the spot.

“The bricks were merely stuffed into the mouths of an opening and were only held in place with a little clay smeared along the top. The pit itself was filled with dirt, rags, bits of a large white coffin, and the lids of straw baskets. Then we took out a couple of bricks and flashed an electric torch inside.

“It was only then that we had our first hint that our tomb was not so simple and uninteresting. A jumble of white shawabti boxes and a headless Osiris figure could be seen just inside the opening. Beyond were several big round baskets to which the lids in the pit seemed to belong, piled against the wall of the corridor. Those big baskets were the kind usually associated with Eighteenth Dynasty tombs. Once our first surprise was over, we began re-adjusting our ideas. We jumped to the conclusion that we had found the tomb of another of Hatshepsut's courtiers.

“That night the tomb was sealed up again and heavily guarded. Then we started to remove the brickwork. One fact was soon established. Originally the corridor had been closed with a carefully built brick wall. All but the bottom courses of this wall had been broken down, and the tomb entered a second time, after which it had been reclosed with bricks and stones. Later all but three courses of this second blocking had been removed and the tomb entered a third time.



THE BRINK OF THE WELL
Here the empty outer coffin was dropped on the brink of the mysterious well

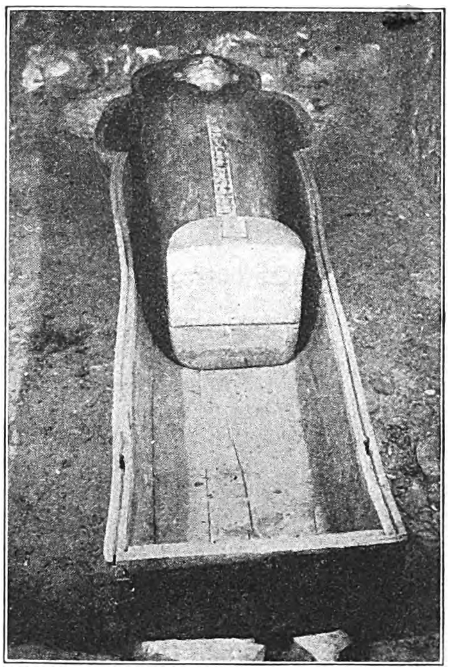
“The last people in the tomb had made a path along the corridor by pushing everything over to one side. On March 3rd I crawled in and gingerly followed in their footsteps. The passage was clear almost to the end, but there my way was blocked by a yellow, varnished coffin. Its lid was missing and inside it there lay a mummy with bandages absolutely intact and with garlands over its face and a wig at its head. Beyond it the lid of a large outer coffin was propped up on its side in a doorway leading to the right, and just beyond the doorway lay the empty outer coffin, the missing lid of the outer coffin, and the cover which belonged over the mummy itself. Here was a most surprising state of affairs. These coffins seemed to be lying just as they had been dropped by a burial party when something had interrupted them—and another flash of the torch showed what that something was. I was on the brink of a deep well that made an absolutely impassable gulf across the corridor. The real crypt of the tomb must lie beyond, and in the far left-hand corner across the well I could see a passage leading off to the left.

GIGANTIC
The problem of location being solved, masons “assembled” the statue of the usurping queen

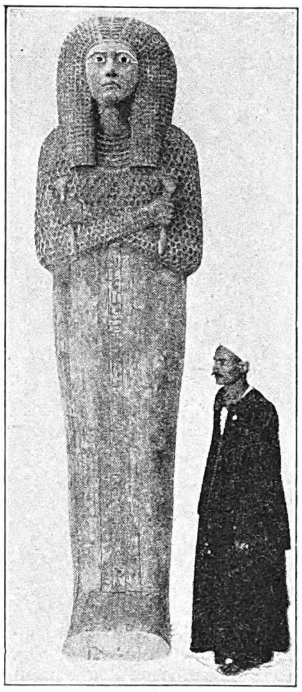
“For the time we were completely balked. The Osiris figure bore the name of ‘the House Mistress, the Chantress of Amen-Re, the King's Daughter of his body, his Beloved, Entiu-ny,’ and the same name appeared on the shawabti figures in the boxes. From the style of the coffins we could safely conclude that we had discovered another daughter of Paynudjem, named Entiu-ny, who died and was buried probably in the years just preceding 1000 B.C. When Entiu-ny died, somebody had known of the existence of this tomb. The pit was dug out, the blocking broken through, and the heavy outer coffin and the three lids were started down the passage. As soon as the first bearers had turned the corner at the end of the corridor, they found themselves on the brink of the well, and dropped their burdens. The bearers crowding from behind with the body had to drop it. Probably a discussion followed, which ended with some of the party leaving the others while they went off to look for a beam to bridge the well. Some were left out of sight among the coffins long enough to chop the gilded faces off all three lids. We could picture them hiding their plunder under their clothes when they heard that no beams could be found. Bricks had been hastily stuffed into the entrance, leaving the Princess Entiu-ny lying just where she had been dropped on the brink of the abyss.

“It was the morning of March 11 before the well could be crossed. We brought down a light beam and worked it across the deep well to the doorsill on the opposite side. On the first we slid a second beam, and on the two, a board. I crawled across on my hands and knees, tingling with curiosity.

“From the doorway on the other side there was one step down, and then inky blackness. I turned on my torch and flashed it around. I was in a chamber just high enough to stand up in, seemingly interminably long in the gloom—and blankly empty. For a moment the bottom seemed to have fallen out of everything, and then my light shone on a narrow doorway at the far end. I came to a standstill just within the doorway beside three little empty saucers and a dried and shrivelled bundle of leaves lying at the foot of an enormous recumbent figure. My light flickered along it, and came to rest on a great placid face staring fixedly upward



THE HUGE COFFIN
The inner wooden coffin of Meryet-Amun in the big outer coffin after removal of lid



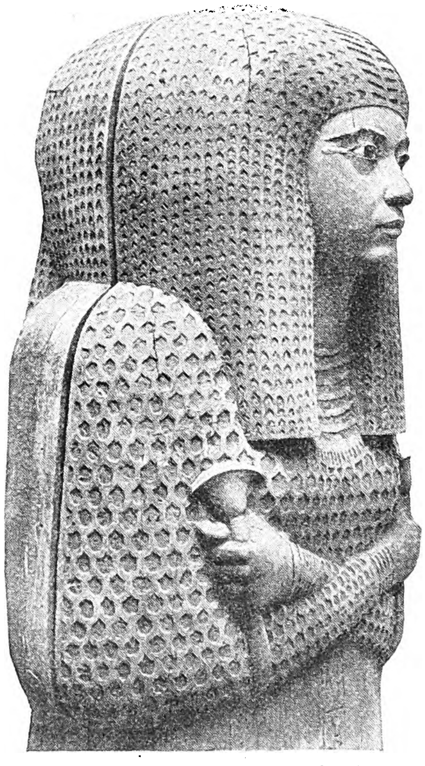
in the deathly silence of the dark crypt. Then it flickered back and followed down a column of hieroglyphs announcing that ‘the King gives a boon to Osiris, the Great God, Lord of Abydos, that he may cause to come forth at the call, bread and beer, beef and fowl, bandages, incense and unguents, and all things good and pure on which a god lives, and the sweet north wind, for the spirit of the King's Daughter and Sister, the God's Wife, the King's Great Wife, joined to the Crown of Upper Egypt, the Mistress of the Two Lands, Meryet-Amun, true of voice with Osiris.’

“On the 15th we raised the gigantic coffin lid and exposed a disproportionately small coffin inside. That was open, and we were looking at a slender little mummy, simply wrapped, and festooned with garlands still fresh enough to show the colors of their flowers. The inner coffin, while much smaller, had been almost as lavishly decorated. On the head we found a tenon hole which had once held the golden vulture head of a queen's crown, and all over the body were rows of nail holes showing that within and without the entire coffin had been encased in sheets of gold. None of this richness was left, however. In place of the vulture head on the brow a uræus had been painted; the wig was colored blue and the face yellow; a blue and yellow collar had been daubed over the breast; down the front was painted a copy of the inscription on the big coffin.

“WITH obvious signs of forcible opening on both coffins, we have a pretty clear story. At some time in antiquity, the tomb of Meyret-Amun had been robbed, and on the discovery of the outrage all that was possible had been done to cover up the damage. The date had been recorded in a docket; that second blocking of the doorway must have been done in 1049 B.C. by the necropolis officials who restored Meryet-Amun's mummy. So far we were still leaning toward our first idea that this tomb had originally belonged to Hat-Shepsut's courtiers. It was only when we had cleared the last of the rubbish out of the tomb that we changed our minds. A pile of rags had been thrown into the unfinished corridor to the left of the well. They turned out to be bandages ripped off a mummy, and among them we found one marked ‘The God's Wife, the King's Wife, Meryet-Amun, beloved Amun. May she live!’ These, then, were obviously the original bandages torn off Meryet-Amun's mummy by the thieves.

“Among other fragments of funeral furniture were bits of an enormous wooden coffin plastered over with white gesso. It had been actually big enough to hold the great coffin of Meryet-Amun. Here was the third outermost coffin of Meryet-Amun so completely wrecked by the thieves it had simply been swept out of sight at the time of the restoration. It followed that Meryet-Amun had been robbed here in this tomb. Thus we arrived at the conclusion that we had discovered the tomb of Queen Meryet-Amun.

“In the first corridor two things gave us a very good idea of the period when the tomb was constructed. That corridor passed obliquely under the north portico of the temple so close that the under side of the temple foundations was actually exposed in one place in the corridor roof, hanging precariously over our heads. Now it is possible to dig under foundations once they are set, and even to expose them without necessarily bringing them down, but it is absolutely impossible to lay heavy stones unsupported across a void. Thus the tomb must have been made after the middle of the Eighteenth Dynasty, when the temple was built. Therefore, we felt safe in dating the tomb of Meryet-Amun to the second half of the Eighteenth Dynasty, and her coffins confirmed this date absolutely. Meryet-Amun could not have been buried earlier than 1480 B.C., when the temple was finished, and probably not much later than about 1440 B.C. The only question that remained was to settle the identity of Meryet-Amun herself. Two queens of that name were known, but our queen could be neither. There remained a Princess Meryet-Amun—‘the King's Daughter, the King's Sister, the God's Wife and Hand (-maiden?), sweet in love, living like Re‘ ’—portrayed in the Shrine of Hat-Hor erected at Deir el Bahri by Thut-mose III. This Meryet-Amun was the ranking daughter of Thut-mose III and of his Great Wife, Meryet-Re‘. The Princess Meryet-Amun, the daughter of Thut-mose III, must have been the wife of his heir and successor, Amen-hotep II. Since Amen-hotep II succeeded in 1447 B.C., and as we already had evidence to place our Queen's death somewhere between 1480 and 1440 B.C., we felt convinced that the two Queens Meryet-Amun were one and the same person. During her father's lifetime she had been ‘the King's Daughter.’ After his death she had become ‘the King's Great Wife.’ But the last title—‘the King's Mother’—had never been hers. She must have died soon after the coronation, for Queen Ti-’o occupied the position during most of Amen-hotep's reign. Of Meryet-Amun, no recognized trace existed until we found her tomb.



ORIGINALLY GOLD COVERED
Once of a richness comparable to the coffin of Tutankhamen, but vandals have completely stripped off the decorations

“KNOWING now, with fair assurance, who Queen Meryet-Amun was, we can complete the story of the tomb. Work was begun on it at least as early as her coronation but it was still unfinished when she died soon afterward. There was no time to hew out an actual burial crypt and her gigantic white outermost coffin was installed in the last of the unfinished passages beyond the well. On the day of her funeral came the enormous coffin overlaid with gold and brilliant with incrustations, the little innermost coffin just large enough to hold the mummy, and the mummy itself heavy with jewelry within its bandages. The coffins were closed, the richest of the tomb furniture was placed nearby, the bridge across the well was removed, and the baskets full of the less valuable clothing and food were stacked in the outer corridors. Then the entrance was carefully bricked up and the pit filled in—and Meryet-Amun lay in peace for the next four centuries.”

Submarine Safety Advances

The "S-29" Is Now a Floating Laboratory for Testing Sub-Sea Safety Devices

LIFTING EYE

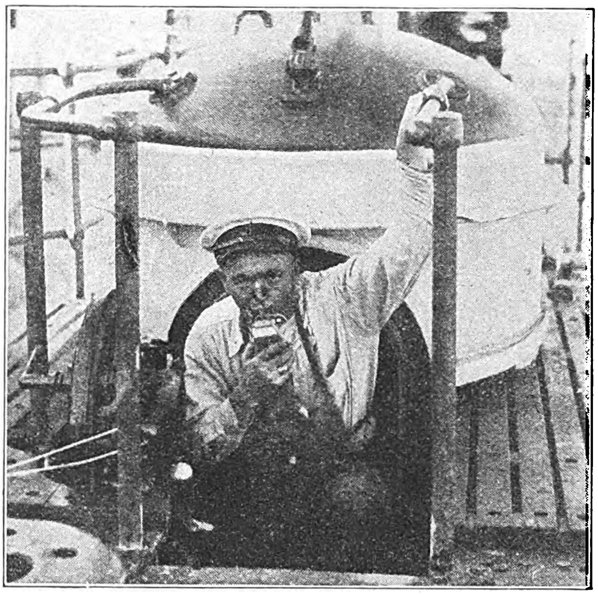
The eye on the hull of a submarine for attaching a pontoon

SINCE 1923, eight United States submarines have been in serious accidents. Only three of these resulted in death to members of the crews but the great hazard of submarines to which all these disasters pointed served to accentuate the widespread insistence that safety measures be taken and safety apparatus be devised to protect, and save in case of trouble, the lives of submarine crews.

Loss of the *S-51*, on September 25, 1925, with five officers and 31 men was appalling enough but when the *S-4* was rammed and lost on December 18, 1927, with her entire crew, matters were brought to a head. The government renewed its submarine safety efforts in earnest. Thousands of ideas were submitted by scientists, engineers, inventors, and laymen. Most of these were quickly discarded but others were considered further; some have been worked out and tested, and a few are still being experimented with.

PERHAPS the most valuable device recently developed in this country is the Momsen "lung," an illustration of which is shown on this page. Named after its inventor, a lieutenant in the United States Navy, this lung is, in effect, a miniature diving apparatus which, when worn, permits the wearer to rise safely from a sunken submarine without danger of suffocating or drowning. This and the other devices shown here are installed on the submarine *S-29* which recently arrived in San Diego Harbor equipped with all the latest rescue and salvage devices. These devices will be tested this winter and early spring.

It has been asserted that submarine design and construction in the United States has been far in advance of that of other nations and our accidents fewer than in any other comparable navy. Not content with this high place, government experts are continually working to devise new safety apparatus and to improve the old.

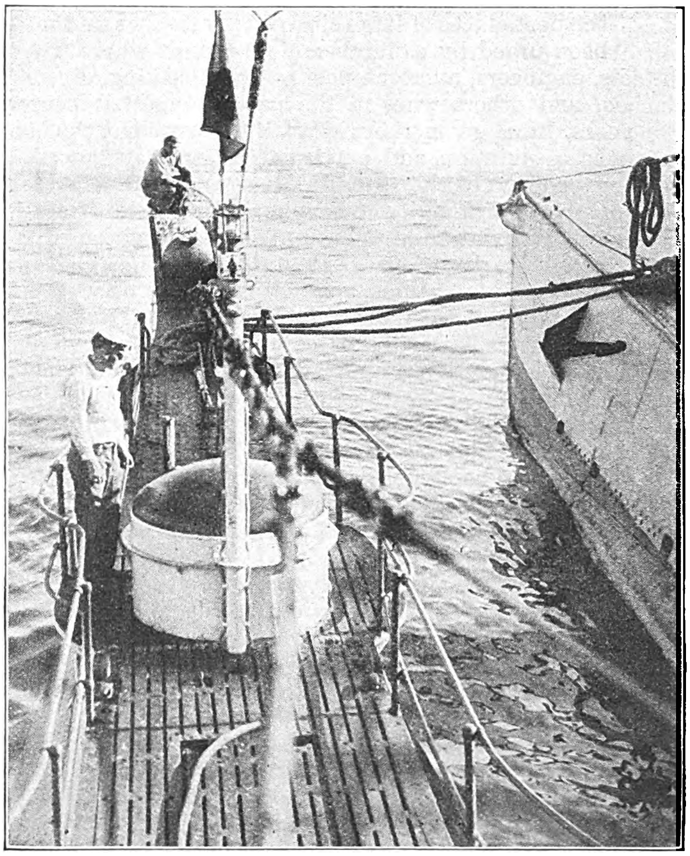


MOMSEN "LUNG"

The breathing mask which men will use to escape sunken submarines

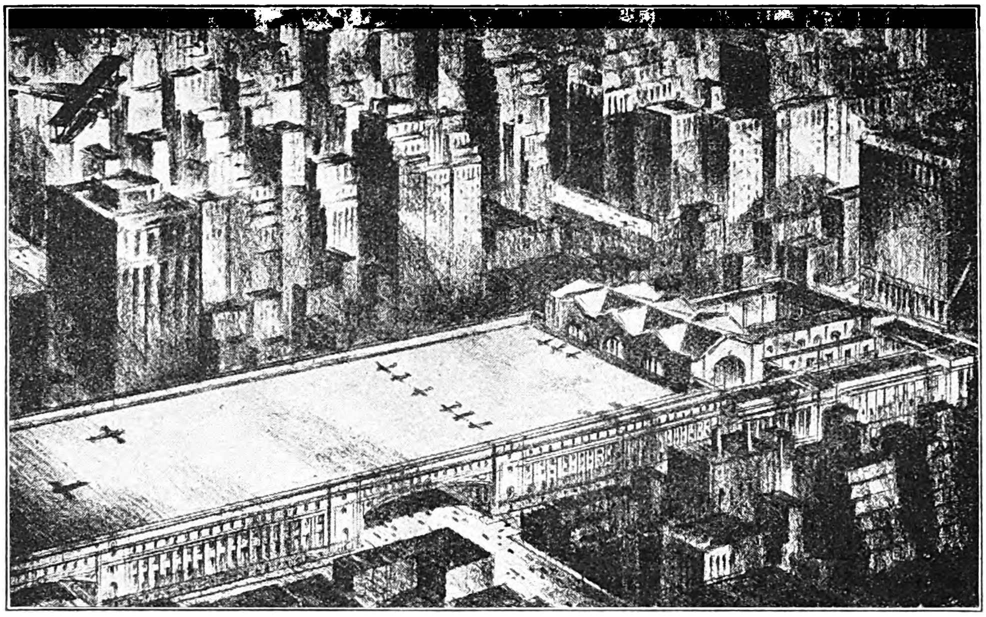
UNDERSEA COMMUNICATION

A member of the crew of the submarine *S-29* demonstrating the use of buoy telephones for talking with a sunken submarine



THE ESCAPE HATCH

This view taken from the conning tower shows an escape hatch and the buoy which carries a telephone line to the surface



IN THE HEART OF THE CITY

Planes landing on this platform "field" over the Pennsylvania Railroad tracks in New York City, conceived by Francis Keally, could discharge their passengers directly in the city while their mail could be shot directly to the branch post offices in the city by pneumatic tubes

Faster Airmail Terminal Service

Pneumatic Tubes Like Those in Cities Between Branch Post Offices Would Speed Airmail Between Post Offices and Airports

By HAMILTON M. WRIGHT

PNEUMATIC tube service for airmail from outlying airports into the post offices of large cities has been urged by a number of architects, engineers, aviators, post office officials, and others who, in the past two years, have given thought to the problems of aviation and particularly to the expedition of the airmail. Since the dispatch of airmail is the backbone of commercial aviation in this country, and since the airmail is constantly assuming larger proportions, any means which will improve this new branch of the postal service is worthy of careful analysis. The present importance of airmail is illustrated by the fact that the scheduled daily mileage of mail pilots in June 1929 was 38,689 miles! But this is only a beginning. Important postal officials have predicted that in a very few years *all* first-class mail will be carried by air.

Unfortunately for aviation, obstacles dangerous to fliers exist in the vicinity of large cities so that mail-contract airports are necessarily located at some distance from post offices and commercial centers. These suburban locations place air terminals at a disadvantage as compared with railway terminals which are much nearer the post offices.

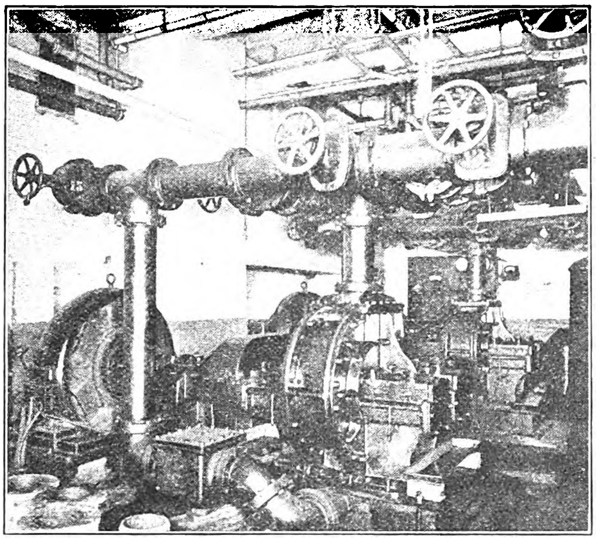
A pneumatic tube for carrying mail between airports and post offices would, however, offer safe, economical, uninterrupted, and rapid service. It is, of course, essentially adapted to large cities where the amount of mail is vast and where the airport is, generally speaking, six to 15 miles distant from congested centers. Other means to overcome the handicap of airports have been suggested, such as dropping the mail from parachutes into nets, building landing stages on the roofs of tall city buildings, or constructing elevated landing platforms above switching yards or wharves in cities adjacent to commercial centers. All these, however, are inherently more or less uncertain or dangerous, and even a helicopter plane, it is said, would not find the proximity of large city buildings conducive to complete safety.

THERE is a great inconsistency between the 100-mile-per-hour, or more, rate of fliers to carry the airmail on time and the slow truck traffic to the distributing centers. It takes a bus 45 minutes to run between the Newark airport and the Hotel Pennsylvania opposite the main New York Post Office.

This sort of delay, to a greater or less degree, but always to an important extent, will occur where trucks must be employed to carry mail between airports and post offices through congested areas of great cities. The red stop light traffic signal is no respecter of vehicles, not even of mail trucks.

The Joint Commission on Postal Service which from 1921 until 1924 made an exhaustive study of the postal system, reported to Congress that on one day that was studied 27,166 mail containers with a capacity of 10,846,400 letters were dispatched through the pneumatic tubes in New York City, and that, for each letter delayed by the tubes, 3915 letters were delayed by the motor vehicle service. They also said that the operation of the tubes and the reduction of the motor vehicles service would reduce the number of accidents in congested streets of New York which, in 10 months, resulted in seven cases of fatal injury and 99 cases of other injuries caused by government-owned vehicles.

Other points were that the pneumatic tubes as a means of transmittal of the mails are secure and reliable; that the delivery of letters is expedited from two to four hours or more by utilization of the tubes, and that the speed of transportation by tube is 30 miles per hour, whereas the speed of transportation by motor vehicle in New York is but 7½ to 10 miles per hour; that approximately half a million letters a day would be advanced in delivery by means of the tubes; and that the tubes have a value apart from speeding the mail, in that they stand ready at all emergencies and are not subject to the irregularities experienced by the motor vehicle service.



BROOKLYN AIR POWER STATION

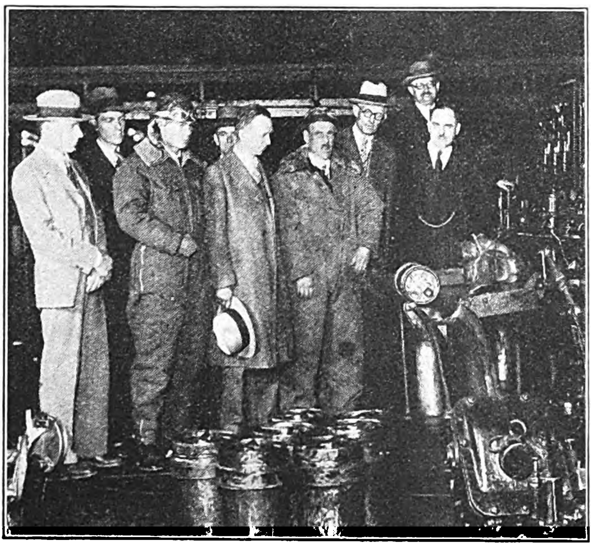
Electrically driven compressors and rotary blowers which supply air to the tube system in Brooklyn

Largely as a result of this report, the pneumatic mail-tube service was resumed in New York and has given excellent results. Letters are now carried more than 140,000 carrier-miles per day beneath the streets of New York, equal to a daily journey of five and two thirds times around the world. The "petit bleu" pneumatic tube service for special delivery mail in Paris is too well known to any experienced visitor there to require any description. Pneumatic tube service also exists in London, Liverpool, Berlin, Vienna, and other cities.

In New York City the pneumatic tube system consists of 27½ miles of double tube extending between the Battery and 125th Street on both sides of the city, and across the Brooklyn Bridge to the Brooklyn Post Office. There are between four and five miles of double tube in Brooklyn.

In New York the operation has reached a remarkably high stage of efficiency. The efficiency of service for several years has averaged better than 99 percent. Interpreting the figure 99.9661 percent for 1928—a typical year—we see that the pneumatic mail-tube service in New York City was within one twenty-fifth of 1 percent of perfect operation. The saving in time in the arrival of mail at its post office destination to reach early mail carriers and for outgoing mail to reach departing trains is one of the outstanding advantages of the system. This advantage could as readily be transferred to the dispatch and receipt of airmail.

The cost of constructing a pneumatic tube system similar to that in New York is estimated at approximately 19,500 dollars per mile. It would cost, therefore, approximately 195,000 dollars to install the system between Barren Island, New York City's new municipal airport, and the Brooklyn Post Office. But the tube would pass five post offices en route and give important factory districts the same mail service that Wall Street now enjoys. Installation of smaller sized tubes like those used in Berlin—for example about 2¼ inch—would cost less for less important airports. The tube system in New York is privately owned, the owners contracting with the government for the handling of mail. According to the majority report of the Townsend Congressional Committee, their use effected a saving as compared to mail trucks.



TUBE MACHINERY

Clarence Chamberlin, consulting engineer for the Barren Island airport, who advocates a mail tube system between the port and New York City, inspecting the pneumatic tube machinery at the General Post Office, New York City

Just a word as to construction of the tubes. They are made of sections of cast-iron pipe approximately 12 feet long, bored out to an inside diameter of 8⅛ inches—designated as 8-inch tubes—and joined together with bell and spigot joints caulked with lead or other suitable material. Change of direction in the tube is accomplished by sections of tube bent to a long radius at true curvatures to permit the containers to slide along without reduction in speed.

The tubes are laid approximately four feet underground between stations.

The containers in which the mail is packed are steel cylinders, 7 inches in diameter and 21 inches long (inside dimensions), and weigh approximately 20 pounds each when empty. The front end of the container is solid and is equipped with a leather buffer designed to absorb the impact when the container is brought to rest. The rear end of the container is a hinged cover, which is opened for the insertion of mail and which, after being closed, is locked by means of an eccentric lever connecting with inside bolts which engage the rim of the cylinder in suitably designed slots. When the cover is unlocked this lever projects beyond the edge of the outside periphery of the cover, thus preventing the container being placed in the tube until the cover is properly locked.

The shell of the container is kept from contact with the tube by means of two bearing or packing rings located near the ends of the container, composed of cotton, duck, and vulcanized rubber, and held in place by keeper rings brazed to the shell of the container. The container slides in the tube on these packing rings, and the tubes are lubricated from time to time to facilitate the passage of the container. The power which propels the containers through the tubes is a current of air which is maintained constantly through the tube at a pressure of from four to eight pounds per square inch, according to the length of the line, by electrically driven air compressors and rotary blowers.

Each station on a pneumatic-tube line is equipped with a receiving and sending apparatus, commonly called a "receiver" and a "transmitter," and the containers are relayed at each station on the line until they reach the station of delivery.

Different types of "receivers" and "transmitters" are used, the receivers being divided into two general types—the "open" and the "closed." With the open receiver, the container is brought to rest by the friction created in its travel around a circular table or trough formed of a half longitudinal section of tube bent to the desired radius. With the closed receiver the container is brought to rest by the compression of air in the dead end of the tube forming an air cushion which, in turn, opens a valve and ejects the container. The "transmitter" most commonly used is of the gravity type, set in the floor at an angle.

The container is dispatched by placing it in a scoop or trough with its front end resting against the upper gate. This gate opens at the interval of time fixed by a time clock, allowing the container to drop into the air chamber. Air pressure is then brought behind the container, forcing it through the lower gate and into the tube, where the current of air carries it to the next station. The system is similar to a stream of water into which floating objects are dropped at stated intervals.

What's In the Sun?

Not Only What Elements Exist in the Sun's Atmosphere, But Now Their Percentages, Have Been Worked Out by Improved Analysis

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

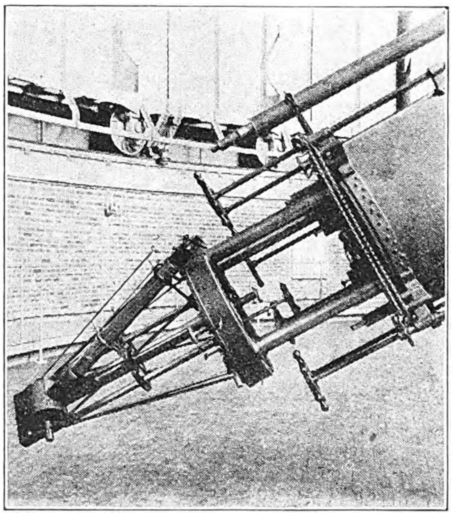
WE told last month how, by measuring the width of lines in the solar spectrum, it is possible to find how many atoms are at work above a given area (say a square centimeter) of the sun's surface in absorbing each particular line. Many readers doubtless realize the possibility of using this method for an improved analysis of the composition of the solar atmospheres. The older method which depended merely upon the identification of solar lines told us only what elements were present there. It was like the qualitative analysis with which the student of chemistry begins—very like it indeed, for these tests in the laboratory give the student an idea whether a given metal is present in large quantities, small quantities, or mere traces, and the same can be concluded from the presence of strong lines, weak ones, or very faint ones in the sun.

But the chemist will not be satisfied with this information. He devises schemes for quantitative analysis which end by telling him the exact percentage composition of the substance he had studied. To do the same for the sun and perhaps also for the stars has long been one of the dreams of the astronomer. Now the dream is coming true.

FIRST steps were taken by Professor Milne (now at Oxford) who devised ways by which the composition of different stars could be compared, even though some were hotter than others. Miss Payne, working at Harvard by this method, found that the numerous stars which she studied were "remarkably similar" in composition, and obtained good estimates of the relative abundance of a considerable number of the more important elements. Now the analysis has been carried further and applied to all the 57 elements which have been detected in the sun's atmosphere.

At first sight the problem looks simple enough. If we can measure the width (technically speaking, the "contour") of one line and calculate how many atoms are at work making it we can do so for all the 20,000 lines in the solar spectrum. Then, adding together the results for all the lines of iron (for example) we have the amount of iron in the sun's atmosphere.

But it is not really quite so easy. In the first place the finer lines are so narrow that even our greatest spectroscopes lack the defining power to show them perfectly; they make them look wider and less black in the middle than they really are. Moreover, influences in the sun's atmosphere may widen the lines slightly—not enough to count for a strong line but quite enough to upset our calculations on a weak one. Fortunately there is an easy way to get around this difficulty. There are hundreds of groups of lines—"multiplets"—in the spectrum for each of which we can calculate theoretically the relative number of atoms at work. For example, twice as many calcium atoms are "doing" the K line as are at work on the H line. In other cases the rate runs up to 100 or even 1000.



Courtesy Yerkes Observatory

SOLAR SPECTROSCOPE

Attached to the great 40-inch refractor at Yerkes Observatory. A more or less "typical" instrument for work on the sun

BY utilizing the rich material thus available it is obviously possible, and was not very difficult when it was tried, to find the relative numbers of atoms which were required to produce lines of different intensities on the arbitrary scale which Rowland used in the great tables of the solar spectrum. We already have, thanks to Unsöld, determinations of the actual numbers of atoms at work on a dozen or so of the stronger lines. With this starting point we can now find it for all the rest.

For the lines which Rowland described as of "intensity 0," that is, those which were just strong enough on his photographs to measure easily, the number of atoms at work comes out at 6,000,000,000,000 (6 x 10^{12}) above every square centimeter. This looks startlingly big, but a layer of ordinary air 1/1000th of an inch thick contains 6 x 10^{12} as many molecules per square centimeter. So we reach the amazing conclusion that to produce one of these faint solar lines would require only a layer of gas 10,000 times thinner than air and a thousandth part of an inch thick, provided of course that all the atoms of this gas were at work on the line. Remarkable as this is, it is fully credible to anyone who knows the extraordinary delicacy of the spectroscopic method of analysis, which habitually reveals traces far too small to be detected by ordinary chemical means.

THE general run of the strong lines of the spectrum for which Rowland's intensity numbers range from 7 or 8 up to 40 demand for their production from 1000 to 20,000 times as many atoms; the H and K lines, which are vastly stronger than any other, about a million times. For the faintest line (of intensity −1 to −3) the number varies from 30 percent to 2 percent of the standard.

We have now overcome this obstacle and can calculate with some confidence how many atoms produced each line. We should be near our goal if the whole extent of the sun's spectrum could be observed.

But this, though it might be possible if we could set up an observatory on the moon, is out of the question for us who dwell on the earth. The atmosphere above our heads, although reasonably transparent to the kind of light which our eyes can see, obstructs the passage of most others. Not very far beyond the range of ordinary observation in the violet, and hardly at all beyond the limit to which the human eye can see under favorable circumstances, the air becomes opaque. For waves of light shorter than about 3000 Angstrom units (the ordinary violet is at 4000) our air transmits not the faintest trace of the rays, which we have no doubt at all that the sun emits and emits strongly.

We know what is to blame—a small proportion of ozone in the upper atmosphere higher than any aircraft or even a pilot balloon may hope to rise. Beyond the wavelength limit mentioned, down through the whole range of shorter light waves, all direct knowledge of the radiation of the sun and stars is permanently denied us.

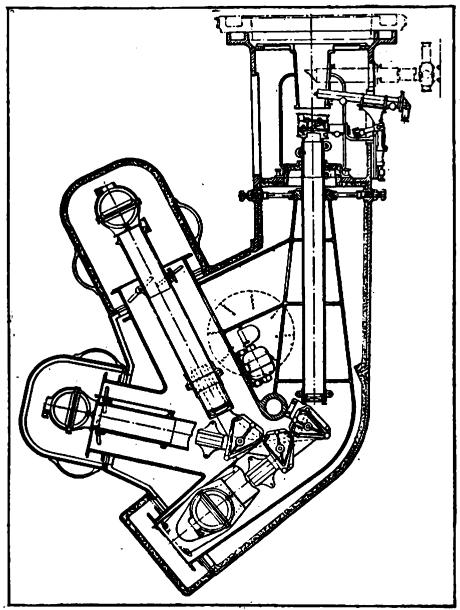
Beyond the red end of the spectrum things are not quite so bad, but there are wide and heavy bands of absorption, due mainly to water vapor, which cut off great regions of the spectrum, and the rest can be observed only by heat-recording devices which, sensitive as they are, are vastly inferior to the eye or the photographic plate. Only the portion of the spectrum between 3000 and 11,000 Angstrom units is accessible to precise astrophysical study.

If, then, an element has practically all its strong lines in this accessible region we will obtain a correct determination of the amount of it in the sun's atmosphere. But if not, our estimate will be too low and may be altogether vitiated.

A few years ago, before the structure of the more complex spectra was understood, this difficulty would have been insurmountable. But now we know for a large majority of the spectra not merely what sort of atom produces the lines but in what state the atom has been to absorb any given line. Some are given by neutral atoms, others by ionized atoms which have lost an electron. Some are produced by atoms in their normal state, others only by atoms which have been "excited," that is, loaded up with an additional store of energy and so raised to one or the other of a large number of additional states. The great majority of the atoms of any one element at any instant will be in the normal state, but a certain proportion will be in each of the excited states. This proportion can be calculated if we know how hot the sun's atmosphere is—which fortunately we do pretty well. For some of the metals such as iron and titanium the strongest lines absorbed, both by the normal state and several of the excited states, are accessible. We can then find the number of atoms in each of these states and the results check with the theoretical calculations closely enough to indicate that it is really safe to apply the theory (which was devised under the assumption of simple idealized conditions) to the actual atmosphere.

THE "abundance," that is, the number of atoms above a square centimeter of the sun's surface, may then be found for a large number of the metals. For some of the others, such as magnesium, the lines absorbed from the normal state are practically all in the ultra-violet and inaccessible, but the lines of the excited atoms remain to work with, and having tested our method we can calculate the whole number of atoms with confidence. Indeed we can get a good idea how strong the principal lines of these elements would appear if we could get outside the earth's atmosphere and look at them. There is a great line of magnesium, for example, at λ2852 (just inaccessible) which must be even stronger than the H and K lines.

So far we have really been talking only about the arc lines, those of the neutral atoms. The ionized atoms must be handled separately but can be treated quite in the same way. In most cases the "ultimate" lines absorbed by the ions in their normal state are quite out of reach, but there are several elements—calcium, titanium, and so forth—for which we can get at them. In these cases we can find the whole number of ionized atoms, as well as that of the neutral atoms. Now the latter of these two depends not only on the temperature of the sun's atmosphere but also on the average pressure; and also, of course, upon the ease of ionizing atoms of each sort. It thus enables us to calculate this average pressure. The results, calculated independently from five different elements, agree satisfactorily.



Courtesy of *Engineering* (London)

A TYPICAL SPECTROGRAPH

Made by Hilger for the new 36-inch reflector for Edinburgh Observatory. Cross-section shows heat-insulated case, motor-driven fan for even air distribution, three prisms, and three cameras. Note hole for main pivot. This permits moving any camera to any part of spectrum

We can now handle one more situation which previously was intractable. Sodium, for example, is very easily ionized, but the principal lines of the ionized atoms are far out in the inaccessible region, and so the amount of ionized sodium can not be found by our spectroscopic analysis. Knowing, however, the average pressure, we can calculate it, and it comes out 1600 times as great as that of the neutral element. The familiar D lines of sodium in the yellow, then, although they are strongest in this part of the spectrum, must be mere wraiths of what we would see if the sun's atmosphere were cooler and the ionization much smaller.

Working step by step it has finally been possible to obtain a complete quantitative analysis of the sun's atmosphere with respect to the metallic elements.

The non-metals are much harder to handle, for their ultimate lines are utterly out of reach, and the only lines we can get at are produced by highly excited atoms. Theoretically, at the sun's temperature not one atom in a million should get into such a state. Various factors of which it is not yet practicable to take exact numerical account may, however, operate to modify this number. The fact that these high excitation lines are present at all in the sun, although faint, shows that the corresponding elements, oxygen, carbon, sulfur, and so on, must be very abundant, but only the roughest numerical estimates can be made. Hydrogen is remarkable, for its lines, although absorbed only by very highly excited atoms, are among the strongest in the whole solar spectrum. There can be no doubt that it is much more abundant than any other element—if we count atoms by number, and light as its atoms are, their total weight probably exceeds that of those of any other sort.

AN investigation recently completed by the writer leads to the following estimated composition of the sun's atmosphere:

	Parts by Volume	Parts by Weight
Hydrogen	60	60
Helium	2?	8?
Oxygen	2	32
Metallic vapors	1	32
Free electrons	0.8	0.0005

The numerical values just given may be considerably changed by future work, but the hydrogen flavored with oxygen and metallic vapors seems likely to stand.

The amounts of the various metals can be stated with much more confidence. Expressed in grams per square meter of the sun's surface the amount of the principal metals are:

Sodium	40	Scandium	0.02	Cobalt	2.5
Magnesium	150	Titanium	0.8	Nickel	4.
Aluminum	6	Vanadium	0.5	Copper	0.6
Silicon*	60	Chromium	2.5	Zinc	0.5
Potassium	25	Manganese	4	Strontium	0.015
Calcium	20	Iron	100	Barium	0.025

No other metal reaches as much as 0.01.

Many conclusions might be drawn from this table but there is no space to speak of them now.—*Florence, Italy, Nov. 3, 1929.*

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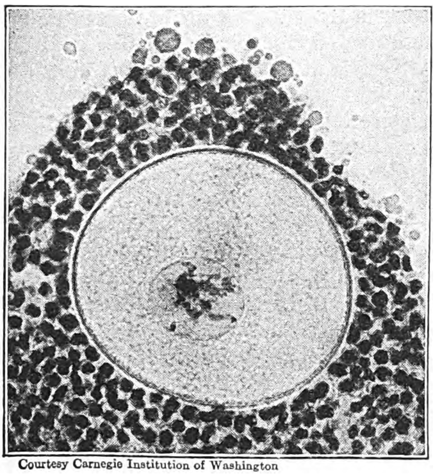
*Silicon behaves spectroscopically like a metal.

How Large Is the Human Egg?

Some of the Findings of Recent Research Upon the Eggs of the Human Species, and Those of Other Mammals

By CARL G. HARTMAN, Ph.D.

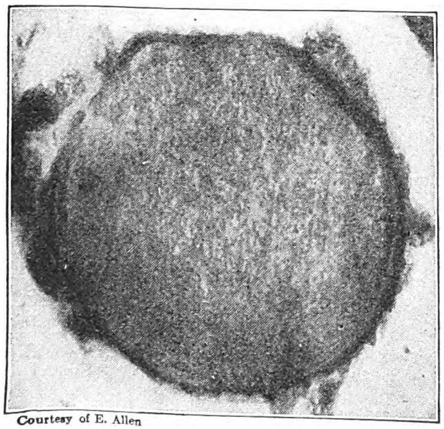
Research Associate, Department of Embryology, Carnegie Institution of Washington
Carnegie Laboratory of Embryology at Johns Hopkins Medical School



Courtesy Carnegie Institution of Washington

A HUMAN EGG

The egg is surrounded by nurse cells in the ovary. The view is a cross-section



Courtesy of E. Allen

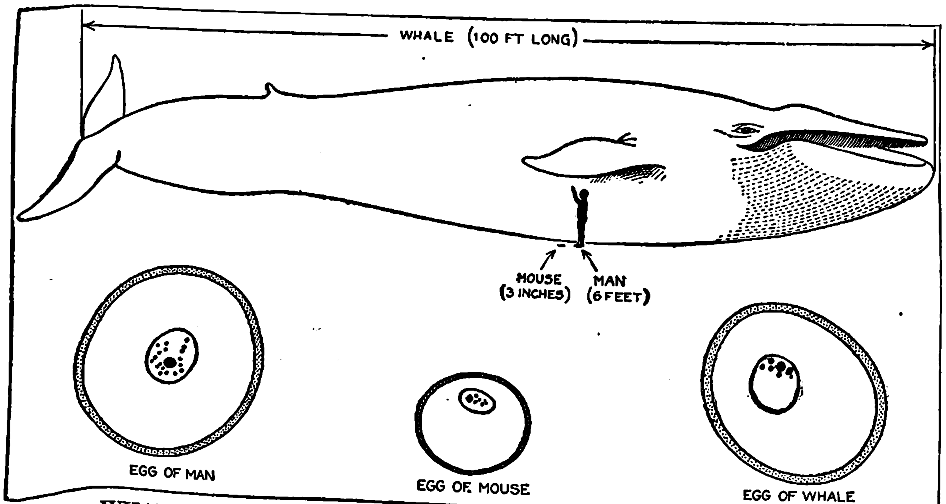
YOUNGEST HUMAN EGG

The youngest human egg yet discovered. Unfortunately this egg was not fertilized

THAT there is such an object as an egg, wherein every human being has his origin, no longer astonishes the layman. Few people, however, realize the minuteness of this all-important microcosm, which is pretty near the borders of unaided human vision. To gain a concrete notion of the size of a human egg, scatter a pinch of sea sand over a sheet of black paper and find the smallest visible grain. This is of the order of magnitude of a human egg. Yet this egg is larger, by a fraction, than most mammalian eggs—it is about double the size of those of the mouse or the rat, which are the smallest, and larger than that of the horse or the cow. But such differences are not significant.

It is no wonder, therefore, that the egg of mammals should remain undiscovered so long, for it was not until the year 1827 that von Baer, a Russian biologist working in Germany, was able to point out the egg of mammals and to tell us something of its size and where in the ovary it was to be found. This marked an epoch in the study of human and animal life.

Throughout the hundred years following, many mammals were studied, rabbit eggs being especially singled out. This was for biological reasons and not because of the traditional activity of the Easter Bunny—the legend of Mother Rabbit is older than any scientific studies upon her. Rat, mouse, dog, cat, pig, and other species have yielded eggs in greater or lesser abundance, according to the difficulty of finding the eggs in any given animal species, and depending upon the perseverance and ingenuity of the investigator.



WHALE EGG, HUMAN EGG, MOUSE EGG—ALL ABOUT EQUAL SIZE

All the mammals have eggs of approximately equal size. The whale, largest mass of flesh controlled by a single brain, originates in an egg little larger than that of a mouse

As a result, we know pretty well what happens during the first few days after conception in a half dozen species of animals; indeed, it has been possible to record in motion pictures the changes of the rabbit egg during the first five days of its development.

Until last year no one had ever succeeded in finding a freshly shed human egg, although a year and a century had passed since von Baer first saw the human egg in the ovary. The fact remains, however, that, except by analogy with animals, we know almost nothing about the development of a human being during the first 12 days of embryonic life. This hiatus in our knowledge bids fair to be filled within the next few years.

THE small size of the mammalian egg demands an explanation. It is the smallest egg of all the vertebrates, yet mammals are among the largest animals that ever walked the earth or swam the seas. By way of contrast, the ostrich egg measures six inches in length and holds a quart of food for the ostrich chick; a certain man-eating shark has an egg eight and one half inches in diameter; the eggs of snakes and turtles, fishes and frogs, possess yolk and egg-white to nourish the developing embryos, so that upon hatching they can survive in a new environment. The mammal embryo, however, and even the egg before the appearance of the embryo, has learned to parasitize the mother directly. Not content to consume the food which the mother's organs place into the egg (as is the case in the bird, for example), the mammalian embryo "digs in" and lives at the expense of the mother's body. It effects its purpose by growing a system of blood vessels and laying them down next to those of the mother's womb. There food and waste substances are exchanged, and there the embryo may remain during a variable length of time until birth.

There are some exceptions to this rule for mammals—links, as it were, in the evolutionary chain. There are, for example, the curious monotremes of Australia, that land of biological surprises—two genera: *Ornithorhynchus*, or the duck-billed platypus, and

THE author of the accompanying article modestly has made little or no direct mention of his own part in the newer research on the living egg of the mammal. The especially interested student will find a technical study of the subject, with further bibliography, by the same author, in the *Quarterly Review of Biology* (Baltimore) Vol. IV, No. 3—*The Editor.*

Echidna, the Australian ant-eater. These mammals actually lay eggs: the ant-eater deposits an egg into a brood pouch on her abdomen; the duck-bill lays a pair of eggs in its nest where it incubates them like a hen. Comes a time for the young to hatch. These wiggle about the milk glands of the mother, setting up an irritation that results in the milk oozing out. This the babies lap up, for these mothers have no nipples. Since they have mammae, or milk glands, it must be admitted that they are mammals, but the mammae have only just "arrived."

Next in the evolutionary series are the marsupials, which, as the name implies, have abdominal brood pouches like the *Echidna*. Our American curiosity, the opossum, is our only marsupial; the others, like the kangaroo, all live in Australia. The marsupials no longer lay eggs; their eggs are reduced in size like those of other mammals, but are provided with eggwhite and a shell membrane. These increase the size of the egg so that only 50 can be laid in a row to make an inch, instead of 170 without the envelopes. Of the full-sized eggs with the envelopes, a thimble would hold no more than 15,000. The opossum eggs are beautifully transparent things when well illuminated under the microscope. Magnified, they look like delicate soap bubbles or spheres of blown glass.

The opossum embryo develops in the mother's womb for only a short time—it is not yet an expert in parasitism. After only 12 or 13 days the babies must be born; tiny bits that they are, 18 of them will just comfortably fill a teaspoon. But Nature has its compensations; it has provided a brood pouch on the mother's belly around the tiny udders. Here food, warmth, and shelter for two months bring the babies to where their eyes are open and their legs are strong.

A PEG higher in the scale come the rabbits. Their eggs have no shell membrane, but they still possess a large amount of egg white, like their contemporary ancestors, the marsupials. All other mammalian eggs, including the human, have lost the egg white and are tiny spheroids of protoplasm. They have become much alike. There are minor differences: the opossum egg has more fat, the dog egg is opaque, while those of the mouse and rat are very transparent. Fundamental differences doubtless exist but they are not discoverable by present means. All rabbit eggs look alike, yet if you take the eggs from a black rabbit and place them in a white mother, the offspring will all be black.

Perhaps the differences between a mouse egg and a whale egg are as great as between adult mice and whales, but size is not one of the characteristics wherein they differ. From the Greeks to the moderns, philosophers have theorized on this point, but their theories are of historic interest and belong to the realm of metaphysics, not biology.

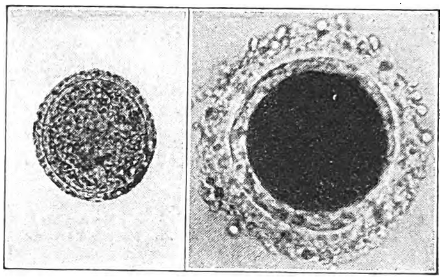
To visualize still better the minuteness of the eggs of mammiferous quadrupeds, let us single out the human egg and make another comparison. Let us assume that the entire human race comprises in the aggregate two billion individuals. Suppose one could assemble in one place all of the eggs from which will arise the next generation of mankind—2,000,000,000 eggs. How much space would they occupy? Would they amount to a houseful, or a roomful, or a hatful?

The last guess is right—a derby hat would suffice. The largest egg known to science is that of the recently extinct Madagascar bird, the *aepyornis*—an egg over a foot in length. This largest of vertebrate eggs will hold 2,000,000,000 of the minute eggs of mammals. The largest mass of animal flesh that ever lived as an individual, controlled by a single brain, is the whale; yet the eggs of mouse, man, and whale are approximately of equal size.

NOW each human egg, before it can develop, must be "fertilized" by a male cell or spermatozoon. Male sex cells are tremendously smaller than the eggs: the 2,000,000,000 of them necessary to fertilize the eggs from which will come the next generation of mankind would easily go into an elliptical vessel the size of a capital letter "O" on the text page of this magazine.

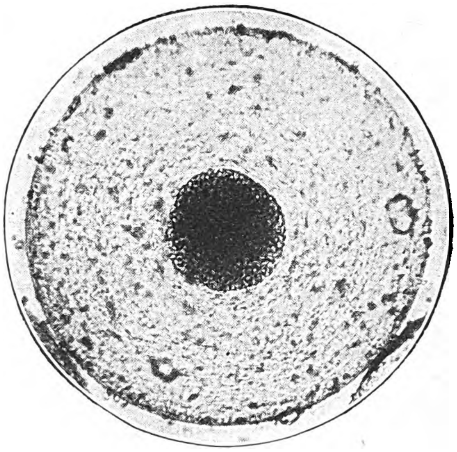
What a microcosm is such a fertilized egg, carrying as it does all the hereditary qualities from both parents that make the individual, into whom it develops, what he is! It is an entity in size somewhere near half way between the electrons and "corpuscles" of which matter is composed and the vastness of space known to the astronomer. Yet in the fertilized egg is bound up the capacity to develop into the complex mechanism of the human body; it has represented in it, perhaps by actual molecules capable of infinite and eternal multiplication, all the characters which the individual inherits from his parents, his grandparents, his ancestors back through the vistas of time, racial and familial—color of skin, hair, and eyes; stature and constitution; temperament and character. These myriads of factors are, moreover, represented, not in the whole egg but only in its tiny nucleus, which, in its turn, contains those self-perpetuating molecules, the genes, that determine at fertilization what each individual shall be.

Truly the unfolding of an individual from the egg is the most marvelous phenomenon in Nature. The evolution of organic forms through eons of time pales beside what we can witness daily, superficially at least, in the development of the individual from the egg.



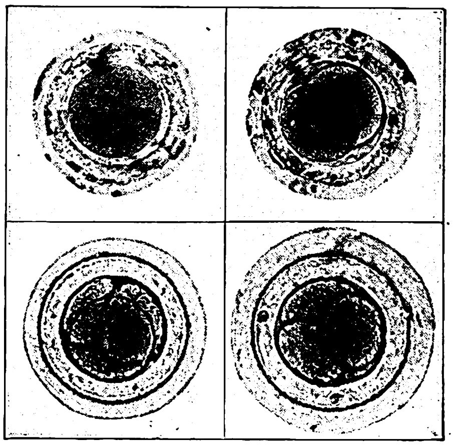
EGGS OF MOUSE AND DOG

The mouse egg (left) is rather transparent, while the egg of the dog is opaque



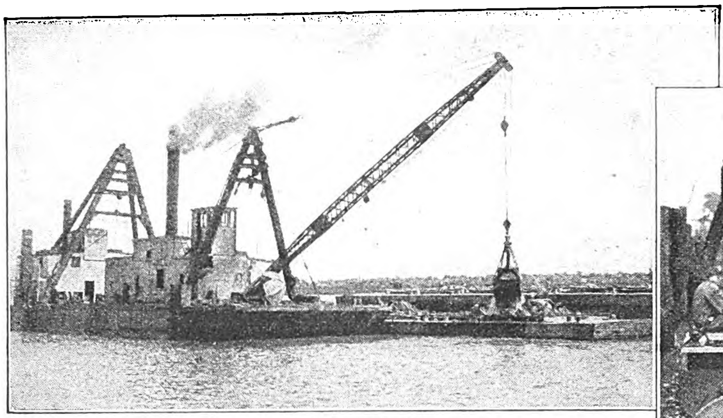
CLOSE-UP OF OPOSSUM EGG

All of the pictures on this page are photomicrographs of actual living eggs



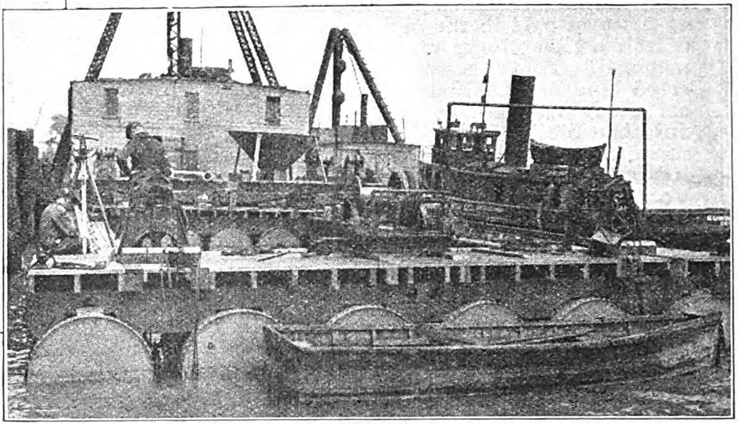
DIVIDING RABBIT'S EGGS

These have been fertilized and are developing. Note one, two, three, and four-celled stages of cellular development



THE "JUPITER"

The floating dredge which excavated the half mile long river-bottom trench for the tunnel sections, which were sunk in place



THE "NONE-SUCH"

Specially designed craft from which a steel grillage was dragged to level off the sand and gravel bed of the trench for the tubes

Detroit Digs Under to Canada

Vehicular Tunnel Under Detroit River, Soon to be Completed, Will be Important International Highway Connection

By HARVEY KLEMMER

A PRODIGIOUS step in Man's never-ending conquest of natural barriers is being taken at Detroit, where engineers are constructing the world's first international vehicular tunnel between that city and the Canadian municipalities across the river. It is particularly fitting that Detroit, the automobile capital of the world, thus should blaze a new trail for the automobile. Crossing the Detroit River always has been a tedious ferry process; the Detroit and Canada tunnel will bring the downtown districts of Detroit and Windsor, Ontario—the Canadian terminus—within three minutes of each other, supplying at the same time a transportation link of importance to all of Michigan and the Ontario Peninsula.

The tunnel has been under construction for the past two years, with the official opening scheduled for this summer. The tube is approximately one mile long, will cost 25,000,000 dollars, and terminates in the heart of the business district at each end. The traffic capacity will be 1000 vehicles per hour in each direction.

This is the third sub-aqueous roadway to be constructed in the United States, and the first to be constructed internationally. The other two vehicular tunnels in the United States are the Holland Tunnel connecting New York City with Jersey City, and the George A. Posey Tunnel under the estuary at Alameda, California.

Construction of the new tunnel is being accomplished by three separate and distinct methods. Some of the engineering processes are similar to those employed on previously-constructed tunnels; others offer new and distinct departures from any methods of construction previously used on an undertaking of this kind.

The work has been divided into five sections in accordance with the methods of construction. The five sections in turn fall into three general classifications. Sections 1 and 5 are the usual box type of subway, with steel bents and concrete jack arches, and are being constructed by the "open cut method." This method of construction is being used on both of these sections up to a depth of 53 feet below street level. Sections 2 and 4 are being constructed by the "tunneling shield method" and extend from the open-cut operation approximately to the harbor line at each end of the tube. Section 3—the river operation—is being constructed by the "trench and tremie method," embodying the sinking of previously-constructed tubes in a trench dug across the bottom of the river.

BY far the most spectacular of all the tunnel operations is the construction of section 3. This is composed of nine steel tubes, all built on dry land, launched like ships, floated into position, and then sunk merely through the weight of interior and exterior concrete. Several engineering departures are involved.

Most land-built tunnel sections heretofore have been sunk through the addition of water or sand to the interior. If they were concreted, that operation generally was performed after the tube was in its river-bottom resting place. Tubes for the Detroit River tunnel, on the other hand, were fully concreted inside and out while on the surface and then sunk without admission of any foreign material to the interior. So accurately was the weight of the concrete computed that each tube thus far has been made to sink practically of its own weight, the addition of a few concrete blocks being sufficient ballast in each case.

The tubes, varying in length from 220 to 248 feet with an over-all diameter of 35 feet, were constructed on a launching way at the plant of the Canadian Bridge Company at Ojibway, Ontario.

As each segment was completed, it was fitted with heavy, water-tight bulkheads and sent down the ways. The interior and some of the exterior concrete then was applied, and the tube was ready for its five-mile journey to Detroit.

Each tube when launched weighed about 500 tons. When partially concreted for towing upstream, its weight had increased to some 4000 tons. When fully concreted the tube became an 8000-ton monster of steel and concrete.

The final concreting was accomplished at an anchorage constructed in the river several hundred feet from shore. As the tube gradually sank beneath the river surface, a large buoyancy scow was placed over each end and the tube suspended from lines attached to winches aboard the scows. The whole outfit then was moved into position over the previously-excavated trench and, moored to anchorages in all directions, the tube was gently lowered into place. Specially-designed flanges permitted locking of the tubes together under water by the three divers kept constantly on the job.

Exact alignment of the tubes was accomplished through the use of tall masts attached to each tube as sunk. When the tube came to rest on its bed of sand and gravel, the tips of the alignment masts were used for exceptionally accurate lining-up. The nine tunnel tubes must be projected across the river bottom to meet the Canadian shield-driven section with an error of less than one inch!

Photographs courtesy Goodwin, Inc.

SANDHOGS USING POWER KNIVES

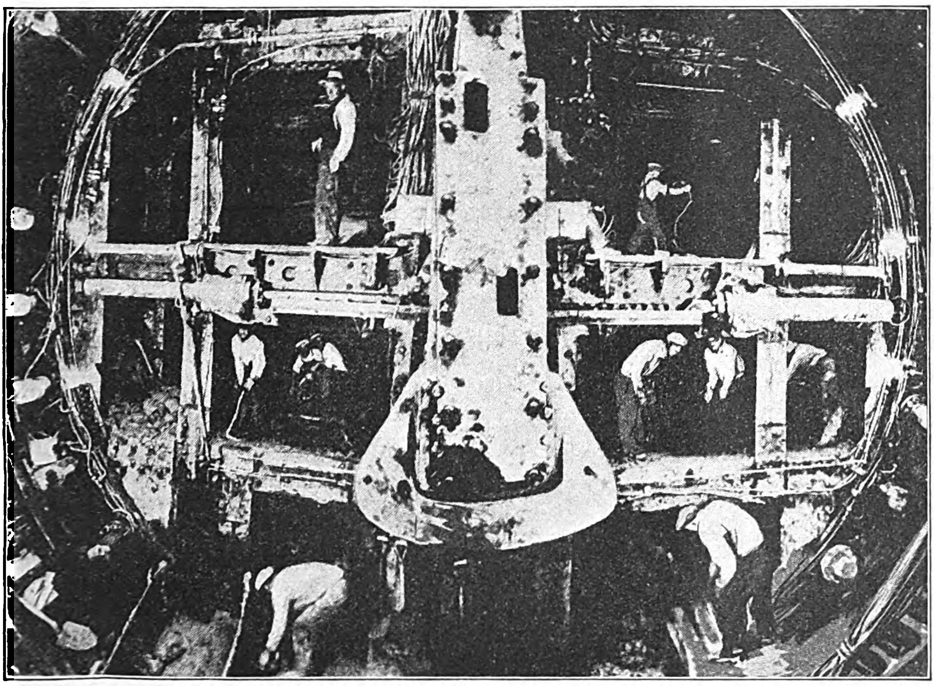
Note consistency of clay, a slice of which is held by one of the men. The knife is a cable-pulled sharp ring

THE irregular bottom left in the trench by the dredging operation was smoothed over by means of a special contrivance designed for the tunnel job. This strange craft, christened the *None Such* by the men, consisted of a huge pontoon arrangement supporting a carriage on tracks. From the carriage was suspended a steel grillage approximately the width of the trench. Sand and gravel were poured into the trench and leveled off by dragging the grillage back and forth over the area to be prepared.

The tunnel shield used for the excavation of sections 2 and 4 is the largest in North America and when designed, was the second largest ever built. The Holland Tunnel, which consists of two tubes, each smaller in diameter than the Detroit tunnel, required smaller shields. The shield has an outside diameter of 32 feet 3 inches, and is 15 feet long. The outside diameter of the steel tunnel lining measures 31 feet 8 inches. The inside diameter throughout will be 28 feet. A 22-foot roadway will allow one lane of traffic in each direction, with an extra lane for emergency purposes.

Progression of the shield-driven section of the tunnel resembles the operations of a giant mole. A gang of workmen known as "muckers," or "sandhogs," digs ahead of the shield, slicing away the earth with power-operated knives. When they have excavated a few feet in advance of the equipment, the shield is forced ahead 30 inches to occupy the space thus won. This is known as the "shove."

Thirty hydraulic jacks, each capable of exerting a pressure of 150 tons, push the shield ahead. The jacks are operated with water from the city mains, forced into an accumulator at pressures up to 6000 pounds per square inch, and fed to the jacks at constant pressure.



LARGEST SHIELD IN NORTH AMERICA

The muckers work in front of this huge apparatus, digging out the clay with power knives and passing it back through the shield to others who remove it to the dump. Note great size

After each shove, a hydraulically-operated erector arm picks up segments of lining and swings them into position. When a complete "ring," 30 inches wide, has been placed, the muckers have again advanced and the shield is ready for another shove.

Another innovation of the Detroit tunnel job is the use of steel lining for the shield-driven section. Heretofore cast iron or wooden lining has been used. In this tunnel the lining is made of stamped, electrically-welded steel plates. The steel plates, surprisingly enough, represent an actual economy as well as a structural improvement over the older forms. The weight of the steel lining is about 2.3 tons per lineal foot of tunnel, while the same unit in cast iron would weigh about eight tons per lineal foot.

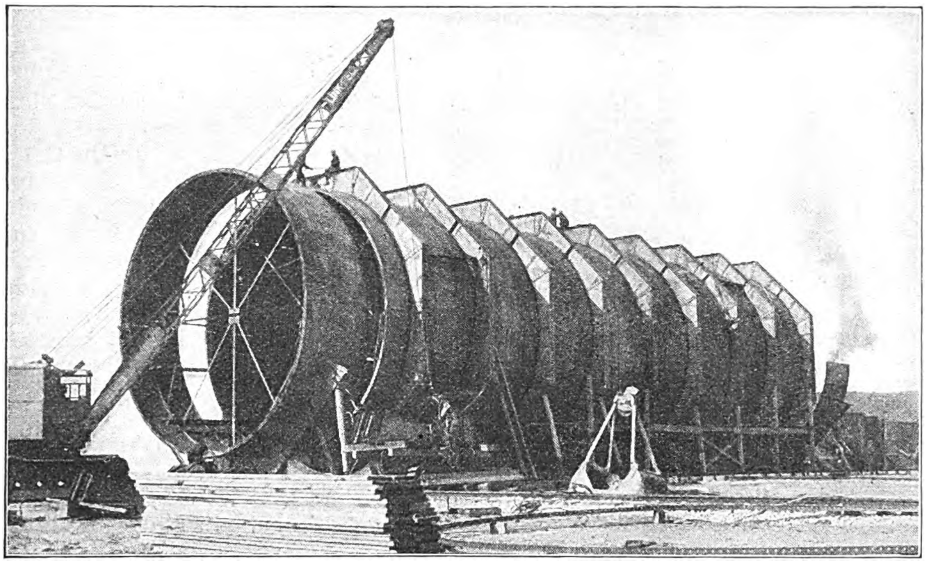
Each segment of lining is 30 inches wide, 10 inches deep, and nine feet long, weighing approximately 1000 pounds. Eleven segments and a key comprise a complete ring of lining. As the shield progresses, the segments are erected and bolted in place, the joints between each segment and between successive rings being waterproofed.

A TOTAL of 466 feet was excavated at the American end of the tunnel by this method, after which the shield was knocked down, hoisted to the surface, and transferred across the river. About 1243 feet are to be excavated in this fashion on the Canadian side. As this is written several hundred feet have been completed and the shield is making progress of 12.6 feet a working day. The Canadian shield is expected to reach the harbor line early in the spring, in time to join the last tube when it comes up the river from Ojibway.

As soon as the shield is removed, interior concreting is begun. Steel forms running on tracks are used in pouring the concrete. The whole structure of forms is run forward 25 feet at a time, concreted, then pushed ahead for another lap.

Sections 1 and 5—the box-type subways—offer no unusual features of construction or design. Steel sheet piling is driven on each side of the open cut and the material taken out with subway shovels and clam buckets. The shoring follows immediately behind the excavation. A three-inch slab of concrete is poured at the invert, upon which four-ply membrane waterproofing is placed. The structural steel frame is erected, the invert, side walls, air ducts, and roof are concreted and backfilled, and the street surface restored. Connecting the portal of the box section and the terminals at each end is a short stretch of open approach, reinforced concrete invert, and concrete retaining walls.

Spacious terminals have been provided at each end of the tunnel, the American terminal plaza being two acres in extent. Traffic at the American end will spiral in coming to the surface, while the Canadian roadway, being farther back from the river, comes to surface level in a straight line.



BUILT LIKE A SHIP

A partially completed tunnel tube on the launching way at the plant at Ojibway, Canada. These tubes were fully concreted inside and out before final sinking to the bottom of the river

Ventilation of the tunnel will follow closely the design worked out for the Holland Tunnel and found extremely successful in practice. There will be two ventilation towers, one at each end of the tube. The equipment for each tower consists of 12 motor-driven fans, six for fresh air and six for exhaust, arranged in successive tiers in different stories and with direct connections to the subway ducts.

THE amount of fresh air that can be pumped into the tunnel will be 1,500,000 cubic feet a minute, giving a complete change of air in the longitudinal ducts every 90 seconds. The fresh air will go into the roadway through curved apertures near the curb line; the vitiated air will be drawn off through two rows of openings located at frequent intervals in the ceiling.

The air in the tunnel, according to the engineers, will be purer than the air in the street outside during rush hours. The power layout is so arranged that any part of the equipment can be operated from either the American or the Canadian side.

Many interesting articles have been brought to light in the various excavations of the Detroit and Canada Tunnel, the engineers report. One of the most interesting is an old Indian sling, with a cord of bark fiber still attached. Other finds include several firearms, a goodly number of bottles of beer and liquor, the remains of two small boats, automobile parts, and three human bodies.

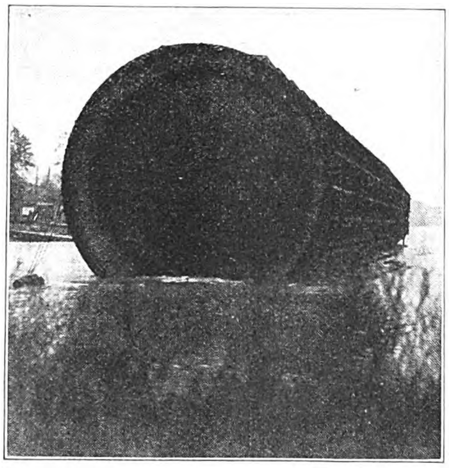
Two of the bodies were found by the river crew engaged in sinking the tunnel tubes; the other was brought up by the dredge *Jupiter* in a clamful of mud. The *Jupiter* also brought up the liquor, the firearms, the boat remains, and the Indian relic. The automobile parts were encountered by the shield in its excavation at the American end of the tube.

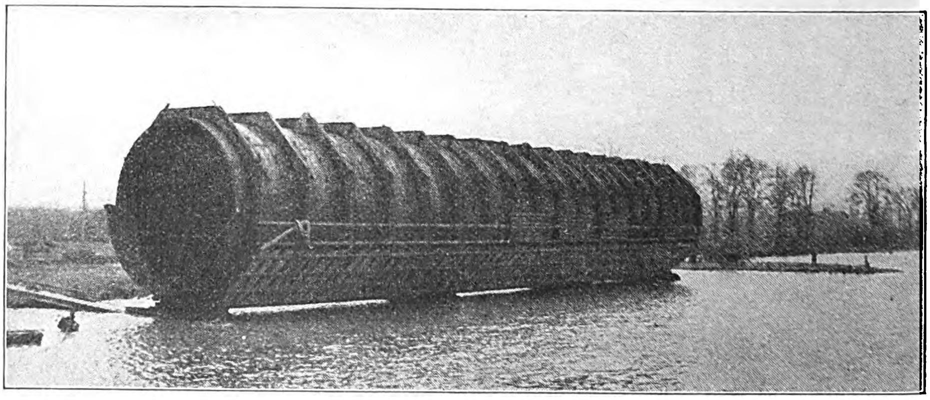
The terminal gang also made a find. Their contribution to the tunnel museum was a goodly amount of old wooden water pipe, placed beneath the streets of Detroit almost a century ago and still in good shape when unearthed.

THE tunnel will be operated jointly by the Detroit and Canada Tunnel Company and a Canadian subsidiary. Policing, regulation of traffic, and enforcement of customs and immigration regulations will be undertaken by the American and Canadian governments, officers of each nation looking after that portion of the tube lying within their domain. Completion of the tunnel is expected to result in an international interchange of visitors such as rarely, if ever, seen anywhere in the world, according to Judson Bradway, president of the tunnel company.

Figures compiled by the Border Cities Chamber of Commerce show that 25,000,000 persons are crossing the river annually at Detroit now. As many as 70,000 automobile passengers have been carried by the ferries over a single week-end, without taking into account the many casual visitors who cross on the ferries without cars for business and pleasure.

Because of the 15,000 commuters who make the daily crossing; because of the 3,000,000 tourists who cross each summer, many bound across country and more headed for the Canadian wonderlands in Quebec and the Georgian Bay country; because of the large number of shoppers and casual visitors; and because of the growing popularity of the Canadian resorts around Lake Erie and Lake St. Clair—because of all these things the Detroit and Canada tunnel is being rushed to completion with a future of singular promise.



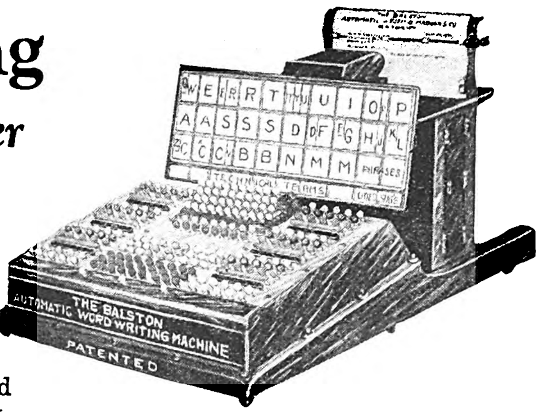


LAUNCHED LIKE A SHIP

Two views of a launched tube just after leaving the ways. With ends bulkheaded, tubes were towed to the floating concreting plant, concreted, and then sunk to the bottom

Automatic Word Writing

Departures From Familiar Typewriter Found in Word Writing Machine


THE BALSTON
AUTOMATIC WORD WRITING MACHINE
PATENTED

WORD WRITING MACHINE

Although less than twice the size of a common typewriter, this machine does the work of many

MODERN business, in its restless search for the ultimate in operating efficiency, is always finding new short-cuts. Of these, an interesting one is a recently patented word and phrase writing machine for use in offices. Although it includes many of the essential features of the typewriter, this device differs radically from equipment now in use.

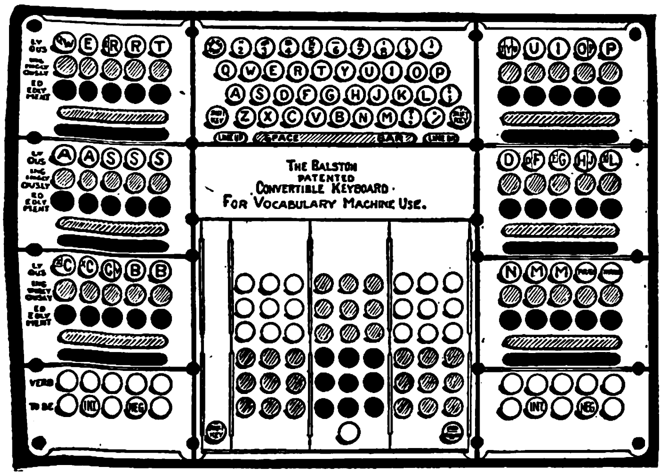
Mr. Clyde C. Balston, the inventor, based his research on the conclusion that there is no justification for the present "unit method" of typewriting. He challenged the prevalent conception that every word written mechanically must be first decomposed into its individual letters and then re-assembled as words on the paper. He decided that it should be possible to perfect a machine which would collect and print the letters of a word automatically, without requiring a separate movement to produce every letter and space. This led to the conclusion that there are a number of common phrases which are used innumerable times each day in office correspondence, which might just as well be impressed on the paper as if the phrase were one word.

Before working out the mechanical details of the machine, Mr. Balston spent some years on an exhaustive study of words to determine the relative frequency of their use. It was found that about 100 words comprise more than 50 percent of all words used in business. Less than 400 words represent more than 90 percent of those we use and about 1000 words constitute slightly more than 98 percent of all business correspondence. For these words, stenographers use "word signs" or symbols, rather than attempting to record the individual letters of each word.

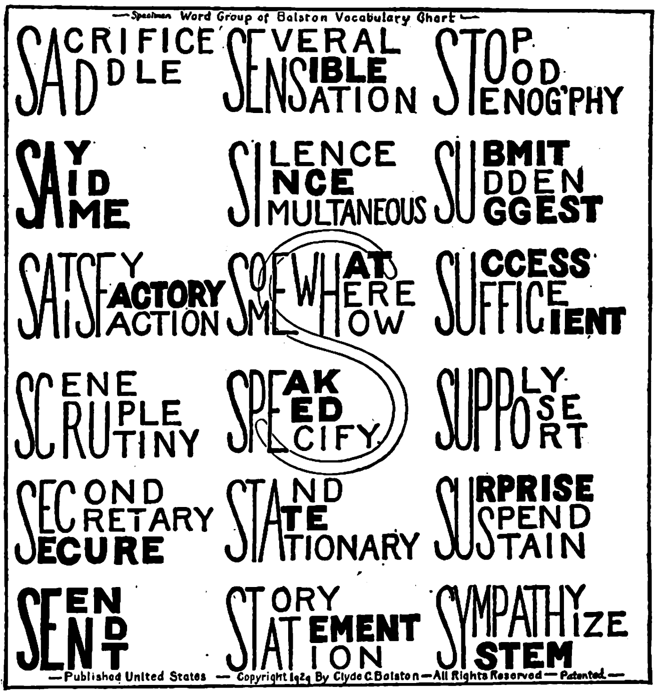
In operating the word and phrase writing machine, there is no need for the typist to use the usual lightning-like movements, because the world's fastest typist cannot compete with a machine that prints a whole word or phrase while a typist using the unit system would be writing the first two letters. With much more deliberation, the operator presses two keys, one representing the initial letter of the word or phrase to be written and the other a selector. The use of the keys is guided by a chart which shows the grouping of the words, and the relative position of the selector keys. As with the "standard" keyboard, the operator may become so familiar with the position of the keys that no time is lost hunting for the right one.

THE machine automatically assembles the letters and impresses the word or phrase on the paper, with the requisite spacing and punctuation. The type is mounted on an assembly of revolving disks somewhat reminiscent of the mileage recorder of a speedometer. A series of interchangeable combs with movable teeth, operated by the selector keys in accordance with the chart, automatically catch the various disks and hold them in the proper position for impressing the word chosen by the operator. As soon as the word is impressed, the disks are released and spring back into a neutral position ready for the next word.

The mechanical writing speed of the machine, according to Mr. Balston, is more than 1000 words per minute, and the operative writing speed is over 300 words per minute, when writing single words. When writing phrases, the number of words per minute is greatly increased. It is significant that the Balston machine retains the standard typewriter keyboard, in addition to the special keyboard governing common words, word-endings, place-names and phrases. The more familiar keyboard provides an efficient means of writing (by the unit system) words seldom used, variously spelled proper names, and other words or phrases infrequently used in business correspondence. The machine has been adapted for use by telephone companies in posting and billing toll charges.


The Balston
Patented
Convertible Keyboard
For Vocabulary Machine Use.
Space Bar

Copyright 1929 by Clyde C. Balston


—Specimen Word Group of Balston Vocabulary Chart—
SA CRIFICE
D DLE
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ENOG'PHY
SA Y
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FACTION
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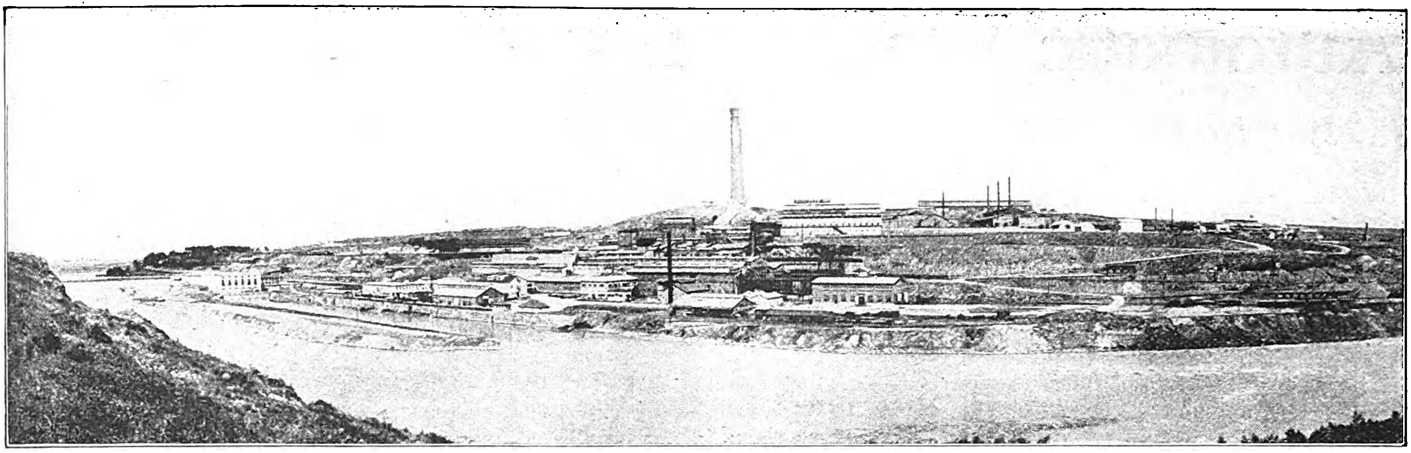
SOMETHING NEW IN KEYBOARDS

Above: Keyboard of the Balston machine, showing arrangement and grouping of keys. Note the standard typewriter keyboard, which has been retained for writing variously spelled words and names. The three 18-key panels are operated according to the groupings of words on a chart mounted within view of the operator of the machine. *Right:* Specimen square of the chart, showing alphabetic arrangement of words used most commonly in business correspondence. Capitalization and terminal forms may be included



GREAT FALLS REDUCTION DEPARTMENT OF THE ANACONDA COPPER MINING COMPANY

Situated on the upper Missouri River in Montana, in the heart of one of America's great hydro-electric developments, the Great Falls Reduction Department includes the largest electrolytic zinc plant in the world, an electrolytic copper refinery, and a copper rod and wire mill

Refining Metals by Electrolysis

Production of Refined Zinc and Copper by the Electrolytic Process in the World's Largest Metal Reduction Plant

By HENRY W. HOUGH

"WHITE COAL" was responsible for the selection of the site for the Anaconda Copper Mining Company's electrolytic zinc reduction plant near Great Falls, Montana. The importance of an ample supply of cheap electric power is easily understood, for the plant sometimes demands as much as 64,000 kilowatts, or 85,000 horsepower. The total connected motor load of the 600 alternating- and 182 direct-current motors in service, including the rotary converters and motor-generators, is 102,000 horsepower. In addition to the zinc plant, which is the largest of its kind in the world, the properties include also a large electrolytic copper refinery and a mill for making copper rod and wire.

TRANSMISSION lines carrying 110,000 volts transport power from the hydro-electric stations of the Montana Power Company at the Great falls and the Rainbow falls, in the upper Missouri River, supplemented by four 6600-volt transmission lines from the Black Eagle falls station adjacent to the plant. A fourth large hydro-electric plant is now being constructed in the vicinity, at Morony Dam. The most distant of these power sources, at the Great falls, is only seven miles from the plant.

Although the mining region centering at Butte, Montana, has been famous for 25 years as the greatest copper producer of the world, it had its inception as a placer gold mining camp, when gold was discovered in the sands of Silver Bow Creek in 1864. Silver soon became the most sought-for mineral, for valuable silver ores were found in the oxidized parts of quartz veins prominently traceable on the hillsides. The claims staked on these lodes later proved to be enormous producers of copper, as the diggings were carried farther beneath the surface. In 1887 about 290 stamp mills were working the silver ores of the Butte district, but the industry reacted sharply to the sudden drop of silver prices in 1902.

Our Basic Industries

DESPITE rumors of business recession as a result of the sharp decline in stock valuations, the foundations of our prosperity are secure. Almost without exception, our basic industries are in sound condition. This fact is discernable in the mining and allied industries. According to the Copper and Brass Research Association, the copper industry is on a firmer foundation than at any time in its history. It has just passed through a year of unparalleled peace-time prosperity. The outlook for the year 1930 is described as "most encouraging." Much of this optimism is due to the increasing demand at home and abroad for copper to be used in railway electrification, transmission lines, power projects, building, and automobile manufacturing.

In accordance with our policy of keeping our readers well informed concerning significant developments in industry, we sent one of our editors to Montana to inspect the world's largest plant for separating and refining metals by the electrolytic process. By previous training and experience, Mr. Hough is well qualified to describe these properties, and the interesting process of refining by electrolysis.—*The Editor.*

However, the copper industry had already reached its full stride. From 1870 to 1879 claims had been staked covering most of the valuable copper deposits, although many of them, like the Anaconda claims, were located for silver ore. The copper ore was originally hauled to Corrine, Utah, on the Union Pacific Railroad. After this 400-mile haul, it was transported to eastern plants for treatment. Some of the chalcocite was shipped to Swansea, in Wales.

IN 1879 the first successful smelter in Butte was built by the Colorado Smelting Company, greatly stimulating the local production. Several other smelters were constructed within a short time, including the Parrot, Montana Copper, Bell, and Clark's Colusa. The Montana Copper Company established its smelter at Great Falls, 180 miles from Butte, in 1892, under the name Boston and Montana Consolidated Copper and Silver Mining Company. The smelter at Anaconda, about 15 miles from Butte, was started by the Anaconda Copper Mining Company in 1883. In 1902 the "new works" was built across the valley. This plant, the largest non-ferrous smelter in the world, treats about one fourth of all the copper produced in the United States.

Its 585-foot smokestack is the highest in the world; the Washington Monument could be placed inside of it, and would be completely out of sight.

At Great Falls, the Boston and Montana Company had erected a plant for the production of blister copper, a blast furnace plant for the re-treatment of converter slag, a furnace refinery, and an electrolytic copper refinery. In 1910 the properties of this firm were taken over by the Anaconda Copper Mining Company, and six years later the first electrolytic zinc reduction plant was erected, after years of costly research and experimentation. The present plant produces about 20 percent of the world's total output of zinc. It has a capacity of 335 tons a day, or about 20,000,000 pounds a month, of practically pure zinc.

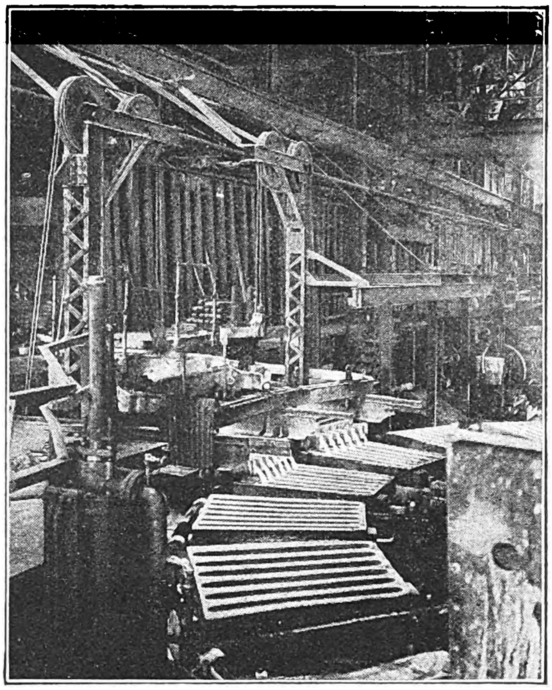
Metallurgical science wrestled for years to perfect the electrolytic zinc process. No one seems to know who first thought of leaching roasted zinc concentrates with dilute sulfuric acid and recovering the zinc as metal from solutions by electrolysis; it had been tried as early as 1883, but the most nearly successful early attempt was made in 1898 at a plant in Australia, erected to treat Broken Hill ores. Aided by the development of the selective floatation process for the preliminary preparation of the ore, and stimulated by high war-time prices for zinc, metallurgists of the Anaconda company developed the process which led to the construction of the plant at Great Falls in 1916. The company has another electrolytic zinc plant in Anaconda. These two Montana plants have a combined output of approximately one million pounds of zinc a day. Other plants of a similar nature, owned by the Anaconda Copper Mining Company, are located in Idaho, Utah, Australia, Poland, Italy, and Germany. New plants are being built in Illinois, Canada, and Norway.

Floatation concentrates arrive at the Great Falls zinc plant in open-top, hopper-bottom, 50-ton steel cars. After control and umpire samples are taken of the contents of each car, for use in deciding its composition and value, the concentrates are dumped into storage bins. There are 19 of these bins with a total capacity of about 3300 tons. Concentrates of varying composition are blended to give a uniform feed for the roasters.

To convert the zinc concentrates into a product suitable for treatment in the leaching plant, the material is roasted. This process converts the zinc and lead sulfides into the sulfate and oxide forms, expelling the excess sulfur and oxidizing the iron and other metals in the ore. Each of the 14 roasting furnaces has an individual motor for driving a revolving center shaft which is five feet in diameter, brick lined, hollow, and equipped with 26 water-cooled arms. These arms have rabbles for moving the concentrates from the circumference to the center of the furnace, and vice versa. The furnaces are each 25 feet in diameter, consisting of a brick-lined shell with seven hearths inside and an open hearth on top.

The furnace gases pass through a settling chamber before going to the "big stack," which is almost as tall as the one at Anaconda. The dust recovered is returned to the roasters; the total flue dust re-treated averages a little over 15 percent of the weight of the new material treated. Calcine, the product of the roasters, is drawn off in hoppers under the furnaces, transported in four-ton cars to revolving coolers, and then discharged into a 400-ton storage bin for shipment by the local electric train to the zinc leaching plant.

Natural gas is used for firing the furnaces. Each one has two burners which are fired directly into the seventh hearth, eliminating the use of fireboxes. As much as eight million cubic feet of natural gas is used daily in the Great Falls reduction works. The gas is piped from the Kevin-Sunburst oil field, about 100 miles northwest of Great Falls.

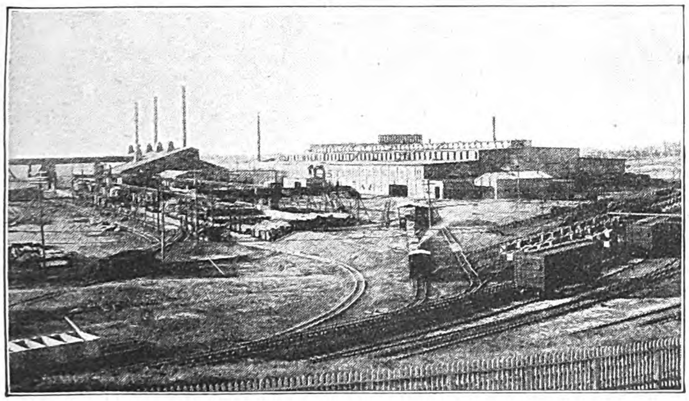


CASTING COPPER WIRE BARS

Streams of molten copper flow into forms that are pivoted upon a casting wheel 40 feet in diameter

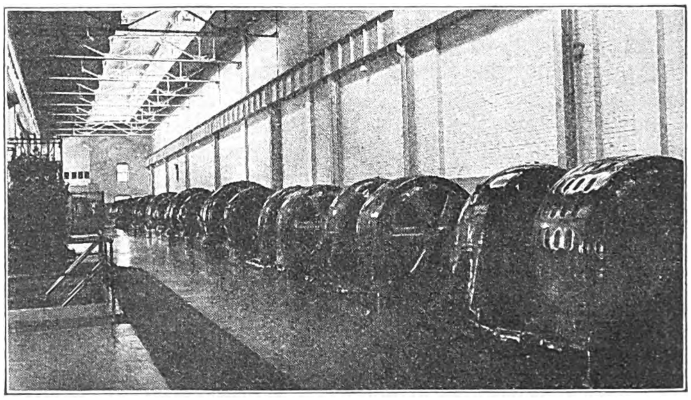
In view of the fact that the furnaces have also been fired with pulverized coal and fuel oil, some interesting comparisons are available. Using pulverized coal of about 9500 B.T.U., it requires about one seventh of a ton of coal for roasting one ton of concentrates. About 14 gallons of fuel oil, with 18,500 B.T.U., and specific gravity of 0.92, is needed for one ton of concentrates. About 2400 cubic feet of natural gas, of 930 B.T.U., is adequate for roasting the same amount of material.

There are three principal steps in the zinc leaching process: first is a neutral or purification leach; second, the acid or finishing leach, and finally a re-treatment of the residue from the acid leach. In huge open tanks of the Pachuca type, the roasted concentrates mix with an acid solution used previously in the electrolytic tanks.



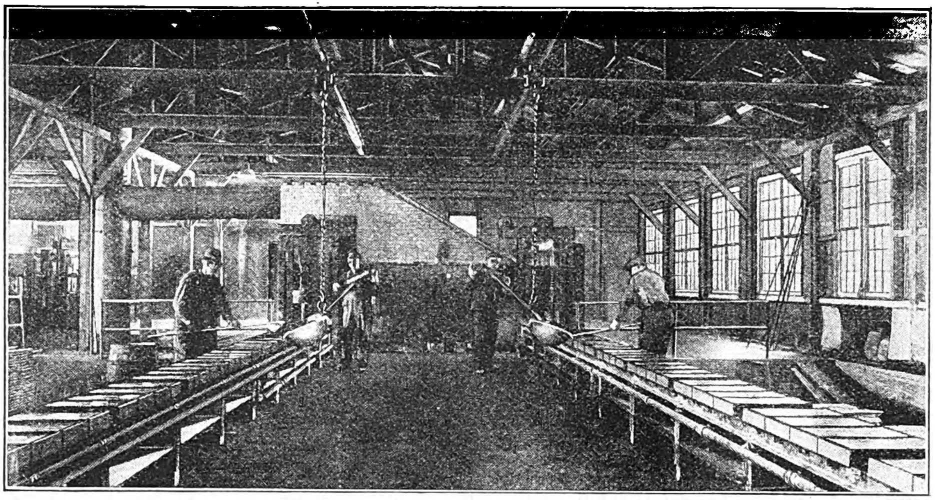
ELECTROLYTIC COPPER REFINING PLANT

In this division of the Great Falls works, smelted copper is refined by electrolysis, melted, and cast into commercial forms



VIEW OF ONE OF THE POWER SUB-STATIONS

Hydro-electric power is received over two 110,000-volt and four 6600-volt transmission lines, then "stepped down" in sub-stations



CASTING REFINED ZINC INTO 50-POUND SLABS

After leaving the electrolyzing division, the thin sheets of zinc are melted. Skilled workmen dip long-handled ladles into the furnaces, and pour the hot, silvery liquid into moulds

The acid is neutralized in the process, and iron, arsenic, silica, alumina, et cetera, are precipitated.

After passing through a series of Pachuca tanks, the solution discharges into Dorr classifiers for removal of coarse material, and the overflow goes to thickeners for the separation of solids from the solution. The pulp is drawn from the bottom of the thickeners and again treated with the leaching solution in the tanks, after which the thickened pulp goes to Oliver filters. The filtrate is returned with the thickener overflow to the first leach, and the residue cake goes to dryers. After passing through the first set of Dorr thickeners, the overflow goes through a purification system which precipitates the copper and cadmium by agitation with zinc dust. After purification, the leached zinc-bearing solution is pumped into storage tanks, ready for the electrolytic treatment.

ACCORDING to Mr. Albert A. Wiggin, manager of the Montana Reduction Departments of the Anaconda company, "The successful electrolytic deposition of zinc from a sulfate solution is primarily dependent upon the purity of the solution fed into the cells." In the leaching and purification processes, no effort is spared to produce a solution entirely free of metals electro-negative to zinc.

Power enters the plant at 110,000 volts, and is stepped down through nine 6100-kilo-volt-ampere, three phase, 60-cycle, water-cooled transformers to 406 volts. This is passed through nine 5800-kilowatt synchronous rotary converters, which yield about 580 volts, direct current, for use in the electrolytic tanks or cells.

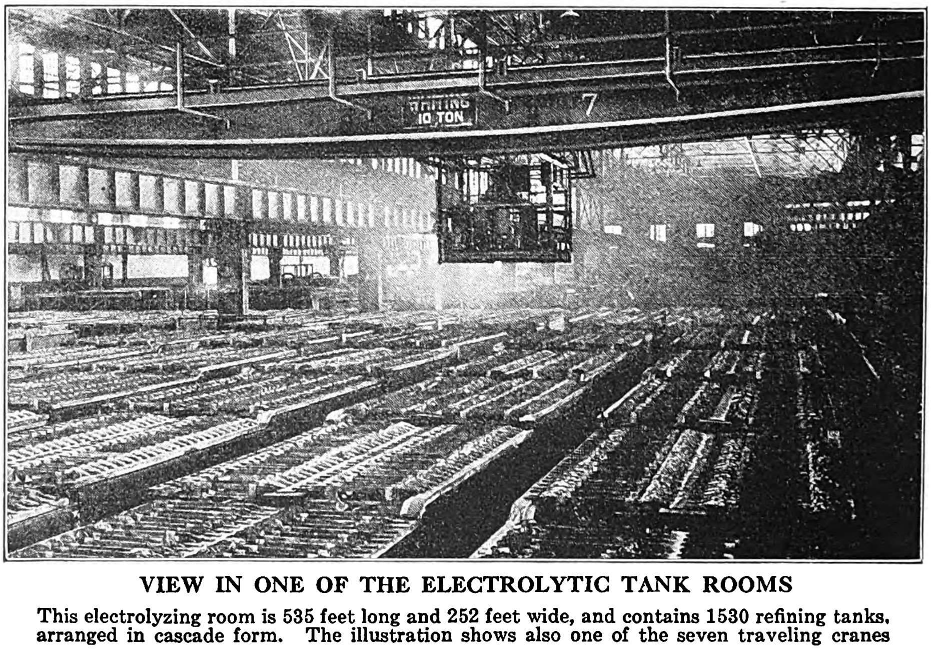
In a building 395 feet by 252 feet, zinc is electro-deposited on aluminum sheets suspended in tanks filled with the zinc-bearing solution. Of the 1164 cells, 1152 are continuously in service. These are divided into eight units of 144 cells each. Lead is used wherever there is danger of contaminating the solution, for lining the cells, and also as anodes from which the current flows to the aluminum cathodes. There is no free acid in the solution when it first enters the tanks, which are arranged in cascade form. When the electrolyte leaves the tanks (to be used for leaching roasted concentrates) it contains acid equivalent to one and one half times the amount of zinc removed during the electrolytic process. To cool the tanks, water is circulated through a lead pipe placed beneath the surface of the solution.

Every 24 hours the zinc-coated aluminum cathodes are removed, and the zinc is stripped off. These thin sheets of zinc are stacked in piles and moved on small cars to the melting and casting department. The sheets are dumped into the furnace through a hole in the roof, probably to be melted beneath the surface, for about 150 tons of molten zinc is kept in each of the three gas-fired furnaces. The molten zinc is dipped out of the furnace by means of long-handled ladles suspended from trolleys on overhead I-beams, and is cast into moulds arranged in rows near the furnace. One man can dip and cast into 50-pound slabs about 30 tons of zinc in an eight-hour shift. No practical scheme has been found for improving upon this laborious method of casting, although various mechanical arrangements have been tried.

Atomized zinc, or zinc dust, is made by transferring the molten metal to graphite crucibles tapped or perforated with one-eighth-inch holes. As the molten zinc falls from these openings it is caught in a jet of compressed air from an atomizing nozzle and is blown into a settling chamber. This product is used in the purification division for removing copper and cadmium from the zinc-bearing solution. Cadmium, by the way, has become an important by-product of the zinc plant, since this metal has come into use for electroplating.

ALTHOUGH the electrolytic zinc plant is the largest of its kind, it is but one of several divisions of the Great Falls Reduction Department. Copper refining operations are conducted on a large scale in an adjoining plant, where copper from the company's smelter at Anaconda is purified by electrolysis.

From 80 to 90 percent of the finished copper produced here goes to the nearby rod and wire mill. For many years all of the copper produced in the Montana mines went to eastern markets, much of it returning later in manufactured form at greatly increased prices. The establishment of the large wire mill at Great Falls has changed this situation, providing for the far west a convenient and economical source of supply.



VIEW IN ONE OF THE ELECTROLYTIC TANK ROOMS

This electrolyzing room is 535 feet long and 252 feet wide, and contains 1530 refining tanks, arranged in cascade form. The illustration shows also one of the seven traveling cranes

Diet Causes Fatigue

Working Efficiency Is Lowered by the Dieting Fad and Increased by Between-Meal Nibbling

FATIGUE, diet, and the working capacity of the modern business girl are closely related, and decrease in working capacity due to fatigue can be offset by the timely ingestion of highly concentrated, energizing foods, according to the findings of Dr. Thaddeus L. Bolton, head of the Department of Psychology, Temple University, Philadelphia, who has concluded a research investigation in which 20 feminine office workers were subjected to exhaustive tests of speed, endurance, mental alertness, and muscular control, at various hours of the business day.

Back of the investigation, according to Dr. Bolton, lies the growing belief on the part of employers that the unwise reducing diets resorted to by large numbers of feminine workers are responsible not only for frequent absences due to illness, but for decreased volume and lowered quality of work while in the office. As the food suplies within the body approach the point of exhaustion, work power begins to fall, and fatigue sets in, starting up muscular trembling and lowering the speed and contractile power of the bodily members.

"OUR studies soon showed," Dr. Bolton says, "that working capacity is comparatively low at the beginning of the office day. The human machine is never, right from the start, ready to deliver its greatest output. Like the race horse, it must go through a warming-up process. Capacity appeared to increase until it reached its maximum at about 2:30 in the afternoon. From that time on, except for a spurt at the end, the curve seemed to fall with a fair degree of steadiness until the office closed in the evening.

"It is well known, however, that in the average office the hours between 2:30 and 5 are the period of greatest rush and strain. The falling curve occurs at the worst possible time. We sought to determine to what extent working power may be sustained at its early afternoon peak by eating suitable quantities of foods which are quick restorers of depleted energy. Foods having a high sugar content were selected because sugar is not only a concentrated energy food, but one which is quickly assimilated by the system. Its effects, therefore, are almost immediately apparent to the trained investigator equipped with the necessary laboratory instruments."

The 20 girls were divided into four groups of five each. One of the groups, the "full food group," was supplied each afternoon with a light meal consisting of cake, candy and sweetened orangeade. Two "mixed food groups" were supplied with the repast on designated days, skipping it on others. The fourth group, known as the "control group," went through the tests of the various elements which, taken together, constitute working capacity, without partaking of the additional meal.

Five different tests were employed, all of which have proved their value in the psychological laboratory. In the "tapping test" the girl tapped upon a metal plate with a stylus at top speed for 15 seconds. Five periods of tapping alternated with ten-second rest intervals. Each tap was recorded by an electrical device. The number of taps determined the score, which, in turn, afforded an accurate measure of the girl's speed and endurance. Both hands, one after the other, were tested.

THE TAPPING TEST

Dr. Charles H. Smelzer of Temple University giving a girl a test for speed and endurance

Co-ordinated muscular action was measured by the "three-hole test." This consisted of making electrical contacts by placing a stylus successively in three small holes in a metal plate, the holes being just large enough to permit the entrance of the stylus. The score made in the test was determined by the time it took to make 80 contacts. The "substitution test," employed to measure mental alertness, consisted of correctly placing five letters of the alphabet on a chart covered with rows of five different geometric figures. The key was given at the top of the chart. Two minutes were allowed for the completion of the test.

"All of the girls showed marked practice gains as they became familiar with the tests," Dr. Bolton says. "This had to be taken into account in compiling our results. Aside from practice gains, the 'control' or 'no food group' continued to show the typical curve of work—the low beginning, the rise until about 2:30, and the falling off until the closing spurt.

"In the case of the 'mixed food groups,' when the girls were supplied with the additional meal as frequently as four times a week, their work appears to have fallen in with that of the 'full food group.' Tabulated summaries of the tests given to members of the later groups show that they were sustained at a higher working rate than the girls in the 'control group.' Their practice gains were continued up to the last, and were greater and more consistent than the gains of the 'control group.'

"THE investigation has shown positive results in favor of small quantities of concentrated food taken in mid-afternoon. The physical and mental let-down which is apt to occur at the busiest period of the business day is to a considerable extent due to insufficient and improperly balanced diets, and can be largely, if not wholly, prevented by eating foods that in small volume act as quick fuel for the body engine.

"Although we dealt only with feminine workers, our findings apply with equal force to the opposite sex. Perhaps, however, special emphasis should be laid upon the support these findings give to the opinions of those who have held that reducing diets are responsible for impairing the efficiency of the modern business girl.

"On the basis of our findings, hard-working business and professional men and women would do well to keep in the drawer of the desk a box of good candy or candied fruit. When energy begins to flag in mid-afternoon, these quick-action foods will act as an emergency ration and supply the calories needed for the rest of the day's work. The sugar in afternoon tea, or in sweetened cold drinks, will have the same effect."

Approximately 500,000 calculations were necessary in compiling, tabulating, and comparing the records of the 20 girls.

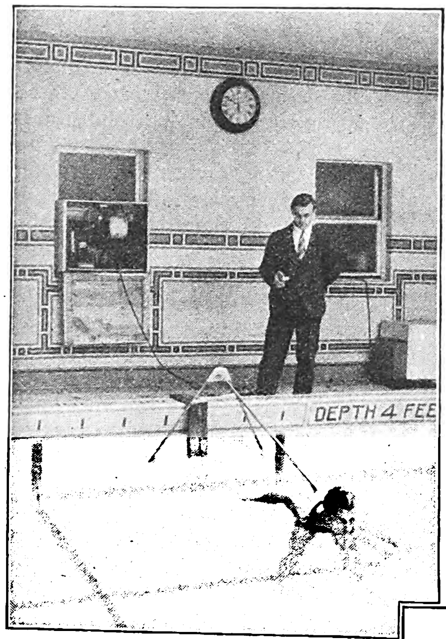
Swimming Speed Analyzed

"In the Breast Stroke We Can Develop the Same Speed as in the Crawl, But Only for a Fraction of a Second"

By PETER V. KARPOVICH, M.D., M.P.E.
Professor of Physiology, Springfield College, Massachusetts

WE watch a powerful swimmer plunge into the swimming pool and then rapidly traverse it using a crawl stroke. He moves so fast and his movements are so well timed that, to our eyes, his speed seems to be perfectly uniform.

We observe another man using a breast stroke. There we can notice that the swimmer is moving by spurts, slowing markedly on recovery, when he draws his arms and legs close to his body. Here we can figure easily the reason for the periodical accelerations and slowing of the speed.



THE NATOGRAPH

Above: The test subject, with the floating tripod and the line connected to the Natograph in the background. *Right: Figure 1:* The simple mechanism of the Natograph

But is the crawl stroke really a stroke where the speed is perfectly uniform? We know that there are several distinct phases in this stroke: lifting one hand out of water and rolling, breathing, pulling, et cetera. Do these changes in posture affect the speed or not? Logically they should, but can we find out definitely?

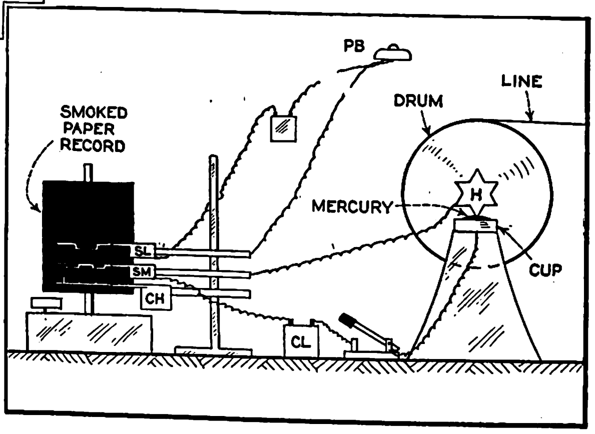
Swimming is an ancient and yet a young sport. People could swim in prehistoric times, but the present highly developed strokes are of recent origin. Some teachers of swimming are still searching for a new combination that will result in a stroke faster than the ones existing at the present time. Others are trying to improve the existing strokes. The latter effort seems to be more feasible and leads to an attempt to study the variation of speed within a single cycle of a stroke. Preliminary consideration showed at once that an ordinary stop watch could not be used because changes may occur within a second on a distance of a couple of feet.

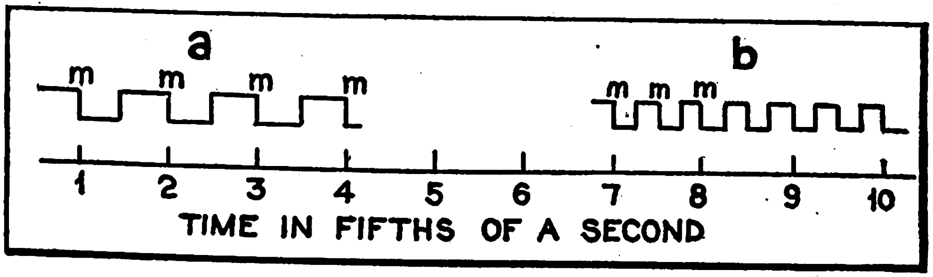
AS the result of a number of experiments, an apparatus has been devised for the purpose. This apparatus has been named the Natograph in order to distinguish it from the other machines used in research along similar lines. The Natograph registers the progression of the swimmer, by recording the distance covered and the time, and enables us to calculate variations of speed in intervals as small as one fifth of a second, and to measure the relative efficiency within a single cycle of a stroke.

The apparatus shown in the photograph and the diagram, Figure 1, consists of a drum around which a line is wound; the free end of the line is attached to the subject. In swimming, he pulls this line and causes the drum to revolve. A sprocket (*H*) is firmly fastened to the same shaft as the drum. On revolution the points of the sprocket touch the mercury in the cup. The mercury and the sprocket are in a circuit with a dry cell (*CL*) and a signal magnet (*SM*). When the sprocket touches the mercury, the circuit is closed and the pointer of the signal magnet is drawn down.

When the contact is broken, the pointer springs back. The circumference of the drum is twenty-four inches; therefore the distance between two points of the sprocket corresponds to four inches of the circumference of the drum. The movements of the pointer are recorded on smoked paper wound around a cylinder, which is set in uniform rotation by means of a clock work. A chronograph (*CH*) marks the time in intervals of fifths of a second. During an experiment we may get a set of tracings similar to the ones represented in Figure 2.

IN this diagram, the distance between any two adjacent "makes" (*m*) of the circuit corresponds to four inches of the distance covered by the swimmer, but we see that the intervals between the makes are not equal. In part *a* we count one interval in 1/5 of a second, whereas in part *b* we find two intervals. This means that the swimmer was moving with a variable speed, the fastest being at *b*.





NATOGRAPH TRACINGS

Figure 2: The time between the marking of the points *m* enables the operator to determine the speed of the swimmer. Parts *a* and *b* consist of records of different swimming speeds

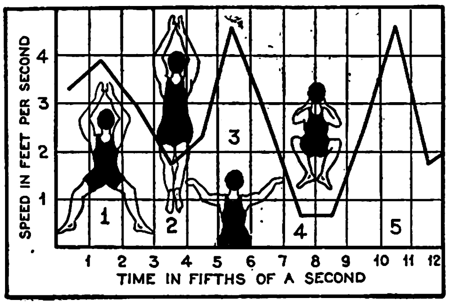
In order to read these tracings more intelligently, another signal magnet (*SL*), Figure 1, was adjusted to the Natograph. This signal magnet was connected with a push button (*PB*) by means of flexible wires 12 yards long. The experimenter carries this push button in his hand and presses it when he wants to mark a certain part of the stroke. Suppose the experimenter wants to mark the moment when the right hand of the swimmer enters the water during a crawl stroke. He has only to press the button at this particular moment, and the writing point of the signal magnet (*SL*) goes down and marks the paper. See upper lines on tracings B, C, D, and E, Figure 3. Of course, particular care should be taken to have the writing points of both signal magnets on the same vertical line.

The construction of the Natograph is very simple, but one problem was at first very difficult to solve. This was the elimination of the momentum of the drum itself. Although the drum was made very light, it was necessary to use a brake which was strong enough to eliminate the momentum without interfering with the freedom of the progression of the swimmer. The resistance of the brake was negligible when compared with the total force developed during swimming.

FOR testing the breast and side strokes we attached the line directly around the waist of the swimmer, but for the other strokes, such as the crawl for example, it was impossible to do this because the feet might kick the string and spoil the record. To meet this difficulty a simple device was made. It consists of a wooden tripod, two legs of which are supported by rubber balls, and the third strapped to the swimmer. The line leading to the Natograph is attached to this tripod so that it always touches the surface of the water.

The Natogram in Figure 4 represents a record of the breast stroke as performed by a good Filipino swimmer. We can clearly see the variation of the speed in this type of swimming. The lowest speed (eight inches per second) was during recovery when the legs and the arms were drawn close to the body; during this time no propelling power was developed and the resistance was greatly increased. The highest speed was attained during the arm pull (five feet per second); during the leg drive the speed was four feet per second, and during the glide the speed dropped to one and one half feet per second. Comparing the action of the legs and the arms, we notice that the legs started to drive from the lowest speed after the recovery, and the arms from a higher level after the glide. This explains why great speed was often attained during the arm pull. If we introduce a correction, subtracting the starting speed from the speed reached at the end, we find that the leg drive is more effective than the arm pull, which is typical for a good swimmer. In the case of a poor swimmer, this condition may be reversed, whereupon the arms furnish most of the power.

The lower curve in Figure 5 represents a very slow crawl stroke. The "ups" of the curve correspond to the arm action. The low limit is determined by the momentum acquired and the leg action. The duration of a cycle is about one and two fifths seconds. The upper curve represents fast swimming by the same man. The curve is much smoother, and varies only between four and five feet per second. The length of a single cycle is about nine tenths of a second.

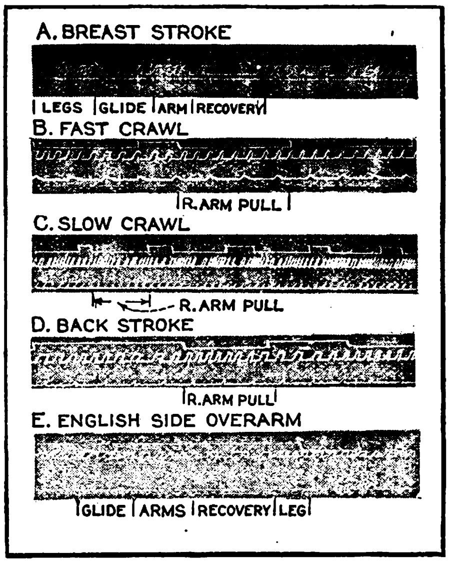


BREAST STROKE

Figure 4: This chart shows vividly how swimming speed with this stroke varies

We have found that the duration of the cycle in the fast crawl is shorter, and pull and recovery are reduced in the same proportion. The time during which both arms remain under water was only slightly decreased. The significance of this has yet to be investigated.

In Figure 6, the subject was swimming fast, using the back stroke. Because the arms cannot act as effectively as in a fast crawl, this curve resembles a slow type of crawl. Each elevation on the curve corresponds to the action of one arm.



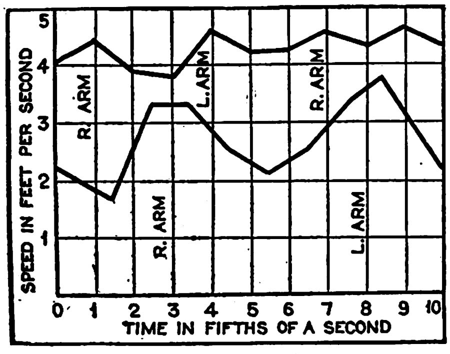
RECORDS

Figure 3: These are reproduced from actual tracings made on the Natograph

In Figure 7, made with the side stroke, we see the four distinct parts: the leg action, the glide, the arm pull, and the recovery.

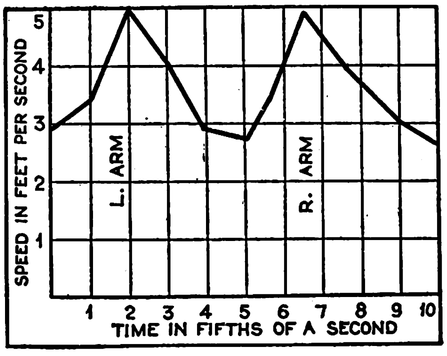
In this short article it is impossible to go into a discussion of all the points that may be discovered on the Natograph. Just recently I have completed the studies of the force developed during various phases of the different strokes and resistance of water that the swimmer has to overcome. The results of these studies perfectly correlate between themselves.

There is one interesting point that should be brought out. Driving a motor car with a variable speed is wasteful. A uniform speed is more economical. The same should be true in the case of the human machine. The crawl stroke is the fastest because it is the smoothest. In the breast stroke we can develop the same speed as in the crawl, but only for a fraction of a second and then on recovery the arms and legs serve as powerful brakes and hinder progress. In making a stroke more efficient, one should utilize the power saved by reducing the resistance.



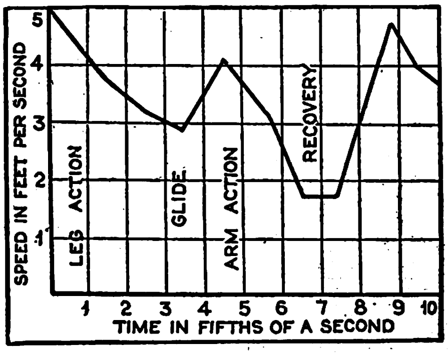
THE CRAWL

Figure 5: Lower curve shows slow crawl: upper, fast. Note the smoother action



BACK STROKE

Figure 6: Curve resembles that of slow crawl because of ineffective arm action



SIDE STROKE

Figure 7: Four distinct parts are shown; leg action, glide, arm pull, and recovery

The Plant's Whimsical Appetite

Some Newly Discovered Requirements for Plant Growth Indicate That Plants Are Highly Sensitive to Certain Chemicals

By EARL S. JOHNSTON
Associate Professor of Plant Physiology, University of Maryland, College Park, Maryland

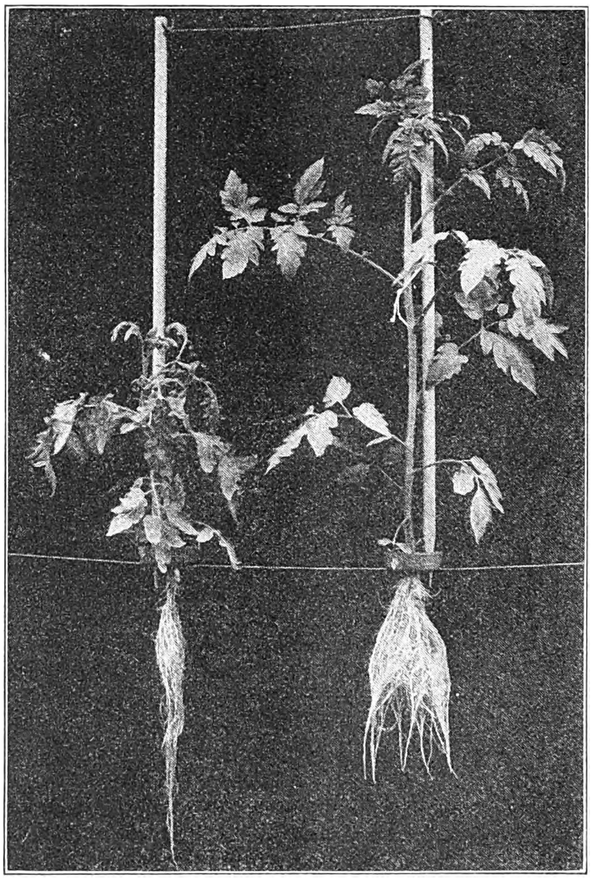
IT is generally believed that plants can grow and develop normally when their diet is limited to the so-called ten essential elements. Most of these elements are found in the ordinary fertilizers used by farmers, gardeners, and other agriculturists. Everyone is familiar with the importance of nitrate, potash, phosphate, sulfate, and perhaps a few other plant food materials. In a somewhat similar manner carbohydrates, proteins, and fats were considered the essential part of the diet for animals, including man. Within recent years, however, it has been realized that man can not live by bread and meat alone. Articles are frequently published on the importance of vitamins. Occasionally, too, we read of the potency of hormones, those interesting chemical compounds manufactured by certain glands, which play such an important part in stimulating or retarding the growth of other tissue. The discovery of iodine in the thyroid was followed by the isolation of a stable iodine-containing hormone, *thyroxine.*

THIS simple example of the importance of iodine in the thyroid has brought into prominence the remarkable rôle that minute quantities of certain chemicals play in animal nutrition. Plant physiologists have been led to see the imperative need for a careful examination of the entire field of plant nutrition and to raise the question: Do plants also need minute quantities of certain less common elements for their normal growth and development?

Chemical analyses have shown that the list of elements found in plants is very long, but the mere presence of such substances does not mean that they are essential. How then can the really essential elements be distinguished from the non-essential? The logical biological test to determine the effect of a given element on plant growth is to grow the plant in soil to which this element has been added. Likewise, to determine the effect of the absence of such an element, the plant should be grown in a soil lacking that particular material. However, soil contains minute quantities of a large number of elements which it is quite impossible to remove or even detect chemically, and since it may be desirable to eliminate even a trace of certain elements in order to see how the plant responds to such a deficiency in its diet, soil cannot be used.

Briefly, the general method in common use is to grow the plants with their roots in pure water to which pure chemicals have been added. Thus a given element can be omitted quite easily. A good plant nutrient solution that contains the common fertilizer elements needed in comparatively large amounts, may be made up from the following salts expressed as volume-molecular concentrations (a method used to express concentration of solutions) and as percentage concentrations:

	vol-mol. conc.	*percent conc.*
$Ca(NO_3)_2$	0.005	0.082
$MgSO_4$	0.002	0.024
KH_2PO_4	0.002	0.027



HEALTH AND UNHEALTH

Figure 1: Tomato plants grown in nutrient solutions. Left, boron deficient; right, similar solution but containing one half part per million of the element boron

In order to keep the plants green, about one cubic centimeter of a 0.5 percent ferric tartrate solution per liter of the nutrient solution should be added daily while the plants are young. The carbon dioxide of the air, and water, help supply the plant with oxygen, hydrogen, and carbon. By the use of distilled water, highly purified chemicals and carefully cleaned culture jars, it has been demonstrated successfully that in addition to the ten elements comprising the old list, we must now add manganese, zinc, boron, and perhaps several others. It must be remembered, however, that these elements are needed by plants in very, very small amounts.

Boron is one of the elements that has been attracting considerable attention. It occurs in boric acid and in common borax, but its need in the plant was not even suspected until recently. In fact boron was considered a poison. Only a few pounds of borax per acre will work havoc to a potato crop. A disaster of this sort occurred a few years ago when certain fertilizers containing borax as an impurity were used. However, a very weak concentration of boron is not only beneficial, but absolutely necessary for the plant's health.

THE necessity of boron to the tomato plant was shown in an experiment in which two groups of plants were grown with their roots in nutrient solutions containing all the so-called essential ions. The solutions were similar with the exception of their boron content. No boron was added to the first group, while just enough boric acid was dissolved in the second to bring its boron concentration up to one part in 2,000,000 parts of water. Representative plants from the two groups are shown in Figure 1. The unhealthy condition of the plant on the left is clearly shown, especially when compared with the healthy one on the right.

Although the concentration of boron (1 part in 2,000,000) is extremely small, yet the plant has little difficulty in detecting it and in making good use of what it absorbs from the nutrient solution. Imagine how much a man would be nourished by eating pea soup in which there was one pea to every 132 gallons of water. That corresponds to the boron dilution which apparently suits the tomato plant. A concentration five times as strong, or in terms of our soup, five peas instead of one in 132 gallons of water, is distinctly injurious to the plant. Two to three parts of boron per million of water cause the margins of the leaves to die and soon the entire plant becomes unhealthy. On the other hand, the beneficial concentration of one part in 2,000,000 will frequently double the weight of the entire plant. The growth response when the proper amount of boron is absorbed by the plant is almost incredibly out of proportion to the small amount of the element involved.

The poisonous effect of too much boron is to be expected, but the surprising thing is that with no boron the plant is even worse off. The stem will not elongate because the terminal bud dies. The conducting tissues within the stem die. These tissues are composed of small tubes which carry the sugars made in the leaves down the stem. With the destruction of these tubes the plant's health is greatly impaired.

THE sugar manufactured in the leaves can not be transported to other parts of the plant where it is used for growth. Some of the sugar solution thus dammed up in the leaves is changed into starch, a storage form of carbohydrates. In the potato plant such leaves become thick and rolled, as illustrated in Figure 2. This condition closely resembles a disease called leaf-roll in which the conducting tubes are destroyed by disease and starch accumulates in the leaves instead of in the tubers.

Great care is necessary in performing experiments to demonstrate the injury caused by a lack of boron. One experimenter found that no boron-deficient injury was found when tap water was used in making up the nutrient solutions for tobacco plants, but if distilled water was used the plants failed to grow. The addition of a very small amount of boric acid solved the problem. There was enough boron in the tap water to supply the needs of his plants, but none in the distilled water until he added boric acid.

About Plant Fertilizers

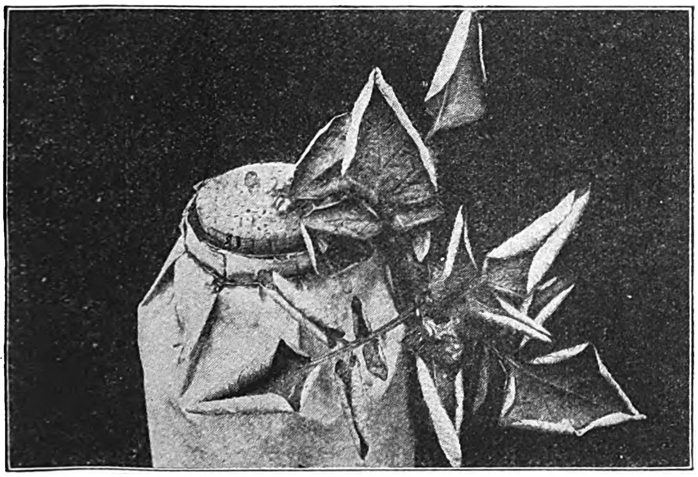
A PURE food and drug act for plants would be a death warrant to all living creatures. Few of us realize on what thin threads life hangs. Perhaps all of us know that in the ultimate analysis all animal life depends on plant life. Not until recently has it been known that many of our crop plants are absolutely dependent on minute traces of impurities or poisonous elements found in most soils and commercial fertilizers. In the light of such knowledge one may question the exclusive use of highly concentrated and purified fertilizers that are being marketed by certain companies.—*The Editor.*

The resourcefulness of the plant in getting its boron is well illustrated by the following incident. Several years ago an experiment was carried out in which potato plants were grown in new earthenware jars filled with pure quartz sand. These cultures were watered with a solution containing the elements previously found essential to plant growth. No boron was added, however. The first set of plants grew very well, but later, when these experiments were repeated, the plants failed to grow normally. After the importance of boron had been pointed out, it was realized that the plants in the first experiment had obtained enough boron from the glaze of the new jars to make good growth. The available supply of boron in the glaze had apparently been exhausted after the first experiment. This theory was put to a test by growing two sets of potato plants in the original jars, using the same general methods and similar solutions made up from the same lot of chemicals. Boron was added to the solutions used in watering one set of plants but not the other. At the end of eight weeks the difference in growth was very marked, as is shown in Figure 3.

PLANT containers of ordinary soft glass, such as the common Mason fruit jar, can very well be used in experiments dealing with boron deficiency. However, such jars may prove worthless when the effects of a zinc-deficient diet are to be studied. Zinc may be dissolved out of certain glasses which would make the results inaccurate in a manner similar to that in which the glazed jars had been used for boron-deficiency studies. In such work, jars made of the familiar Pyrex glass used in baking dishes serve the purpose very well, although they too, like glazed jars, are worthless for boron experiments. When such precautions are taken it has been clearly shown that zinc is just as much needed by a number of higher green plants as is nitrogen or potash, although of course in very much smaller quantities. It must be remembered that zinc, like copper and arsenic, is exceedingly poisonous.

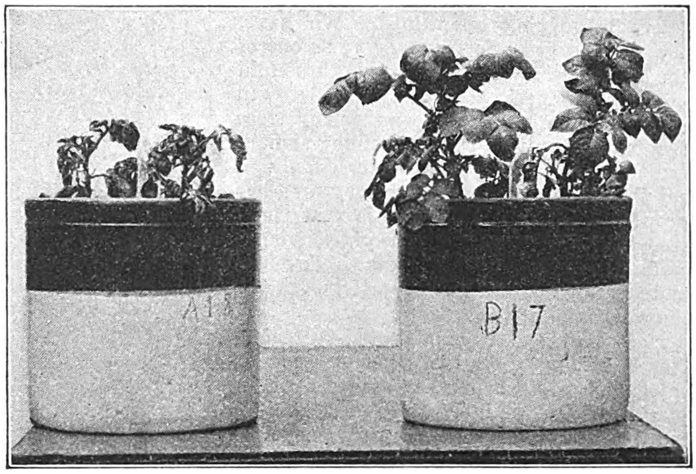
Thus it appears that there are a number of inorganic poisons which act as stimulants or as food to plants when given to them in small amounts. The concentrations of such substances vary with the poison as well as with the type of plant being treated.

With such examples in mind it is no wonder that earlier investigators on the nutritional requirements of plants failed to include some of these rarer ash elements in their list of essential elements. As methods became more and more refined and the chemicals purer, it was found that plants, like animals, demand minute quantities of certain substances which no one heretofore had even imagined to be important, much less absolutely necessary in the plant's diet.



POTATO SEEDLING, BORON DEFICIENT

Figure 2: The seedling was grown in a boron-deficient nutrient solution. The leaf roll characteristics are evident in the picture



A STRIKING CHECK TEST OF PLANT DIET

Figure 3: Potato plants grown in sand cultures treated with boron-deficient solution (left) and (right) with boron solution

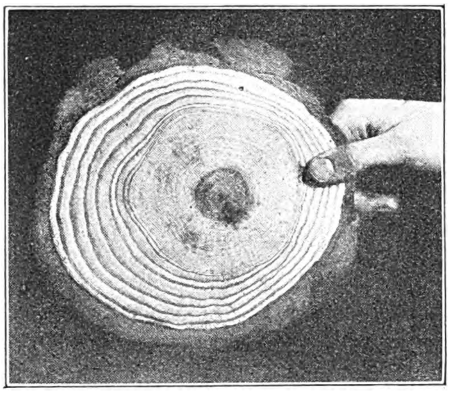
The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Bottle Drifts 7000 Miles

TWO unusually long bottle drifts have just been reported to the Washington Hydrographic Office. One bottle, thrown overboard by Officer O. Haugstad of the Norwegian steamer *Childar*, was picked up among the Marshall Islands after having drifted about 6000 miles. The second was found among the Caroline Islands after a drift of about 7000 miles. This bottle was one thrown overboard by Second Officer R. M. Stall of the American steamer *K. R. Kingsbury*.

The longest drift in the records of the Hydrographic Office is one made from the southern Indian Ocean to the tip of Cape Horn between May 31, 1909, and May 19, 1912, a total of about 11,820 statute miles. —*Science Service.*



Thin section of a "Pondosa" pine showing more rapid growth after mature and unhealthy growths were cut from around it. A tree puts on one or two rings each year

Rapid Lumber Growth Due to Selective Logging

IN the past SCIENTIFIC AMERICAN has commented frequently upon the necessity for conservation of our timber resources, for reforestation, and for the elimination of waste in logging operations. We have, therefore, urged selective logging as one of the best possible answers to this three-fold problem. When only the mature growth is cut for lumber and the unhealthy trees are weeded out, the remaining small, healthy trees are given a better chance to get the sun and light so necessary for their proper growth. The result is that these trees mature much more rapidly, young seedlings are given a chance to develop, and the forest may be cropped in exactly the same manner as a farm.

It is difficult for some people to realize how they may apply this principle in their wood lots. The writer has known farmers to cut ruthlessly all the trees of small forests for firewood or for lumber. To impress the truth upon such people, they have to be shown in a striking manner. Therefore we asked the Shevlin-Nixon Company of Bend, Oregon—whose policy of selective logging is well known—to send us facts to illustrate the benefits of the principle. They forwarded the thin section of a tree, a photograph of which is reproduced on this page.

The tree from which this section was cut grew very slowly for the first 80-odd years of its life, as shown by the compactness of the center growth rings. It was left standing when the mature and unhealthy trees all about it were logged. The result was that it grew in the last nine years of its life a greater volume of wood than it had during all its former life. It thrived on the sun and light that had been denied it while it was crowded by other larger trees in the immediate neighborhood.

"Tempered" Copper

"THE ancients" had hardened copper—tempered copper, as some believed—and so have we moderns. Indeed, we have had several varieties for many years. Nevertheless, persons yet talk of hardening of copper as a long lost art. Numerous uninformed inventors have sought to recover this art.

Dawson, a famous inventor of hardened copper, claimed to shave with a copper razor. He made surgical instruments, shears, and other edged tools of copper. We have a pair of shears, that after at least ten years will cut thin paper and other things demanding a keen edge. His copper was alloyed with 17 percent to 18 percent tin and ½ percent nickel. Through the influence of the nickel, Dawson's copper had a fine grain structure.

Erwin A. Sperry, a Connecticut metallurgist, proposed about 1905 an alloy of silicon and copper for springs. Plain silicon-copper alloy seemed difficult to handle and no one was successful with its fabrication.

Everdur and Tempaloy are two relatively new kinds of hardened copper. Both are alloys of copper with silicon and other metals and have approximately the physical properties of steel. Each was a by-product of research directed primarily toward another end.

During the World War, the du Pont Company was buying chemical plants in order to get their acid works. Some were in bad condition; quick repairs had to be made. Plain copper would not withstand the attack of certain chemicals being made or used in these plants. Tin was so scarce and costly that it could not be used for alloying the copper. Charles B. Jacobs, who was in charge, made castings from silicon copper to meet the situation. They were brittle and did not machine well.

Silicon was being produced in commercial quantities but was not being used for alloying copper. Silicon bronze had been known for a long time, but silicon bronze was tin bronze deoxided with silicon. Of course there was residual silicon in silicon bronze. That is to say: for thorough removal of oxygen a slight excess of silicon was used and a little remained in the alloy. Silicon, however, was not one of the main constituents.

Acid-resisting metals were much needed; researches were being made for alloys of desired qualities using metals that could be had in America. Reserch by Jacobs led to addition of manganese in various proportions to silicon-copper alloy. The alloy thus made worked satisfactorily and gave the required service. It had strength as well as acid-resisting qualities. It was patented and commercial manufacture undertaken. Everdur for castings contains 94.8 percent copper, 4 percent silicon, and 1.2 percent

Courtesy The Shevlin-Nixon Company

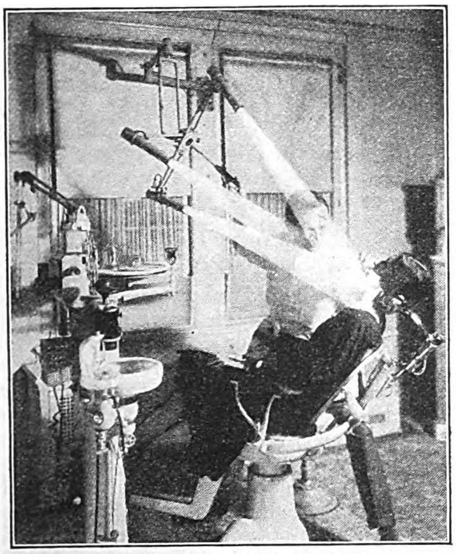
Selective logging removes all but the younger, healthy trees with the result that they get more sun and are protected from fire and windfalls

manganese. For wrought forms, such as rods, wire, sheets, and tubes, Everdur contains 96 percent copper, 3 percent silicon and 1 percent manganese.

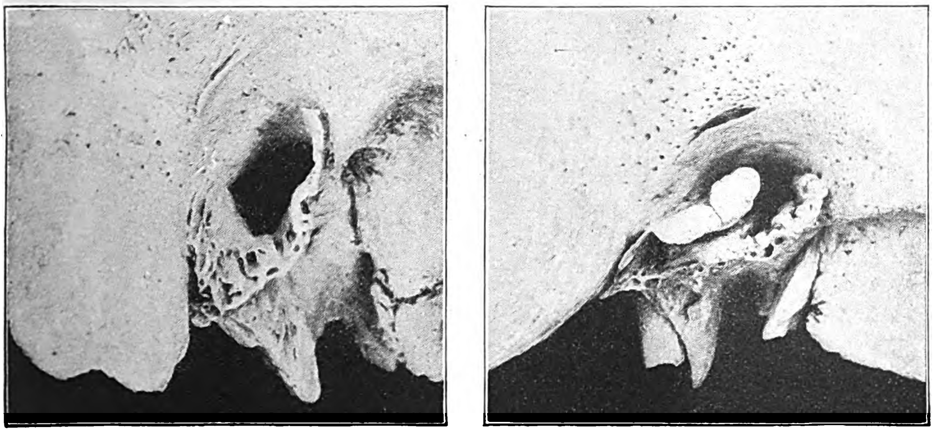
Everdur made for casting can be forged and rolled hot, but will not stand much cold working. It hardens rapidly in both hot and cold working. Hence the need for an alloy that could be worked. Wrought Everdur is hardened by drawing or rolling, with marked increase of tensile strength and of hardness. Everdur resists corrosion by many kinds of acid and alkaline liquids. A great variety of uses are being found for this alloy.

Tempaloy is copper carrying nickel silicide. In other words, it is an alloy of copper, silicon, and nickel. It resulted from researches by Michael G. Corson in the laboratory of the Union Carbon and Carbide Research Laboratories during which the possibility of hardening copper by means of certain silicides became apparent.

When heated to 750 degrees to 800 degrees, centigrade, and then chilled, Tempaloy is soft and ductile and can readily be worked cold. Age hardening takes place when the alloy is held at 450 degrees for a few hours. It can be age hardened without cold working or after cold working, as may be convenient. Age hardening after cold working gives considerably higher results than age hardening of Tempaloy which has simply been softened by heating. Addition of aluminum strengthens Tempaloy appreciably and accentuates its hardening properties.



With the simple twist, the dentist "spots" a light where he wants it



Indians did not always have keen hearing. At the left is shown a normal ear cavity; at the right, hard tumors in the ear of an ancient Indian

Tempaloy, therefore, is a copper that can be tempered, or more correctly stated in modern phraseology, its properties are developed by heat-treating.

Everdur and Tempaloy open the engineering field to copper. By suitable treatments they can be given such strengths that rods having cross-sections of one square inch would require pulls of 50,000 to 150,000 pounds to break them. Scientific research has thus produced two strong metals, resistant to almost all ordinary forms of corrosion and adaptable to numerous and varied uses. By industrial research in laboratories of the American Brass Company, both metals have been developed for practical application.—W. H. Bassett in *Research Narratives.*

Deafness in Ancient Times

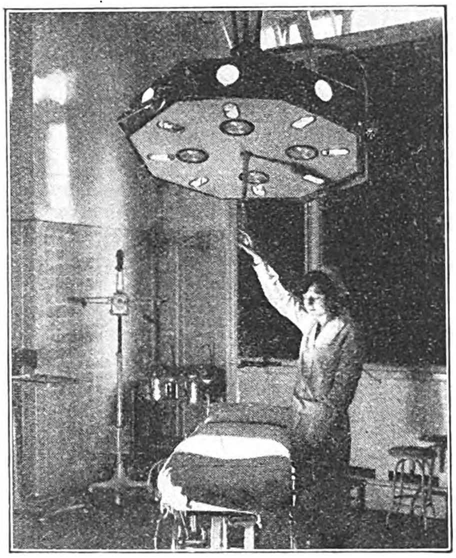
WE are so accustomed to think of Indians as possessed of the most acute vision and the keenest sense of hearing that we can hardly credit the statement that many Indians of ancient times were stone deaf. A common cause of deafness was due to the growth, in the outer ear passages, of numerous small, hard, ivory-like tumors which often filled the passages in both ears, preventng the entrance of sound waves. The condition was widespread among ancient Indians of pre-Columbian Peru, in a prehistoric tribe in Arkansas, in wandering bands of Indians found on the seacoast of southern California, and among aborigines living on the tiny island of San Nicolas, the most seaward of the California Channel Islands. Another type of deafness is due to the infections of the ears arising from large abscesses formed about the teeth.

An accompanying illustration shows the ear canal of an ancient Indian from Peru; another shows several small, hard tumors beginning to fill the passsage. Such tumors are not known among modern people.

Reproduced Daylight for Surgeons and Dentists

SURGEONS and specialists in the hospital operating room, as well as the dental surgeons in their offices, have long felt the need of a proper method of illuminating their work. Through an invention of Dr. Leon Lazar, a practicing dentist of New York City, a lighting device has been conceived that is totally different from anything heretofore used.

The Lazar light is so constructed that several beams of light may be projected from different angles onto the spot where the surgeon or dentist is working. All beams are controlled from a single handle so that the operator can focus and merge all the beams into one spot of intense illumination, thereby giving a shadowless effect. Each light source is provided with a daylight filter which can be instantly snapped on to convert artificial light into reproduced daylight. Under this light colors and shades appear in their natural values, a feature that is indispensible in matching of teeth, porcelain fillings, and similar work.



The hospital unit with which surgeons may illuminate the point of the operation without a diffused and troublesome glare

This new light is made in three models: one, the hospital light, is for major surgery; another, the specialist light, is for nose, throat, mastoid, eye, and other minor operations; and the third is the dental light. Many dentists and a number of large hospitals are using these lights, and a number are in use by the United States Navy on battleships and at the Brooklyn Naval Hospital.

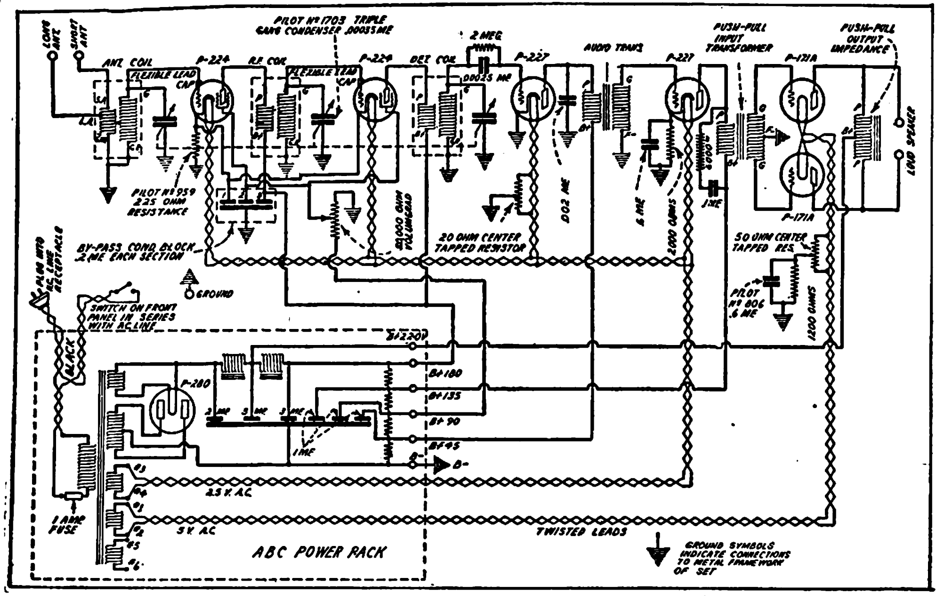
New Wrought Iron Process Eliminates "Puddler"

EGYPTIANS made wrought iron thousands of years ago. This tough and long-wearing metal continued to be made by the same primitive means until the invention of "puddling" in 1784. This slow and expensive hand process is just now giving way to a revolutionary mass-production process developed by Dr. James Aston of the Carnegie Institute of Technology. Adopted by the A. M. Byers Company of Pittsburgh, it will abolish the picturesque "iron puddler" and bring this useful metal back to the many uses for which it has no adequate substitute.

1929 Sunspots Set 25-Year Record

ONE of the things for which 1929 will be remembered in astronomic circles is the record sunspots of its closing month. The spots on the face of the sun from November 24 to December 6 were pronounced at the time as unusual, and an examination of the photographic records of the sun for 25 years has confirmed the first impressions.

C. D. Higgs and F. E. Roach, of the Yerkes Observatory, Williams Bay, Wisconsin, have examined the thousands of


LONG ANT
SHORT ANT
ANT. COIL
FLEXIBLE LEAD CAP
P-224
R.F. COIL
PILOT Nº 1703 TRIPLE GANG CONDENSER .00035 MF
FLEXIBLE LEAD CAP
P-224
DET. COIL
2 MEG
.00025 MF
P-227
AUDIO TRANS
P-227
PUSH-PULL INPUT TRANSFORMER
P-171A
PUSH-PULL OUTPUT IMPEDANCE
LOUD SPEAKER
P-171A
PILOT Nº 959 225 OHM RESISTANCE
BY-PASS COND. BLOCK .2 MF EACH SECTION
50,000 OHM VOLUMGRAD
20 OHM CENTER TAPPED RESISTOR
.002 MF
.5 MF
2000 OHMS
1 MF
50 OHM CENTER TAPPED RES.
PILOT Nº 806 .5 MF
1200 OHMS
PLUG INTO AC LINE RECEPTACLE
GROUND
SWITCH ON FRONT PANEL IN SERIES WITH AC LINE
BLACK
B+220V
B+180
B+135
B+90
B+45
B-
P-280
2 MF
3 MF
3 MF
1 MF
2.5 V. AC
5 V. AC
1 AMP FUSE
ABC POWER PACK
TWISTED LEADS
GROUND SYMBOLS INDICATE CONNECTIONS TO METAL FRAMEWORK OF SET

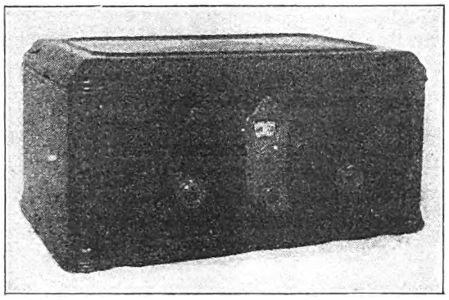
Circuit diagram of the kit-type receiver described herein

photographs made of the sun during the past quarter century, and they find that "there not only was as extensive an area of total spottedness as had ever been recorded in that interval, but also a single spot which probably was not exceeded in size."—*Science Service.*

A New Screen-Grid Radio

THE development of the screen-grid alternating-current tube has opened up a new field to the radio enthusiast. Using these tubes, enormous sensitivity can be obtained, but many experimenters have been disappointed with the results as regards selectivity. This has invariably been due to a lack of understanding of the new tubes and their application to receivers and has now been overcome for the radio constructor by the introduction of a complete, reasonably priced kit that can be made up into the commercial-appearing receiver illustrated in these columns.

This kit, which comes in three forms—the set alone with front panel, the set and a metal cabinet, and the set, cabinet, and a completely assembled power pack that delivers all the required A, B, and C voltages for all the tubes—can be assembled in a short time using only a screw-driver, a pair of pliers, and a soldering iron, even though the constructor knows little or nothing about radio. Every part, down to the last nut and washer, including wire, is furnished with the kit.



Screen-grid receiver in its metal cabinet. Note simplicity of controls—switch, tuning, and volume

A study of the circuit reproduced here will show at once that the set uses two screen-grid tubes, two A. C. tubes of standard design, and two 171A types in a push-pull audio amplifier circuit. Loose coupling between the antenna and the first radio-frequency amplifier insures ample selectivity for all purposes and makes possible the efficient use of single-control tuning. The volume control takes the form of a variable resistance in the screen-grid circuits, and a "tone equalizer" in the second audio circuit serves to suppress some of the higher tones and thus make the lower registers more prominent and pleasing. This equalizer takes the form of a resistance and condenser in series.

The necessity of shielding screen-grid tube circuits is met in this set by the use of aluminum shield cans totally enclosing the two screen-grid tubes and the three radio-frequency transformers. Most of the wiring is located under the sub-panel where it is out of the way and where it is easiest to install. The three variable condensers in the "gang" are provided with "trimmers", which are adjusted for best reception when the set is first placed in operation, after which they need not be moved.

Readers interested in this latest modern radio receiver kit will be supplied with further information upon request.

Chemical Kills Weeds but Lets Little Trees Live

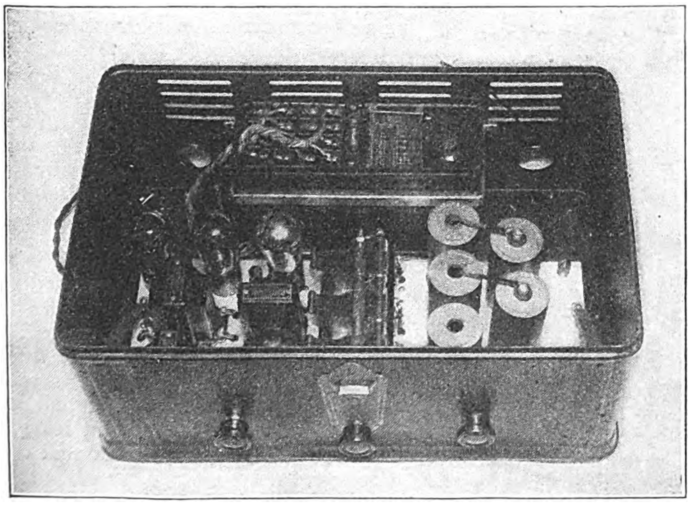
ZINC sulfate, sometimes called white vitriol, will kill weeds in a plant bed full of conifer seedlings but will not harm the little trees, Prof. Ferdinand H. Steinmetz and Prof. Fay Hyland, of the University of Maine, have found. They reported their discoveries recently to the American Society of Plant Physiologists.

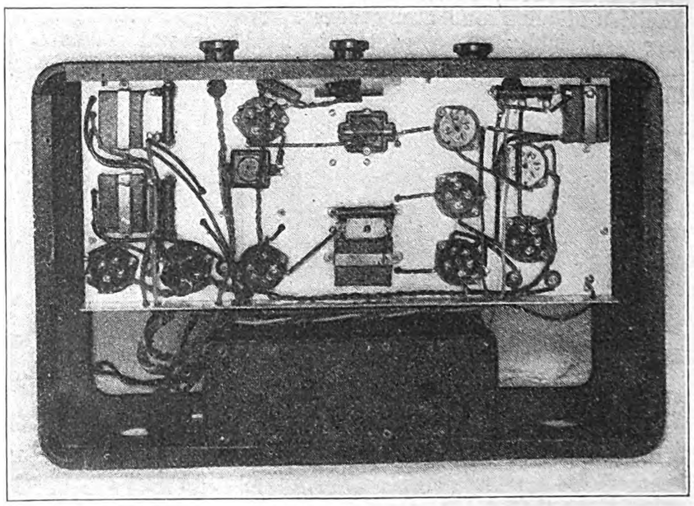
Eight grams of zinc sulfate, dissolved in sufficient water and sprinkled over a square foot of ground, is most effective, it was learned. Germination of the seeds and growth of the little trees was only slightly reduced by the dose, while practically all the weeds were killed.—*Science Service.*

Earth as Power House Yields 200,000,000 Amperes

THE earth itself is a huge electric dynamo generating enough current to supply light, heat, and other electrical needs to the 10 largest cities in the United States for at least a million years. Recent researches on thermal reactions inside the earth, conducted by Dr. Ross Gunn, civilian scientist of the Naval Research Laboratories and inventor of a short-wave oscillator and airplane altimeter that have been taken up by the radio and aircraft industries, indicate that the earth is the greatest known electrical wonder in the universe.

Dr. Gunn has published a theoretical treatise on his studies in the *Physical Review.* The intricate theoretical problem of the earth's electrical condition showed that





Photographs courtesy Pilot Radio and Tube Corporation

Cover of cabinet removed, showing set chassis and powerpack. At right are shielded screen-grid tubes

Bottom view of set. Practically all wiring is below the sub-panel. Note the twisted leads that carry the A. C.

the currents generated inside the earth amount to more than 200,000,000 amperes. Dr. Gunn is careful to emphazise that this tremendous source of energy is unavailable for use by man. Like atomic energy, it will be kept in Nature's storehouse for use perhaps a million years in the future, he says.

According to Dr. Gunn, the tremendous electrical currents that are produced inside the earth arise from the motions of the tiny electrical charges known as electrons. The motions are caused by the very high temperatures existing inside the earth's crust.

Due to a peculiar and complicated type of interaction, the electrons are caused to drift around the earth's axis of rotation. This drift of electrons constitutes an electric current which is so large that, if it were sent through the huge cables supporting Brooklyn Bridge, it would melt them in less than a thousandth of a second.

The presence of the currents that flow in the hot interior of the earth may be detected by anyone who cares to observe the action of a magnetic compass on the surface of the earth, says Dr. Gunn, for it is precisely these deep-seated electric currents that orient the compass needle in a north-south direction. He adds that it has been known for thousands of years that the earth behaved like a giant magnet, but the mechanism by which this magnetism was produced was not understood.—*Science Service.*

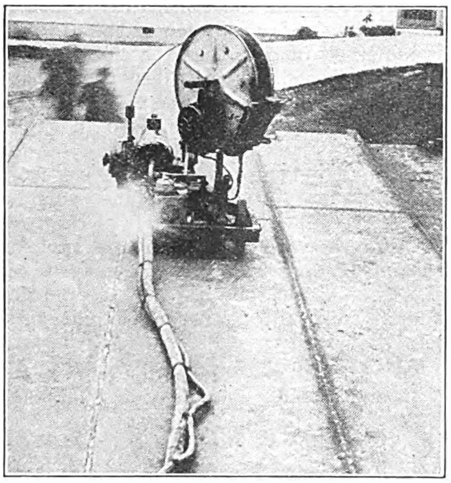
Welded Steel Flooring for All Buildings

THE long-cherished dream of many architects and builders—to erect 100-story buildings—may now be realized as the result of the development of a new type of electrically welded flooring which materially reduces the weight of the structure. The new floor construction, known as the "battledeck" type, was announced and given its first public demonstration at the seventh annual convention of the American Institute of Steel Construction, Inc., at Biloxi, Mississippi, recently.

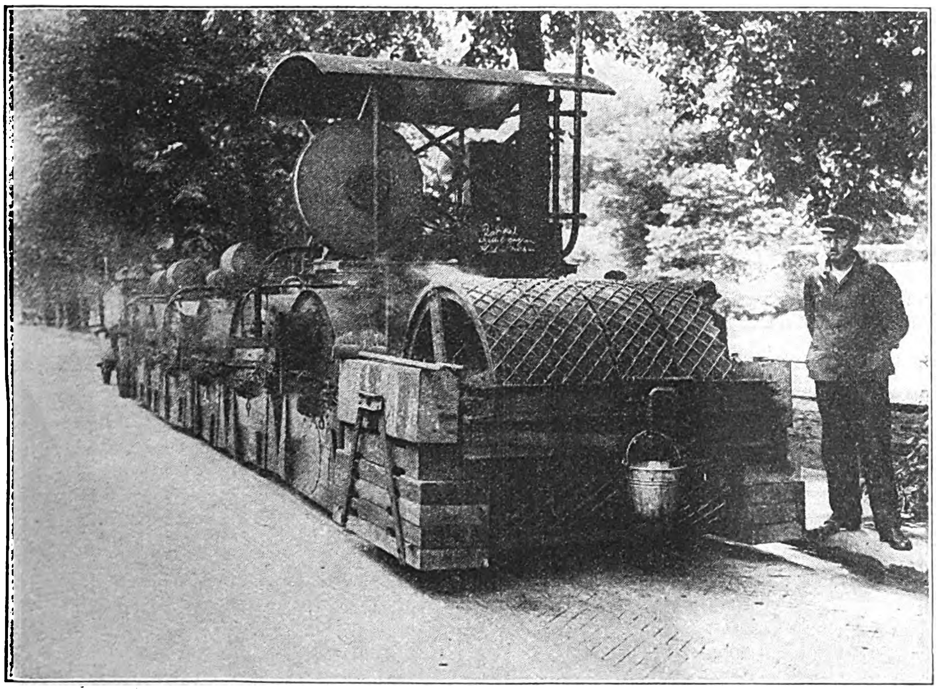
A sample structure was erected and a demonstration flooring was constructed in the presence of the institute membership, using steel plates and structural steel beams, the plates and beams being "stitched" together to form the flooring. The resulting structure met all specifications and tests satisfactorily.

A special electric arc welding machine, operating automatically, has been designed by the General Electric Company for this application and one of the new machines was used in the demonstration.

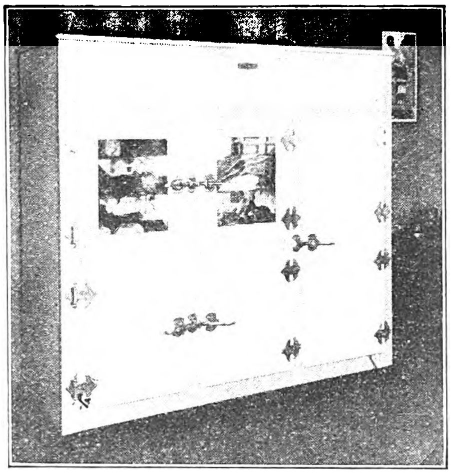
This machine consists of a three-wheeled self-propelled vehicle driven by an adjustable-speed motor. On the framework are mounted a wire-feeding device, a reel of welding wire, the travel motor, and the control devices. A motor generator at a remote point supplies, through a trailing cable, the current for welding and for operating the travel motor. The speed of travel and the speed of the welding-wire feed can be varied easily by adjusting small rheostats, thus making it possible to suit the operation to any particular circumstances. In the demonstration at Biloxi a satisfactory weld was accomplished at a speed of 9½ inches per minute.



The outfit with which the seams of steel plate flooring are welded. Its operation is notably simple



When the weather is warm in Berlin and the asphalt is soft with the heat, this machine is rolled over pavements to mark them with a pattern like that of bricks to prevent skidding of automobiles. The roller is heavily weighted



A new development: 60 cubic foot commercial refrigerator cabinet

In operation the machine is placed on the beginning of a seam where it is lined up and started running. If by any chance it should tend to deviate from the seam during the course of travel, it can be steered by means of a small wheel on the mechanism. At the end of the seam it is merely necessary to turn the machine around and place it on the beginning of the next seam, proceeding from this point as before until all seams are welded.

The new floor is described by the Institute of Steel Construction as being a solid steel deck which acts as a girder to prevent any torsional distortion of the building when subjected to wind or earthquake action.

The new steel floor is equally applicable to residences, multiple-story buildings, and bridges, and for building construction it will save from 20 to 60 pounds per square foot of floor in dead weight. In connection with a 75-story building with floor panels 21½ feet by 22½ feet, the saving in dead load on the foundations for each column is nearly two million pounds, and indicates that its use will permit an increase of 25 percent or more in the height of the building or in the number of floors without increasing the loads on the foundations.

Commercial Electric Refrigerators

EMBARKING on a still wider field of operations with a new line of products, Frigidaire Corporation has announced a series of porcelain commercial boxes, constructed along principles which have already proved successful in the household refrigeration field, and designed to meet the requirements of virtually every kind of retail business.

The new boxes are of 35, 60, and 110 cubic foot capacity. The smallest is similar to an enlarged household model, having four service windows. The two larger models have a full length door besides the four windows. This door gives access to a meat rack for hanging quarters of meat. Engineers pointed out that three sizes were selected after an exhaustive study of the most popular sizes for commercial refrigerators.

E. G. Biechler, president and general manager of the corporation, in announcing the new boxes, emphasized the fact that the company will continue to make refrigerating equipment to be used with other makes of refrigerators, but in addition now is able to provide a box engineered exclusively for electrical refrigeration and covered by its standard factory guarantee.

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

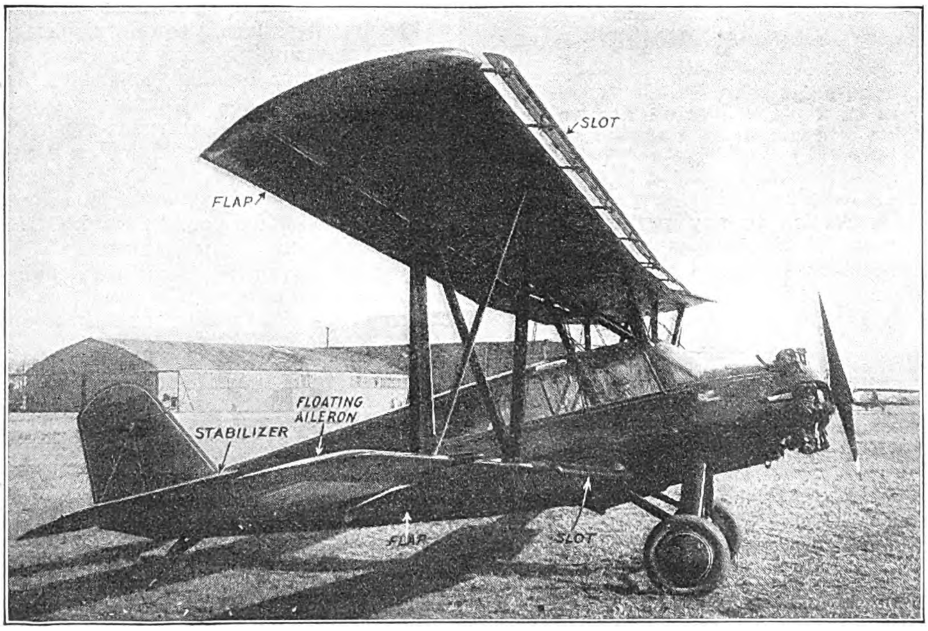
CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

The Safe Aircraft Competition

FROM the writer's personal view of the recently closed Guggenheim Safe Aircraft Competition, in which the Curtiss *Tanager* was the only one to qualify, there emerge the following conclusions:

1. The speed ranges as advertised by our manufacturers, that is, the range between maximum and minimum flying speed, are greatly over-estimated. Those which such manufacturers advertise, in all honesty, are apt to shrink considerably when submitted to the acid test of independent and accurate testing. If the competition makes this clear to industry and public alike, it will have achieved a real service to aviation.

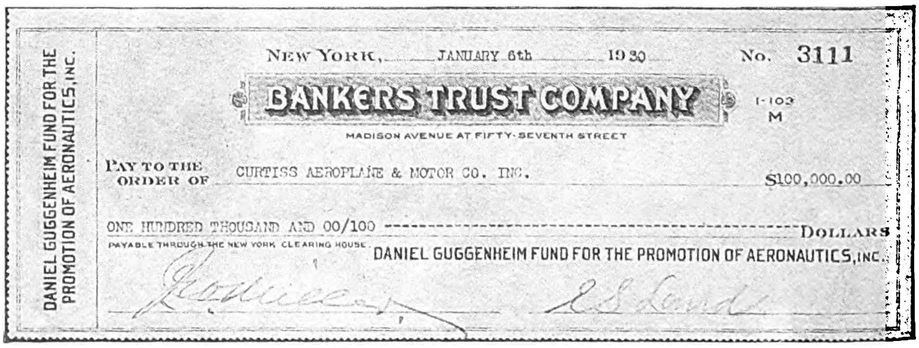
2. It is far more difficult to diminish the minimum speeds, and hence the landing speeds, than to increase the top speeds. Dr. H. E. Wimperis, of the British Air Ministry, points out that the speed of a British fighting plane was increased by 70 miles an hour in the course of a single year. As demonstrated by the Schneider Cup Races there seems to be no limit to the speed of our racing aircraft. At the lower end of the range, progress seems to be much slower and the conventional airplanes, such as many of those entered in the competition, frequently have stalling or minimum speeds of well over 45 miles per hour.



A side view of the prize-winning *Tanager*, with the various important parts indicated and named. These features are described on this and the opposite pages

3. The only way to achieve progress at the lower point of the speed range, without sacrifice of other good qualities, is to adopt some device for increasing the maximum lift coefficient of the airfoil.

4. The competition indicated that variation of the camber alone, or variation of the angle of incidence, were not very effective methods of improving the landing speed. It was most unfortunate that one entry which embodied both variable area and camber was not ready in time to undergo tests.



NEW YORK, JANUARY 6th 1930 No. 3111

BANKERS TRUST COMPANY 1-103 M

MADISON AVENUE AT FIFTY-SEVENTH STREET

PAY TO THE ORDER OF CURTISS AEROPLANE & MOTOR CO. INC. $100,000.00

ONE HUNDRED THOUSAND AND 00/100 DOLLARS

PAYABLE THROUGH THE NEW YORK CLEARING HOUSE

DANIEL GUGGENHEIM FUND FOR THE PROMOTION OF AERONAUTICS, INC.

E S Land

DANIEL GUGGENHEIM FUND FOR THE PROMOTION OF AERONAUTICS, INC.

A reproduction of the check tendered to the designers of the qualifying Curtiss *Tanager*. Requirements of the competition are put forth on the opposite page

5. The competition indicated quite clearly that the slot, acting in conjunction with a rear flap, was at that date the most powerful and the most practical means of improving the lower range of the aircraft. It indicated further that the slot and flap could be embodied in the design of an airplane without any undue complication and without any danger of failure in flight. Both the Curtiss entry, the *Tanager*, and the Handley Page entry carried the front slot and a rear flap. These planes suffered, in the exceedingly severe tests of the competition, a variety of mishaps such as broken landing gears and damaged tail skids, but at no time did the slot and flap offer any difficulties either in reliability or in pilot's operation.

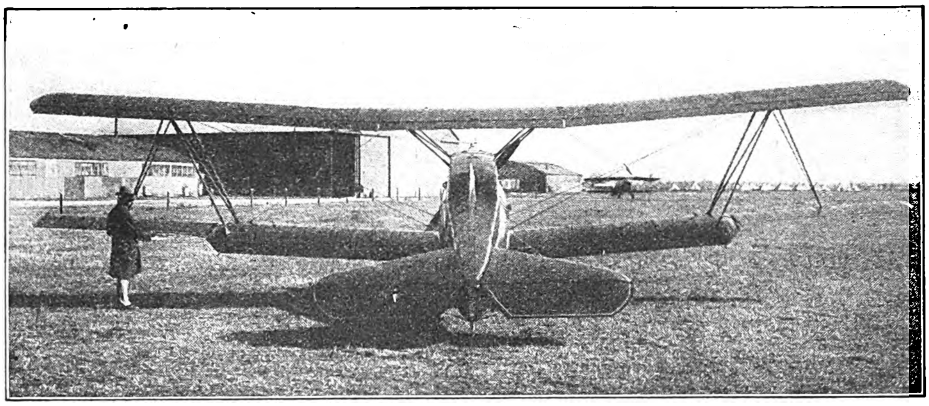
6. The Curtiss Company has announced definitely that it will put the *Tanager*, a cabin biplane, into production. We believe that other American manufacturers will be convinced soon that slots and flaps belong in the modern airplane, and that their use will become general in a few years.

Considering the *Tanager* in some detail, there will be noted first of all, that there is the slot, consisting of an auxiliary airfoil mounted at the leading edge of the main wing. When at high angles of incidence, with the suction on the upper surface of the wing concentrated towards the leading edge, the small auxiliary airfoil mounted on a suitable form of roller moves forward automatically and creates a Venturi-like passage between the auxiliary airfoil and the main wing. The streamline flow, destroyed by the high angle of attack, is immediately restored by this passage which allows an auxiliary flow from the region of high pressure below the wing to the region of low pressure above the wing.

The opening of the slot allows the wing to go to an incidence of some 24 degrees, instead of the usual 16 before "burbling" of the air flow occurs. The lift is thereby increased some 40 percent for a thick wing, and some 60 percent for a thin wing. It is difficult to use the action of the slot alone, because to take advantage of its lift-increasing property, it is necessary to have an airplane whose angle of incidence at landing is high. The chassis, to realize a three point landing with front wheels and tail skid touching at the same instant, must be long and stilt-like. This decreases the performance of the aircraft because the weight and air resistance of the landing gear increase with its length.

If, however, a rear flap is placed all along the rear edge of the wing, the situation changes. First of all the use of the rear flap in conjunction with the front slot increases the lift not some 40 to 60 percent, but over 100 percent! Secondly, the depression of the rear flap brings down the angle of incidence at which maximum lift is achieved to normal proportions, and the landing gear design need no longer depart from convention.

The front slot can be suitably linked up



Looking at the *Tanager* from the rear. This photograph shows plainly, at the lower wing tips, the two ailerons which are always at a zero angle of incidence

with the rear flap, so that the action of the rear flap is also automatic. As the front slot opens it pulls down the rear flap. As the front slot shuts, the rear flap gets in line with the wing as should be the case within normal flying speeds.

The Handley Page entry had the rear flap interconnected in this manner. The designers of the Curtiss *Tanager* preferred to place the control of the flap in the hands of the pilot.

Experience in the competition seemed to indicate that the manually controlled flap is preferable. The automatically controlled flap has a tendency to take charge itself and to shut the front slot just when its help is needed the most. This is because the air presses up on the flap and tends to raise it at all times, so that the flap and slot are, so to speak, working against one another.

Another important feature of the Curtiss entry was the floating aileron. In order to achieve the maximum possible increase in lift, it is advisable to have the rear flap run the entire length of the wing span. Hence the ailerons should, if possible, be outside the wing system proper. Also, the conventional aileron acts least effectively at high angles of incidence and low speed, when it is required the most. The floating aileron as used by the Curtiss company gets around this difficulty. The ailerons are so arranged that they float in the air stream and are always at zero angle of incidence, although they can at the will of the pilot be raised and lowered on respective sides so as to achieve lateral control.

The great advantage is that the ailerons always start from a neutral incidence and are therefore effective no matter what the incidence of the wing as a whole may be. Further, since the ailerons are symmetrically double-cambered surfaces, when one is lowered and the other raised their air resistance remains the same because of this symmetry. Hence the ailerons introduce no unequal resistance at the tips of the wing, and no tendency to turn the machine off its course.

Still another feature of the *Tanager* is the rapidly adjustable stabilizer which can be moved through a far greater range than the ordinary adjustable stabilizer. At very high angles of incidence, with the flap depressed, the center of pressure tends to move back, and it is hard to keep the machine in the high angle of attack condition. The rapid and powerful adjustable stabilizer action takes care of this difficulty.

The main dimensions of the *Tanager* were as follows:

Spar—43 feet 10 inches (for both wings)
Chord of both wings—5 feet
Wing area—330 square feet
Overall length—26 feet 7 inches
Weight empty—1900 pounds
Useful load—850 pounds
Engine—170 horsepower Curtiss "Challenger"

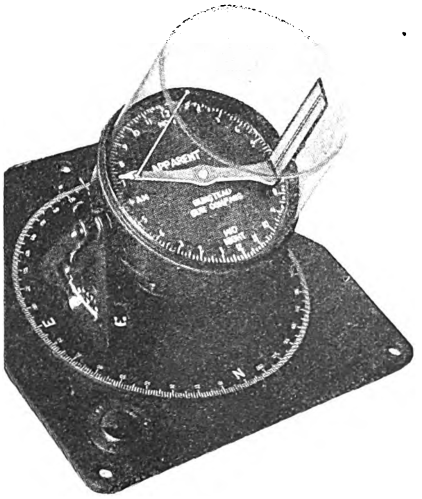
The exact performance of the *Tanager* in the competition has not yet been released, but our readers will appreciate its performance sufficiently well if they note that the plane satisfied all the requirements of the competition, although only by a narrow margin. These requirements were:

Useful load per horsepower—5 pounds
High speed—110 miles per hour
Climb—400 feet per minute
Low speed—power on—35 miles per hour
Minimum gliding speed—power off—38 miles per hour
Length of landing run—100 feet
Steady glide over an obstruction 35 feet high, and coming to rest 300 feet from base of the obstruction
Length of take-off, 300 feet
Take-off over an obstruction 35 feet high at a distance of 500 feet from rest
Flattest glide of 8 degrees to the horizontal
Steepest glide of 12 degrees to the horizontal at a speed not exceeding 45 miles per hour.

The Sun Compass

To establish a course, the pilot has the conventional magnetic compass and the more refined earth inductor compass. Both types are fairly satisfactory everywhere, except near the poles where the magnetic directing force becomes too uncertain.

Accordingly, for his successful flight over the South Pole, Commander Byrd had recourse to an instrument operating on a totally different principle—the sun compass. The sun compass is a clock with a single hand, moving at the same speed as the earth about the sun. The face of the clock bears the usual hour divisions. The tip of the hand carries a needle and the base bears a screen marked with two perpendicular lines. The sun casts a shadow of the pin on the screen.



The Bumstead sun compass

Before starting from Little America, Commander Byrd set the hand of the clock at true solar time. He turned the entire instrument until it read due south, as indicated by the compass markings on the base plate. Then he moved the latitude scale and set it at 90 degrees, the location of the pole. When the party took off, the pilot swung the plane until the sun cast the shadow of the pin between the lines of the screen, where it was held until the goal was reached.

Inasmuch as the hand of the clock makes one revolution in 24 hours and the earth makes one complete revolution in the same time, the compass and the hand of the clock remained in a constant relative position so that a straight line might be maintained.

When Commander Byrd reached the South Pole and turned for his base, he rotated the base plate until it read north instead of south, and the airplane was again directed to bring the shadow of the pin back on the screen.

Air Transport Communication

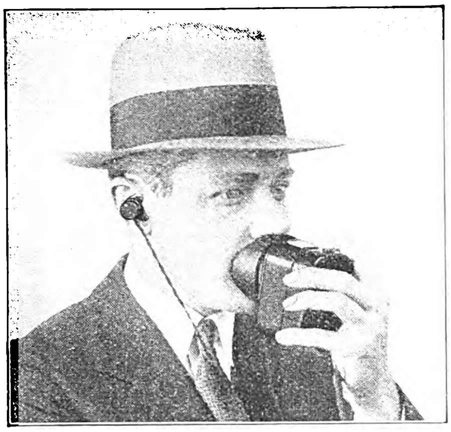
R. L. JONES and F. M. Ryan, of the Bell Telephone Laboratories, in a paper delivered recently before the American Institute of Electrical Engineers, dealt with the very important subject of telephone communication between plane and ground.

In air transport work the dependence on weather conditions makes it an absolute essential of safety that there be frequent and complete communication between the pilot and the ground. Radio telephony is preferable to radio telegraphy as it requires no skilled operator and is much more rapid.

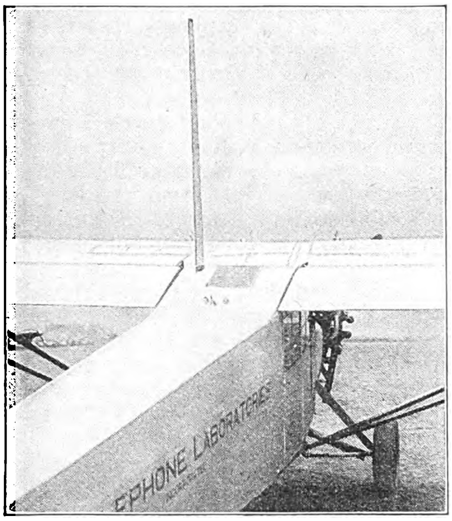
The problem of establishing such radio telephone service presents many difficulties, but the engineers of the Bell Telephone Laboratories, using a large three-engined plane as their flying laboratory, have practically solved it.

The experiments conducted at Whippany, New Jersey, furnish another argument for high altitude flying. Both the strength and the intelligibility of the telephone signals are improved when the plane is high above the ground.

The antenna is quite a problem in aircraft radio. For reception, all that is needed is a self-supporting, stream-lined mast of hollow wood construction, with an internal conductor, and extending about seven feet above the fuselage. For transmission, however, such masts are not generally suitable. The frequency band for aircraft radio telephony is between 1500 and 6000 kilocycles. It is the lower frequencies which give the best results, but for this work, long trailing wires are essential. It may therefore be necessary, in



Owing to the high noise level in airplanes, a special type of telephone transmitter must be used. Here is the hand type which has been developed for this use



A general type of self-supporting stream-lined mast antenna widely used for airplane radio receivers for the reception of weather reports and signals from beacon stations

air transport work, as distinct from military aviation, to use the less suitable higher frequencies because they permit of fixed antennas of relatively small dimensions.

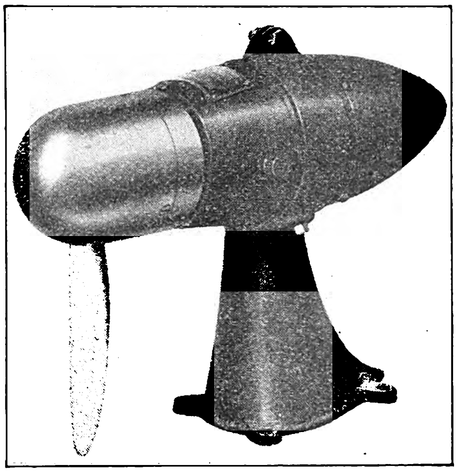
Aircraft radio telephony must meet many unusual requirements. There is first of all the noise of engine, exhaust, and propellers to overcome and in the design of both the microphone and the receiver, special precautions must be taken to exclude external sounds.

Another problem is in the violent electrical disturbances introduced by the usual ignition system of the aircraft engine. Magnetos, the electric ignition circuits, and the spark plugs, must all be electrically shielded. Here is another argument in favor of the Diesel engine; it will dispense with the ignition system and thus aid radio telephony.

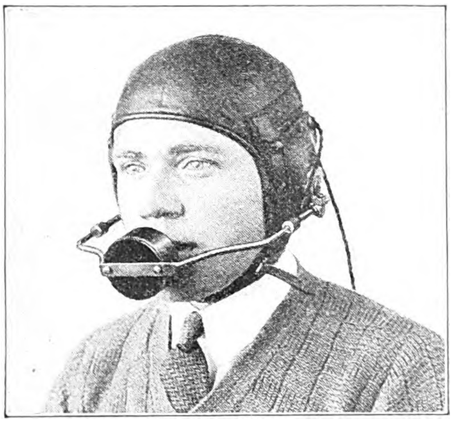
Again, it is necessary to bond all metal parts of the airplane, in order to avoid noises in the receiving equipment from intermittent contacts between various metal parts of the plane. When transmitting apparatus is used on board an aircraft, such bonding is also necessary to prevent the possibility of high voltages developing between metal parts and causing sparks or arcs.

At the moment radio telephony reception is probably more important in air transport than transmission. The aircraft receiver for government weather signals is a comparatively simple affair. It is equipped with three tuned circuits—one for the antenna and one for the output circuit of each of the stages of radio frequency amplification. The receiver is mounted in a metal box about 12 inches long by 8 inches high, and weighs only 13 pounds. A small electric generator supplies the necessary power; it is driven by propeller, which is one-bladed, and the centrifugal force of the unbalanced blade actuates a governor so that speed and output remain constant, no matter what the speed of the airplane may be.

Another characteristic of radio telephony is the special headphone which is used by the pilot and the special telephone-type transmitter which may be fastened to the head or held in the hand.



A single-blade wind-driven generator of the type used to supply filament and plate voltages to the receivers used on airplanes. The speed and output are constant



The special telephone set used by the pilots in airmail planes. The receivers are in the helmet

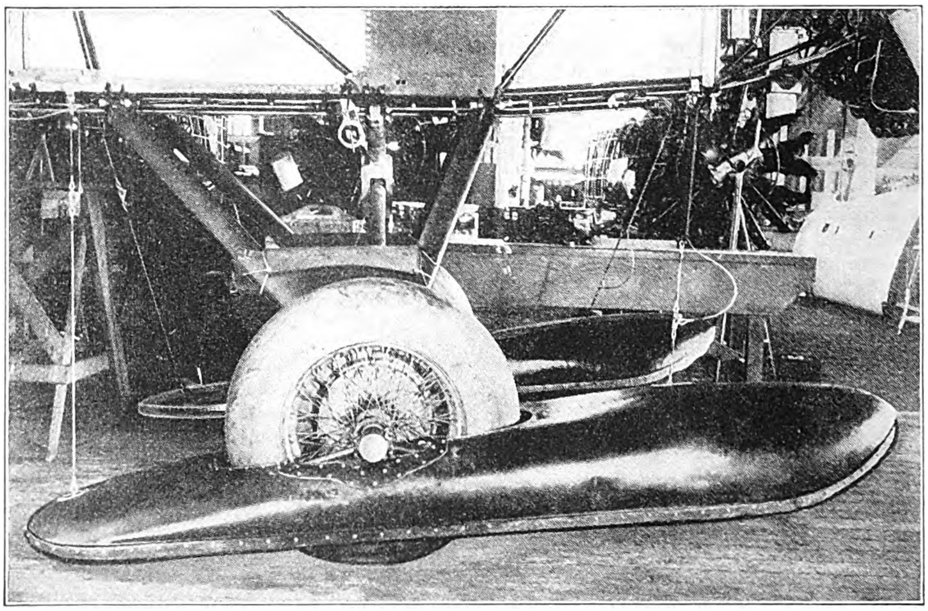
Beryllium

MUCH interest has been aroused by various notices which have appeared in this magazine concerning the extraordinary light metal beryllium. In our January issue, on page 89, mention was made of the cost of beryllium ore at about 60 dollars a ton. This high price, it is hoped, will be greatly reduced in the near future so that the price of approximately 225 dollars a pound for the refined metal may be placed at a level where it will not be prohibitive to the industrial development of uses for the material.

Snowphibions

SNOWPHIBIONS is a recently coined term to designate airplanes which can alight on dry land or on snow indifferently, in analogy with the amphibion which can alight on water or land. The snowphibion built by the Boeing Airplane Company is being put in use on their airline between Chicago and San Francisco, where differences of climate over the long stretch make it uncertain whether snow is to be expected or not.

The snowphibion is provided with a long ski, something like a pontoon in construction. This is pivoted about the wheel axle, with the pivoting motion restrained by rubber cords. Also, by a mechanism analogous to that of the retractible chassis, the ski can be raised or lowered relative to the wheel axle. When lowered, the plane lands on the ski; when raised the wheel is free to act as usual.



A close-up view of a snowphibion landing gear for use in regions where the pilot may be called upon to land on either snow or bare ground. The ski may be lowered or raised: when lowered, the plane may land on snow; when raised, the wheels are used. In the photograph the ski is shown raised

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Engineering

MANUAL OF FIRST-ORDER LEVELING, by Henry G. Avers, (Special Publication Number 140, U. S. Coast and Geodetic Survey) contains general instructions for this type of surveying, as revised to conform to the present accepted practice. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

CONSTRUCTION, REHABILITATION, AND MAINTENANCE OF GRAVEL ROADS SUITABLE FOR MODERATE TRAFFIC, by Carroll C. Wiley (Circular Number 18) is a well illustrated report covering investigations and tests made concerning the methods, materials, and equipment best suited for gravel highways. *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—30 cents.*

THE MOJAVE DESERT REGION IN CALIFORNIA, is a 759-page book with accompanying maps giving complete information about the geographic, geologic, and hydrologic features of one of the continent's most interesting regions, covering an area of about 25,000 square miles. *U. S. Government Printing Office, Washington, D. C.—Two dollars.*

DESIGN STANDARDS FOR OXWELDED STEEL AND WROUGHT IRON PIPING is an illustrated booklet prepared to enable the engineer and architect to design piping systems according to the best practice yet developed. *Linde Air Products Company, 30 East 42 Street, New York.—Gratis.*

Commerce

MARKET DATA HANDBOOK, a 535-page compilation of authoritative statistical data, covers the entire country by counties. The information is arranged in convenient classifications for reference use, showing the localization of all industries as a guide to aid sales managers, manufacturers, advertisers, *et al.* The book is issued by the Department of Commerce. *U. S. Government Printing Office, Washington, D. C.—$2.50.*

COAL BUNKERING STATIONS AND FUEL OIL STATIONS, a new fueling directory covering 300 world ports, has been prepared by the Shipping Board and the Department of Commerce, from data collected by the Department of State through its consular officers. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

FOREIGN COMMERCE AND NAVIGATION OF THE UNITED STATES, is a 661-page volume containing classified statistical and summary tables for 1928 and comparative years, covering all United States foreign trade. *U. S. Government Printing Office, Washington, D. C.—$1.50 (buckram bound).*

Wood

SMALL DIMENSION STOCK, ITS SEASONING, HANDLING AND MANUFACTURE, is a report of the National Committee on Wood Utilization, the 12th of a series on the marketing and use of lumber. The purpose of the report is to develop standard methods of small dimension production, by detailed recommendations. *U. S. Government Printing Office, Washington, D. C.—20 cents.*

THE STORY OF AMERICAN WALNUT begins with the days of King Solomon, marches down the centuries with the master woodworkers of various periods, and concludes with a lesson on means of identifying and judging walnut furniture and interior woodwork. *American Walnut Manufacturers' Association, 616 South Michigan Avenue, Chicago.—Gratis.*

Miscellaneous

ABSTRACTS OF DISSERTATIONS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (1929) covers numerous papers dealing with specialized topics in science, education, history, and classical literature. An appendix covers the activities of the Graduate School. *University of Pittsburgh, Pittsburgh, Pennsylvania.—Gratis.*

BRIEF OF WALTER H. WHEELER, applicant for a permit to produce hydro-electric power for phosphate fertilizer manufacture on the Flathead River in northwestern Montana. This brief shows clearly the plans, as presented before the Federal Power Commission, for the development and utilization of power from "the Muscle Shoals of the West." *Forbes and Daniels, Kellogg Building, Washington, D. C.—Gratis.*

MANUAL FOR BIRD BANDERS, by Frederick C. Lincoln and S. Prentiss Baldwin, (Miscellaneous Publication Number 58, Department of Agriculture), describes and illustrates many approved types of traps and contains much information in regard to ornithological research. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

SOME SOCIAL AND ECONOMIC ASPECTS OF HOMEWORK, Special Bulletin No. 158 published by the New York Department of Labor, treats the problem of homework from the viewpoint of the statistician interested in effecting curative measures. *Department of Labor, 124 East 28th Street, New York City.—Gratis.*

BLACK HORSE OF THE SEA, by Robert D. MacMillen, is a handsome booklet describing the salvage service symbolized by a runaway black horse, known for nearly 70 years by sea-faring men. *Merritt-Chapman and Scott Corporation, 17 Battery Place, New York City.—Gratis.*

RARE METALS is a booklet presenting in very readable form the history, properties and uses of the metals tantalum, tungsten, and molybdenum. *Fansteel Products Company, Inc., North Chicago, Illinois.—Gratis.*

Tantalum, described in the booklet "Rare Metals," is obtained from a remote district in Australia. The inset shows the ore, powder, and a tantalum bar

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Process Enables Metal Coating to be Sprayed on Anything

METALLISATION, as its name implies, is a process by which articles are covered with a metal layer. The latest developments of this process make possible such startling achievements as the spraying of molten metal on such delicate surfaces as paper, cloth, and celluloid, forming a coating so adhesive that it seems almost an integral part of the base. Usually the metal which is to be deposited is employed in the form of a wire, although metal dust or powder may be used if another apparatus is employed.

The usual apparatus consists of a pistol, weighing about three pounds, connected to cylinders of oxygen and acetylene, and to a source of compressed air. The compressed air actuates a small turbine which feeds the wire—supplied from a reel—through the nozzle of the pistol, where it meets the oxy-acetylene flame and is melted, the compressed air atomising the molten metal and forcing it at high velocity—some 3000 feet per second—against the object which is being coated.

The rate at which the wire is fed through the nozzle varies according to the nature of the wire, control being provided by a needle valve which adjusts the air flow to the turbine. As the flame is of a reducing nature, the atomised metal is protected from oxidation, hence metallisation can be continued until the desired thickness of coating, from 0.001 inch upwards, is attained. A pleasing matte finish is obtained, which can be buffed if a polish is desired.

The only precaution required, apparently, is to ensure that the surface to be metallised possesses an open texture—metal articles should be sand blasted, using dry sand—and that it is perfectly clean and free from moisture, scale, or oil. Paper, cloth, and wood can be metallised without trouble, but the paper must not be glazed, and wood should be sandpapered or given a light passage in the sand blast. It should be remarked that there is very little heat effect on the surface of the work; therefore delicate materials such as celluloid or a photographic film can be treated without harm. The coating is extremely adherent, and cannot be separated from its support, either by bending or severe hammering.

Simple Device Measures Explosive Gas in Mines

A RATHER clever device for the determination of the amount of the explosive "fire-damp" gas in mines has been perfected in England. The principle of its operation is chemical, being based on the fact that one volume of methane, when burned, produces two volumes of steam. The steam condenses, producing a reduction of pressure, the reduction being proportional to the amount of methane burned. The methane is burned in a copper combustion chamber containing an electrically heated platinum spiral and connected with a U-tube liquid gage graduated to read directly in percentages of fire-damp.

Chemists Pre-Determine Relative Corrosiveness of Soils

THREE billion dollars a year is lost by the corrosion of iron and steel, according to Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research. It is small wonder, therefore, that methods of reducing this staggering waste occupy the attention of chemists in many industries. One very large item on this corrosion bill is that charged against the corrosion of pipe lines, for distributing gas, oil, and water. W. T. Smith, in a recent issue of *Chemical and Metallurgical Engineering* describes how chemists analyze the soil in which the pipe is to be laid and thus determine the best methods of protecting it against corrosion.

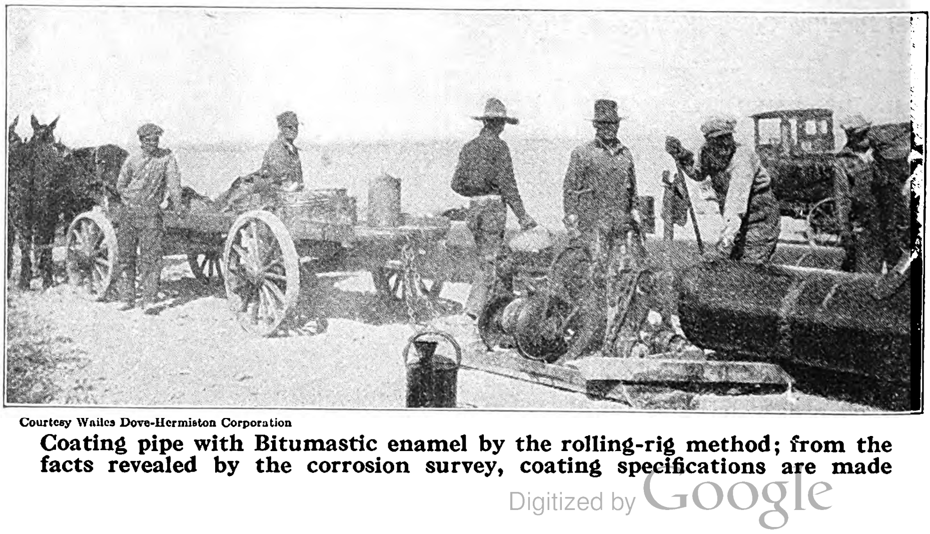
Soil samples are taken, at intervals of not more than one mile, by means of an auger, to the depth at which the pipe will lie when in service. Wherever definite changes in topography or surface conditions are encountered, additional samples are taken, as are liquid samples from any streams or rivers the line may cross. Each representative sample is placed in an air-tight container marked with specific information for identification at a later date.

When the samples arrive at the laboratory they are weighed as received, air-dried, and weighed again to determine the moisture content. A solution is made by thoroughly mixing a portion of each sample with distilled water. Both the solution and the soil are then subjected to a carefully worked-out series of chemical analyses to determine the amount of certain constituents known to be active factors, under certain conditions, in accelerating or inhibiting corrosion. In addition to the chemical analyses, each sample is subjected to determinations for hydrogen-ion concentration and physical, electrolytic, and accelerated corrosion tests.

Courtesy J. W. Richards & Son

***Left and above:* Taking samples of soils along a pipeline for use in charting the relative corrosiveness**

When the complete analytical data has been calculated and charted, an equally important part of the corrosion survey begins. It is one thing to "analyze" a soil and quite another to interpret the knowledge gained in terms of relative corrosiveness. By means of a method worked out



Courtesy Wailes Dove-Hermiston Corporation

Coating pipe with Bitumastic enamel by the rolling-rig method; from the facts revealed by the corrosion survey, coating specifications are made

by Percy J. Richards, of J. W. Richards and Son, and William Thompson Smith of Ford, Bacon and Davis, Inc., all the known and suspected corrosive factors are correlated and balanced against each other. As mentioned above, these factors include surface conditions, analytical data, moisture, and any other local situation that may be of importance. The result is interpreted in terms of relative intensity of corrosive action at all points along the pipeline, with specific recommendations as to the amount of protection necessary on varying sections.

Electrical Eye Detects Smoke

An electrical smoke detector is the latest example of the invasion of the "mechanical man" into the field of the chemist. Scientists of the General Electric Company have developed a machine that is so sensitive to the existence of smoke or haze in air that it immediately reports the situation. We have previously described, in these columns, several of the ingenious devices used to detect poisonous carbon monoxide in the mines and tunnels, such as the Holland Tunnel connecting New York and Jersey City. Now we present the electrical eye which detects excess haze or smoke in this tunnel, thus warning the superintendent that the ventilating fans should be speeded up.

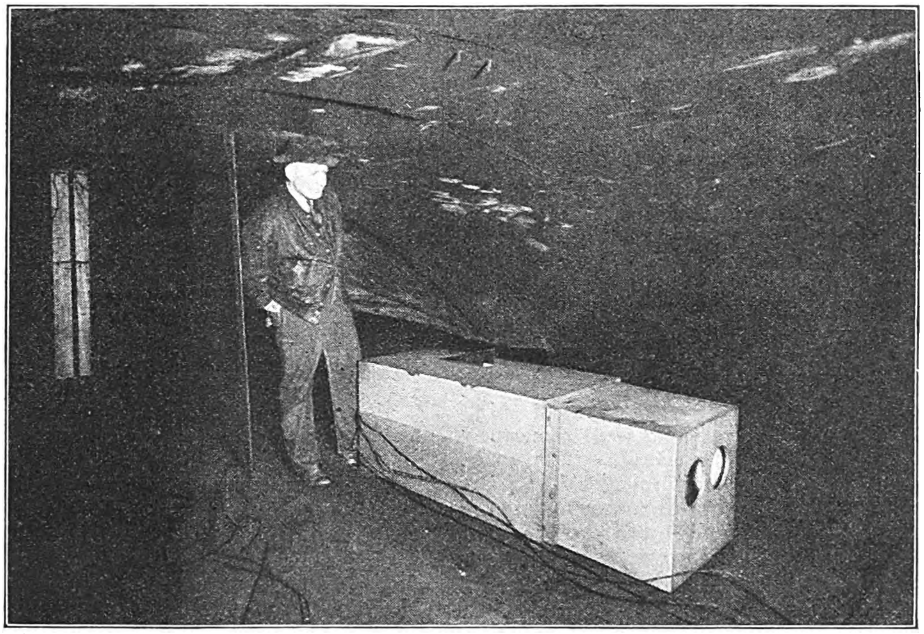
In applying the light-sensitive photo-electric cell to tasks of this kind, Ole Singstad, Chief Engineer and Superintendent of the Holland Tunnel, hopes to work important operating economies and to provide an additional safeguard in controlling the air conditions in the tunnel. As now used experimentally in the tunnel, the "electric eye" is directly connected to a recording device a quarter of a mile from the mouth of the tunnel. Impulses from the photo-electric cell circuit guide a pencil point over a sheet of paper graduated in time and in volume. At any instant the supervisor knows how much haze is in the tunnel, and if the visibility decreases from any cause whatsoever he can relieve the situation by speeding up the fans or by putting additional fans into service.

At the present time the detector is located in an exhaust duct, a long cave-like chamber above the traffic lane, near the New York exit and at the point where the roadway grade is at the maximum and where the amount of exhaust gases expelled from the heavy truck traffic is greatest. The exhaust duct is dark except for fitful beams of light admitted through narrow openings in the roof of the passage way. These openings provide an exit for the air.

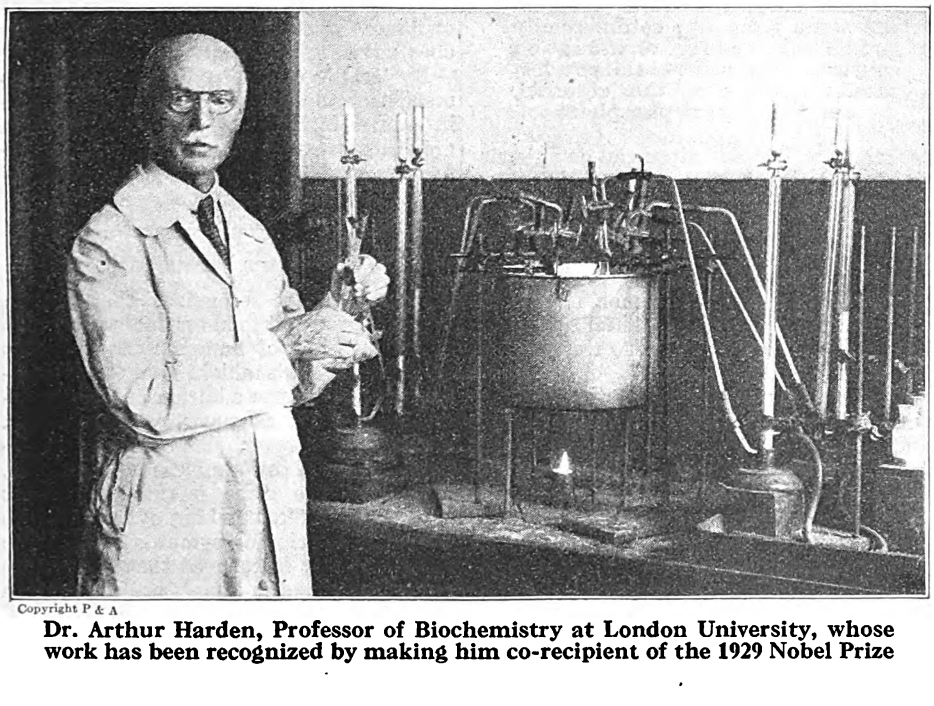
The detector consists of two units, a light source and a photo-electric cell and, 150 feet away, a target. Light provided from a lamp with concentrated filament is directed through a lens to the distant target. This target consists of two mirrors set at right angles. The light beam hits the first, which directs it to the second mirror and thence is reflected back 150 feet to the light-sensitive tube.

As the exhaust air of the duct passes through the light beam, the quantity of the light is diminished. This variation or dimming of the light is not perceptible to the human eye but the photo-electric cell responds to the most minute changes. The greater the amount of light, the greater the current passing through the tube. The photo-electric cell, which is about the size of the familiar "peanut" radio tube, is directly connected to an amplifier where the current is built up, and passed on to the recording device a half mile away.

The projected use of the photo-electric cell as a fume detector may presage the development of a household and business house robot watchman, which will be a smoke detector that will sound an alarm at the first appearance of smoke on the premises. A photo-electric cell and a light source might be installed in cellars, in attics, or in warehouses filled with combustible goods. Such a tube connected to a bell or some other form of alarm could be depended upon to give warning with almost the first appearance of smoke.



The "electrical eye" now being tried out in the Holland Tunnel under the Hudson River; the photo-electric "eye" detects the presence of excess smoke



Copyright P & A

Dr. Arthur Harden, Professor of Biochemistry at London University, whose work has been recognized by making him co-recipient of the 1929 Nobel Prize

Coats Aluminum With Lime as Base for Paint

Aluminum articles, when boiled with milk of lime containing a little calcium sulfate, are given a fine-grained, closely adherent, dead-white coating which may prove to be an excellent foundation for the application of paints or enamels, says Leon McCulloch, in a recent issue of *Chemical and Metallurgical Engineering*. The coating probably cannot be recommended for corrosion resistance but it gives a surface that can be written upon. If alloys of aluminum rather than the pure metal are given the treatment, various shades of gray are obtained.

In applying the coating, ten grams each of lime and calcium sulfate (preferably the fully hydrated sulfate) are used for each liter of water. Although the action of the calcium sulfate is unknown, it is found to give smooth, adherent coatings which would otherwise be pitted.

As there is apparently deterioration of the bath upon aging, fresh materials should be added each day. The bath is stirred gently and is kept at about the boiling point, although a temperature of 85 degrees, centigrade, has given satisfaction. Time for the process may vary slightly, although the coating does not increase ap-

(*Please turn to page* 245)

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

The Cause of Influenza

IN 1892 a bacteriologist named Pfeiffer described a germ which he thought was the causative organism of influenza. At various intervals since that time other organisms have been described, also alleged to be causative, and the bacteriologists continue to debate the question as to the exact nature of the influenza germ.

Modifications of the Pfeiffer organism have been described every year, associated with various coughs, colds, and similar infections of the nose and throat. It is emphasized that the various types of germ described as Pfeiffer organisms do not constitute in any instance a unit; that is to say, they are not uniform in distribution or in the way in which they bring about disease.

During the last great epidemic of 1918, organisms were recovered from thousands of cases all over the world, and there is no evidence that uniformity exists even in the many types of organism associated with that epidemic.

In attempts to discover and definitely to identify the influenza germ, experiments have been made with human beings who voluntarily submitted themselves to inoculation with pure cultures of the various germs that have been isolated. The earliest definite report of successful human inoculation with pure culture of the Pfeiffer organism is that recorded by Dr. D. J. Davis in Chicago in 1906.

However, Doctor Davis pointed out at the time that while the Pfeiffer germ may produce definite symptoms on inoculation into human beings, the symptoms produced are not those of true influenza.

During the 1918 epidemic, volunteers were inoculated with 13 different strains of organisms isolated from cases of influenza. All of them developed symptoms, but again it was shown that these symptoms were not the typical symptoms of epidemic influenza.

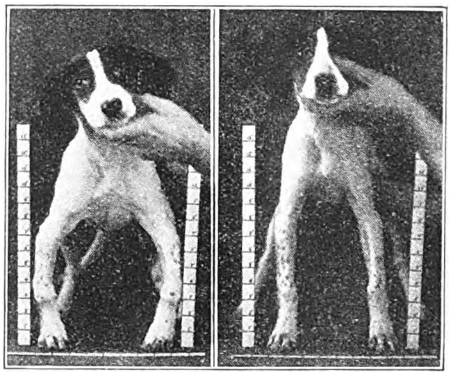
Indeed, after surveying all of the evidence of innumerable inoculations with all sorts of organisms taken from the nose and throats of people during epidemics, Prof. E. O. Jordan comes to the conclusion that it can not be definitely asserted that negative inoculation experiments are not in themselves sufficient to rule out Pfeiffer's organism as the cause, since it is quite possible that there are some unknown factors influencing the likelihood of a person to catch influenza or associated with the way in which the organism is transferred from one person to another. After death from influenza no uniformity of kind or distribution of bacteria can be detected in the body.

During influenza the resistance of the body is lowered and a great variety of germs invade the tissues. As a result, all sorts of bacteria have been found in influenza and the medical profession has become exceedingly suspicious of new discoveries in this field.

Until a germ isolated by any investigator has been thoroughly tested by independent investigators under various conditions in different hospitals and laboratories, it is not safe to accept it as the causative germ of this extremely difficult and elusive malady.

Of the organisms given most serious consideration in recent years, the green-producing streptococcus isolated by Mathers and Tunnicliff in 1918, the one discovered by Rosenow in 1919, and innumerable similar germs isolated in various parts of the world immediately thereafter deserve special consideration. The filter-passing organism described by Meyer in 1919 and the organisms discovered by Olitzky and Gates of the Rockefeller Institute and called by them *bacterium pneumosintes* would seem to deserve as much consideration as is now given to the Falk germ recently announced as the cause of this disease.

Recently investigators in the University of Chicago have carried out a series of experiments on human beings and on animals and have isolated an organism which they feel is the specific cause of influenza. Four monkeys were inoculated with the Pfeiffer bacilli, but did not develop symptoms resembling influenza in man. Such symptoms were developed in 16 monkeys which were inoculated with material obtained from eight human beings who were suffering with influenza. Cultures of bacteria developed from the secretions of patients with influenza were sprayed into the nose and throats of the monkeys and these monkeys developed symptoms resembling influenza. Monkeys which had developed symptoms following inoculation with cultures were put in cages with other monkeys, and the other monkeys apparently caught influenza from the infected monkeys. There were controls made by spraying the nose and throats with salt solutions and non-infectious material, and monkeys sprayed with these materials did not develop any of the symptoms referred to. During the course of the investigation, several of the workers developed symptoms resembling those which are caused by influenza.



Two female dogs from the same litter, one of which, left, received as the primary constituent of its rations 66.9 percent of untreated oats; the other received the same quantity, commercially irradiated. The rest of the ration consisted of skimmed milk powder, casein, alfalfa, sodium chloride, and tricalcium phosphate

Unfortunately it is difficult to interpret these results, due to the fact that it is hard to tell clinical epidemic influenza from other respiratory infections both in monkeys and in man. A great deal more work must be done under controlled conditions by workers in other laboratories before a certain appraisal can be placed on the value of the work already accomplished.

Irradiated Cereals

WORKERS in Wisconsin in the department of agricultural chemistry showed in 1923 that the food taken by a rat could be exposed to ultra-violet and in that way serve to prevent rickets in the rat. Later numerous investigators throughout the world showed that a definite compound, ergosterol, is the substance which is rendered potent against rickets by exposure to ultra-violet rays. The workers in the University of Wisconsin later developed methods for irradiating rolled oats and other cereals, and such foods are now generally available for use in the average home.

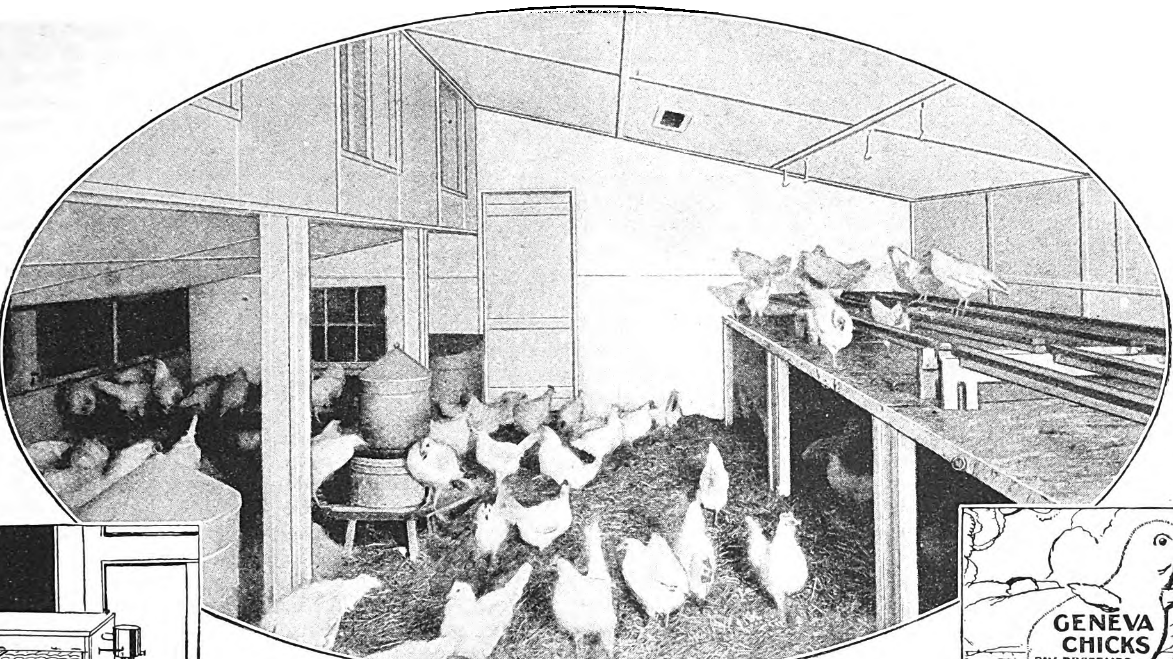
It has been shown by experiments on animals that rickets may be prevented by feeding such products to them. The irradiation does not seem to destroy the other vitamins that are in the food, nor does the irradiation of the food produce harm in those who eat it. Apparently the outside limit for vitamin D is far beyond the amount that the average person could take in an ordinary diet. Storage of the food does not cause destruction of the vitamin that is formed, except after periods of almost two years. Household cooking does not affect the activity.

By feeding commercially irradiated oatmeal, rickets was prevented in dogs and in rats and there was no interference in growth or in reproduction, as was shown in tests made on rats over a period of 15 months in four generations.

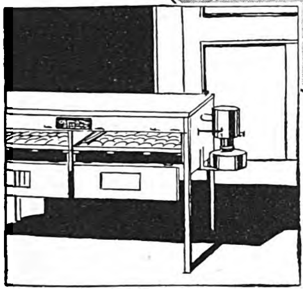
Soy Beans Versus Milk

IT is generally recognized that human milk is the best food for infants and that in the absence of human milk, the best substitute is cow's milk in some form, modified usually by the addition of various ingredients, such as sugar, water, or egg. There are, however, some diseases in infancy in which cow's milk is not desirable, and there are some infants who react severely to milk, breaking out with eruptions and developing symptoms like those of asthma. It is believed that some cases of severe eczema in infants are due to such sensitization.

In case an infant is unable to take cow's milk, it is necessary to have another sub-



For easily cleaned floors in poultry houses



For sturdy incubators

GENEVA
CHICKS
PAY DIVIDENDS
QUALITY
CHICKS

For signs and cut-outs

They *hatch 'em–raise 'em–sell 'em* with PRESDWOOD

In Racine, Wisconsin, a big manufacturer of incubators finds that Masonite Presdwood gives his product great strength, withstands moisture, is naturally attractive in appearance, and requires no paint for protection. On a Missouri farm, an expert poultry raiser uses this same grainless wood on hen house floors and under roosts, because of its smooth sanitary surface which is so easily cleaned.

Withstands the weather

In Kalamazoo, a sign manufacturer makes attractive cut-outs which advertise baby chicks, and finds Presdwood ideal for his purpose. It does not crack, split or splinter; is easily cut to shape. It withstands the weather, takes any finish readily, and does not warp when properly handled.

And so it goes in hundreds of industries and in thousands of home workshops where Presdwood has been adopted because of its many advantages.

Factory experts, operating punch presses, milling machines or band saws, like Presdwood for its workability. It is strong and dense, yet easily cut. It can be worked with knife or chisel or saw, and can be nailed near the edge without splitting. Always the same in strength and density, Presdwood adds quality and dependability to manufactured items. Makes manufacturing more profitable, too, because of the way this grainless wood cuts down costly rejections in final inspection.

Contractors, handling concrete work, use Presdwood to line the forms because of the thousands of dollars it saves. Its lighter weight cuts down drayage costs. Its workability reduces the time of making, erecting and wrecking the forms. Its perfect smooth surface eliminates all grain and knot marks, and produces a superior surface that requires no hand smoothing except at construction joints.

Masonite Structural Insulation

Presdwood's companion product, Masonite Structural Insulation, was used in the walls and roof of the hen house above illustrated.

It was used to save fuel, to reduce the feed needed in the generation of body heat, to keep the hens warm and healthy in order that egg production might be kept at a maximum during the winter.

The Presdwood booklet is Free

No wonder builders, home owners and manufacturers everywhere are turning to Presdwood. The complete story of this grainless wood, with illustrations of its uses, is in the Presdwood booklet which is sent Free on request. Your copy will be mailed promptly on receipt of the coupon.

MASONITE CORPORATION
111 West Washington Street Chicago, Illinois

MASONITE CORPORATION, Dept. E-3, 111 W. Washington St., Chicago, Ill.
Please send me, Free, a sample of Masonite Presdwood and the Presdwood booklet.
Name..........
Address..........
City.......... *State*..........
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Masonite PRESDWOOD
Made by the makers of
MASONITE STRUCTURAL INSULATION

stitute for human milk. In an attempt to find such a mixture, Drs. L. W. Hill and H. C. Stuart of Boston have experimented with a preparation of the soy bean. This has been used in one form or another in China as a supplementary infant food for many years. Using a soy bean flour as the basis of a preparation, Doctor Hill found that infants sensitive to cow's milk can be kept in a good state of nutrition by a preparation containing soy bean, calcium carbonate, and salt. The soy bean flour already contains some magnesium, potassium, and phosphorous. In order to raise the amount of fat, olive oil was added to the mixture.

Device for Determining Hemoglobin

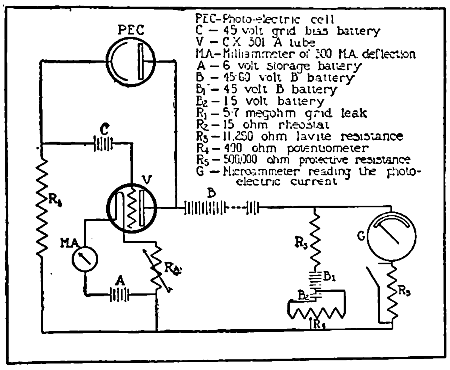
THE hemoglobin or red coloring matter of the blood is one of the most important substances in the human body, since it is responsible for carrying oxygen throughout the system to the various tissues. There are innumerable rough methods for determining the amount of hemoglobin that is present in the blood at various times. Few people are able to show what is called "100 percent", although florid types and people with certain diseases may show extremely high figures. The vast majority of people in good health show figures around 85 to 95 percent. In certain forms of anemia and jaundice, the hemoglobin may drop to low figures, and newspapers are likely to say that "the blood has turned to water".

Workers in the Mayo Clinic have developed an exceedingly ingenuous apparatus for measuring the amount of hemoglobin by a photo-electric method, involving the use of a photo-electric cell illuminated by a scource of light which is kept constant, providing readings on a galvanometer. When a solution of a substance which contains a characteristic absorption band is placed between the source of illumination and the photo-electric cell, together with a selective spectral filter which transmits radiant energy in the region of the characteristic band, the amount of light which reaches the photo-electric cell will depend on the concentration of the substance in solution possessing the specified absorption band. By calculating according to certain definite physical laws, it is possible in this way to measure accurately the amount of hemoglobin in any specimen of blood.

Another advantage of this method is its applicability to the determination of the amount of various unknown substances in true or colloidal solutions, provided the unknown substance in solution possesses at least one characteristic absorption band for which a spectral filter, transmitting radiant energy only in the specified region, can be made and used in the device.

The Heart of Pharaoh

THE Book of Exodus said, "And the Lord hardened the heart of Pharaoh," and that he did not listen to those who tried to counsel him to pity. Investigators in Egypt removed the wrappings of the mummy of this Pharaoh on July 8, 1907. The identity of the monarch was proved by the writings on the shroud. When the body was examined, it was found that there were patches of actual hardening in the heart and in the large blood vessels leading from the heart. A portion of the tissue was sent to the pathologic museum of the Royal College of Surgeons in England and Mr. S. G. Shattock compared the tissues with those of a man recently dead from hardening of the arteries. They were quite similar. It is possible to infer from the nature of the degenerative changes, that as Pharaoh became older his outlook was narrowed, his spirits depressed, his enthusiasm lessened, and that he would be likely to hesitate to embark on any new venture.


PEC-Photo-electric cell
C – 45 volt grid bias battery
V – CX 301 A tube
MA-Milliammeter of 300 MA deflection
A – 6 volt storage battery
B – 45-60 volt B battery
B1 – 45 volt B battery
B2 – 15 volt battery
R1 – 5-7 megohm grid leak
R2 – 15 ohm rheostat
R3 – 11,250 ohm lavite resistance
R4 – 400 ohm potentiometer
R5 – 500,000 ohm protective resistance
G – Microammeter reading the photo-electric current
PEC
C
V
B
R1
MA
R2
A
R3
B1
B2
R4
G
R5

Diagrammatic sketch showing the electrical hookup of the photo-electrometer. In the upper right-hand corner is a list of the component parts, together with the key letters used in the diagram. An ordinary radio vacuum tube is used as the amplifier

The Extent of Illness

ONE of the first reports of the Committee on the Cost of Medical Care, which is making a five-year survey of disease in the United States and the manner in which it is controlled by the medical profession, indicates that the vast majority of time lost from work is due to the common cold and other respiratory diseases. Digestive diseases and similar disorders follow, and women suffer greatly with disturbances associated with their particular physiology. Acute and chronic diseases of the kidney and diseases associated with childbirth are also exceedingly frequent. The United States still has 36,000 cases of smallpox every year, an utterly inexcusable condition, in view of the fact that this disease could be stamped out completely if an enlightened public opinion should force general vaccination and isolation and quarantine of all cases.

There are approximately 900,000 feeble-minded imbeciles and idiots, 100,000 blind, 1,000,000 with speech defects, and 3,000,000 children either wholly or partially deaf.

The United States has more physicians proportionate to the population than any other nation of the world. Our hospitals have increased more rapidly in number and equipment than those of any other nation. Approximately 1,000,000 people are ill every day and about 700,000 are in hospitals.

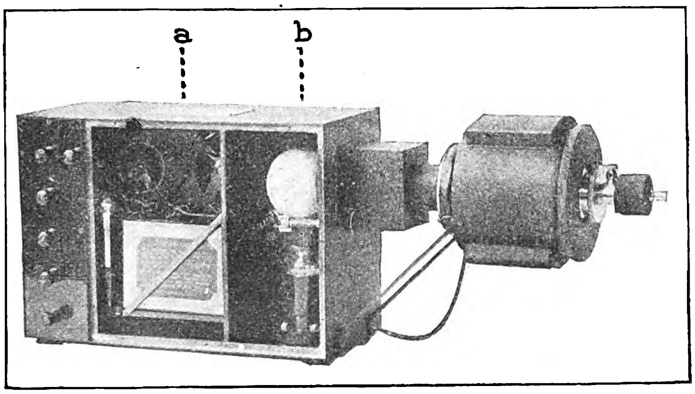
The problem of disease is one of the most serious of all of the considerations that affect mankind, and it is not surprising that its investigation should be attracting the greatest brains and the largest outlay of funds that are provided by the great foundations developed for the social welfare of man.

Anaphylaxis

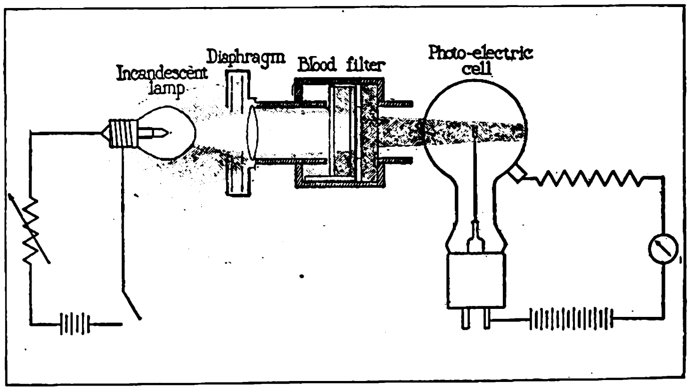
THERE is something in the human and animal body that causes it to become sensitized to various protein substances and to react to these substances by a series of symptoms which may be sufficiently severe to produce sudden death. This reactability is known as anaphylaxis and the exact mechanism is not yet wholly understood. Recently Dr. R. W. Lamson has again surveyed the subject in an endeavor to find out just what produces the symptoms.

When a guinea-pig is injected with a serum and is re-injected with the same serum about three weeks later, it manifests anaphylaxis by a sudden shortness of breath, primarily due to its inability to empty the lungs. Human beings become sensitized to various protein substances by heredity, through overdoses, through injection, or in various other ways. There are people who are sensitive to light, to heat, and to cold.

All of this indicates how scientific medicine is beginning to understand the nature of the human body, but also what a vast amount still remains to be learned concerning the specific mechanical and physical reactions of the tissues.

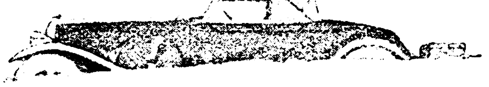


The photo-electrometer with side removed to show at *a* the vacuum tube used for the amplifier, and at *b* the photo-electric cell in position. See above text, at left



A schematic diagram of the essential physical features of the photo-electrometer as applied at the Mayo Clinic to the measurement of hemoglobin of the blood

CARS THAT STAY YOUNG



Look for car beauty, of course, but also make sure of the extra thousands of trouble-free miles that come with a "Timken Bearing Equipped" car.

Consult the list—note where the Timken Bearings are—give thought to the hard service points that need this extra protection and safety—that is the way to measure car worth in terms of continued youth.

For unequalled staying qualities are definitely assured by the combination of tapered construction, *POSITIVELY ALIGNED ROLLS* and Timken-made steel—*found only in Timken Bearings.*

THE TIMKEN ROLLER BEARING CO.
CANTON OHIO

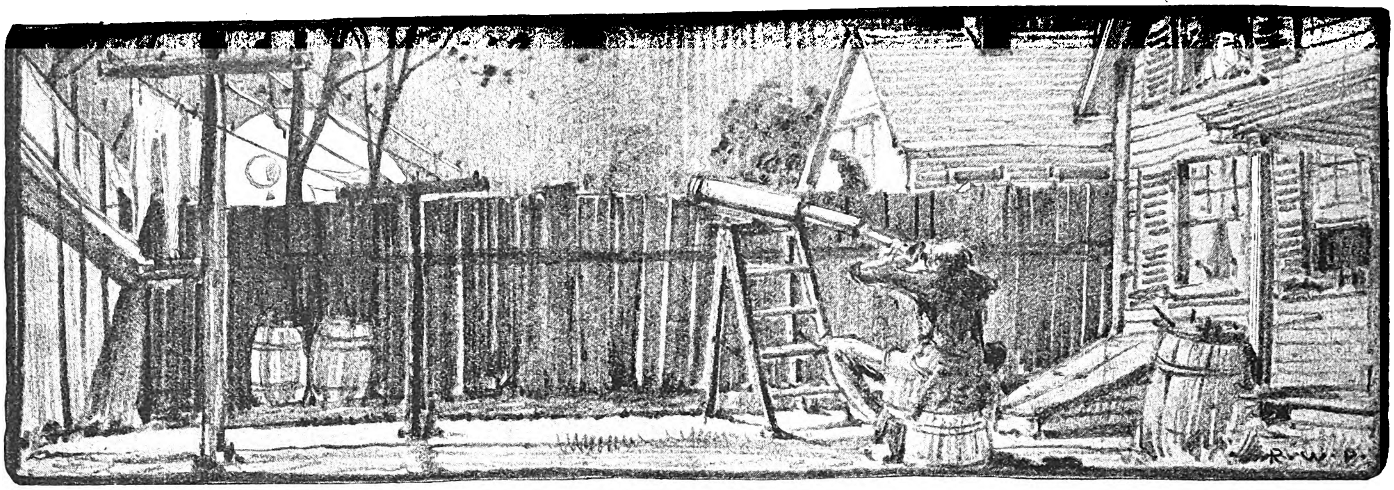
TIMKEN BEARING EQUIPPED

CROSSES INDICATE
"TIMKEN BEARING EQUIPPED" POINTS

MAKE	MODEL	Front Wheels	Rear Wheels	Pinion	Steering	Differential
Auburn	All	.x.	.x.	.x.	...	.x.
Cadillac	All	...	...	...	...	.x.
Chrysler	De Soto	.x.	.x.	.x.	...	.x.
	Plymouth	.x.	.x.	.x.	...	.x.
	66, 70, 77	.x.	.x.	.x.	...	.x.
	Imperial	.x.	...	...	...	.x.
Cord	All	.x.	.x.	...	.x.	.x.
Cunningham	All	.x.	.x.	.x.	...	.x.
Dodge	All	.x.	.x.	...	...	.x.
Durant	40, 60, 63, 66	.x.	.x.	.x.	...	...
	70	.x.	.x.	.x.	...	.x.
Elcar	75	.x.	.x.	.x.	...	.x.
	95, 96, 120	.x.	.x.	...	...	.x.
Ford	All	.x.	...	.x.	.x.	.x.
Franklin	All	.x.	.x.	.x.	.x.	.x.
Gardner	All	.x.	.x.	.x.	...	.x.
Graham-Paige	612	.x.	.x.	.x.	.x.	.x.
	615	.x.	.x.	...	...	.x.
	621, 827, 837	.x.	.x.	...	.x.	.x.
Henney	All	.x.	.x.	.x.	...	.x.
Hudson and Essex	All	.x.	.x.	.x.	...	.x.
Hupmobile	Model S	.x.	.x.	.x.	.x.	.x.
	Model C	.x.	.x.	.x.	.x.	.x.
Jordan	All	.x.	.x.	.x.	...	.x.
Kissel	75 & 95	.x.	.x.	.x.	...	.x.
	126	.x.	.x.	.x.	.x.	.x.
Kleiber		.x.	.x.	.x.	...	.x.
LaSalle	All	...	...	...	...	.x.
Lincoln	All	.x.	.x.	.x.	.x.	.x.
Locomobile	86 & 88	.x.	.x.	...	...	.x.
Marmon	68	.x.	...	...	...	.x.
	78	...	.x.	...	...	.x.
	Roosevelt	.x.	.x.	.x.	...	.x.
McFarlan	All	.x.	.x.	.x.	...	.x.
Moon	All	.x.	.x.	.x.	...	.x.
Nash	Std 6	.x.	.x.	.x.	.x.	.x.
———	All	.x.	.x.	...	.x.	.x.
Peerless	All	.x.	.x.	...	...	.x.
Pierce-Arrow	All	.x.	.x.	.x.	.x.	.x.
Reo Flying Cloud	The Master	.x.	.x.	...	.x.	.x.
	Flying Cloud	.x.	.x.	...	...	.x.
Roamer		.x.	.x.	.x.	...	.x.
Stearns-Knight	6-80	.x.	.x.	.x.	.x.	.x.
	8-90	.x.	.x.	.x.	.x.	.x.
Studebaker and Erskine	All	.x.	.x.	.x.	.x.	.x.
Stutz	All	.x.	.x.	.x.	...	.x.
Willys-Knight and Whippet	All	.x.	.x.	.x.	.x.	.x.

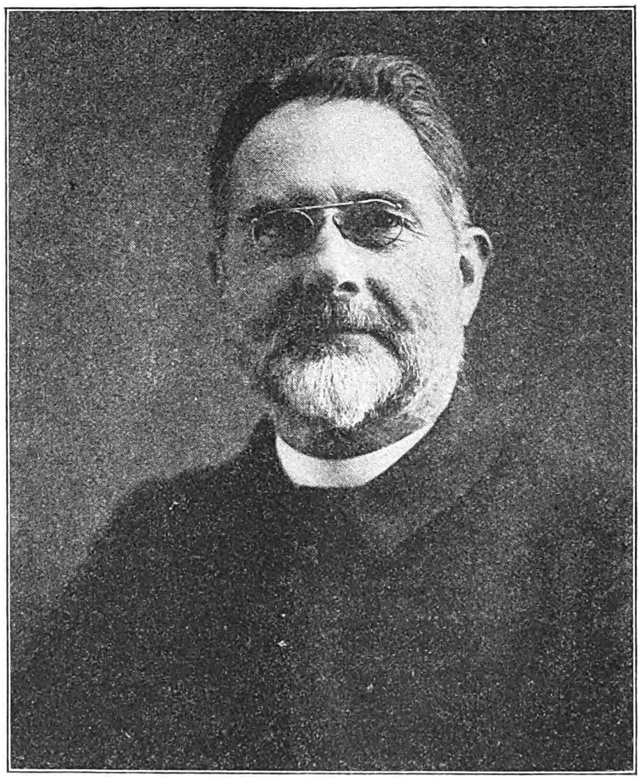
TIMKEN *Tapered Roller*
BEARINGS

© 1930, The Timken Roller Bearing Company



The Amateur Astronomer

MEMBERS of the amateur telescope making fraternity—the "C. P. R" (carborundum, pitch, and rouge) as Ellison our original preceptor once dubbed us—will take keen interest in the photograph reproduced at the right. This is a perfect likeness of Ellison. It is suggested that amateurs paste this picture in their copy of "Amateur Telescope Making." Had it been at hand when the new edition of that instruction book was in preparation it would surely have been included within the volume, which was originally built around Ellison's book, "The Amateur's Telescope" as a nucleus.



The Reverend Mr. William F. A. Ellison, telescope maker, Director of Armagh Observatory, Armagh, Northern Ireland

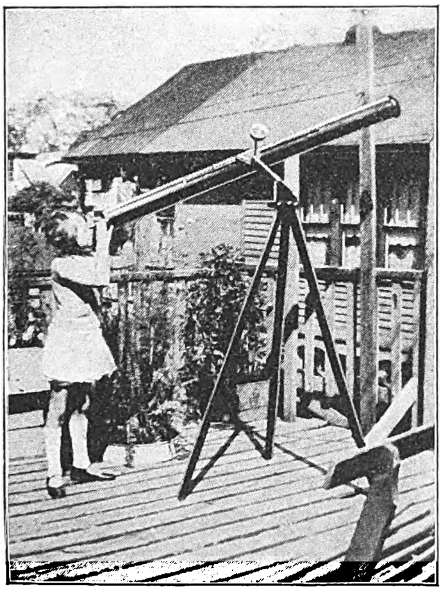
NOTHING but refractors are shown this month. So far as is known, these are all of the refractors that have been made since Ellison's unequalled instructions were included in "A. T.M." It is possible to make a refractor (of a sort) without due attention to the calculation of curves and care with other details; in fact many have been made from second-hand lenses previously used for other purposes. Henry Kawecki of Chicago (no street address submitted), a high school student, has made the one shown at left, using as the objective what he describes as "a lens which was once a mirror of plano-convex type from which the silver and paint were removed." The tube is three lengths of four-inch stove pipe and the eyepiece was taken from a microscope. Despite what some might regard as a doubtful type of objective, the maker states that he sees clearly Saturn's rings and Jupiter's moons, using 125 diameters magnification. "The chromatic aberration," he writes, "is not as bad as may be expected." He is now making a reflector.

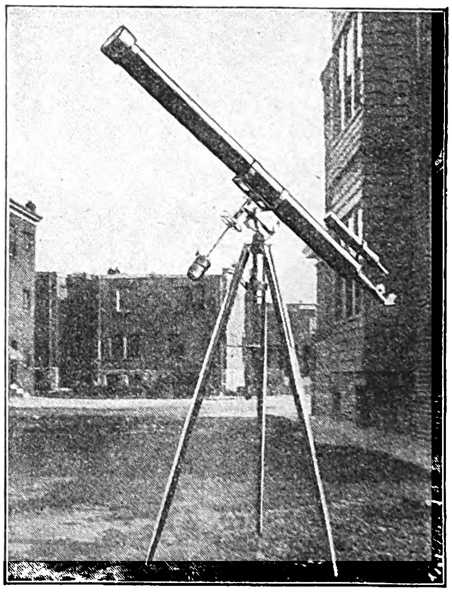
Fred Caley, 5122 Hawthorne Street, Frankford, Pennsylvania, writes: "I enclose a photo of a refractor I recently constructed, thinking it might be of interest to the ever-increasing army of telescope makers. I used the second formula given in 'A.T.M.' viz., three equal curves and a plane surface. Ellison states, 'The only snag is the plane surface.' I *heartily corroborate* his statement. The objective is 5¼ inches clear aperture and has a 76-inch focal length.

"The telescope is equipped with a worm gear, universal joint, and extension rod that can be worked without taking the eye from the ocular. Setting circles and a diagonal eyepiece are also fitted. Total cost, not more than 70 dollars.

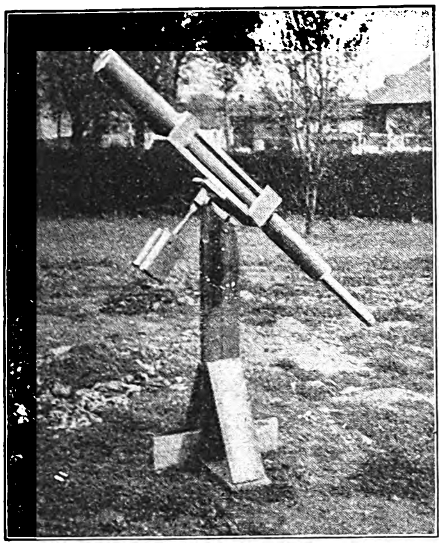
"I previously ground and figured an eight-inch reflector which gave very satisfactory results. I also made a 5½-inch flat and a couple of prisms, in order to gain experience. The refractor turned out much better than I expected."

Mr. Caley has obviously gone at this job right: after suitable preparatory experience of a prac-





Left: Mr. Kawecki's synthetic refractor, and (*right*) the 5¼-inch refractor made by Mr. Caley, from Ellison's instructions



Franklin W. Smith's refractor

tical nature—making mirrors, prisms and flats, all of which enlarges one's resourcefulness in optical work—he has tackled the more difficult objective lens job and succeeded.

A SIMILAR approach to the objective lens has been made by Franklin W. Smith, 407 Scott Avenue, Glen Olden, Pennsylvania, whose telescope is shown in the illustration reproduced above.

"After finishing my first reflecting telescope, which was described in your January, 1927, issue, I have made several small reflectors, and have recently completed a refractor," Mr. Smith writes. "The achromatic objective has an aperture of three inches and a focal length of 60 inches. Great care was taken while polishing the convex surfaces of the crown glass to prevent wearing down the centers excessively; in this way, positive spherical aberration was avoided, and it was therefore possible to finish the figuring, which was controlled by Ellison's ingenious 'auto-collimation test,' quickly and without difficulty.

"The color correction and defining power of the telescope seem satisfactory; double stars such as *alpha Geminorum, gamma Virginis,* and *gamma Leonis* are readily separated, even under the rather poor conditions of seeing which prevail here at certain times of the year.

"Although it takes vastly more time and labor to make a refractor than to make a reflector of the same aperture, the actual work is really no more difficult, assuming, of course, that the worker has had sufficient

George E. Stephenson and refractor

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experience to enable him readily to produce a zone-free optical surface. I found that it required over four times as much work to make the three-inch refractor as to make a five-inch reflector. Not only are there four surfaces to work instead of one, but at least three of the four curves are much deeper than the single curve of the reflector. While rough grinding I soon came to the conclusion that the use of metal tools previously turned on the lathe to the proper radii would be a much more economical means of producing the deep curves necessary, since a glass tool grinds the edges as well as the center of a concave surface and the center as well as the edge of a convex, and much labor is needlessly expended.

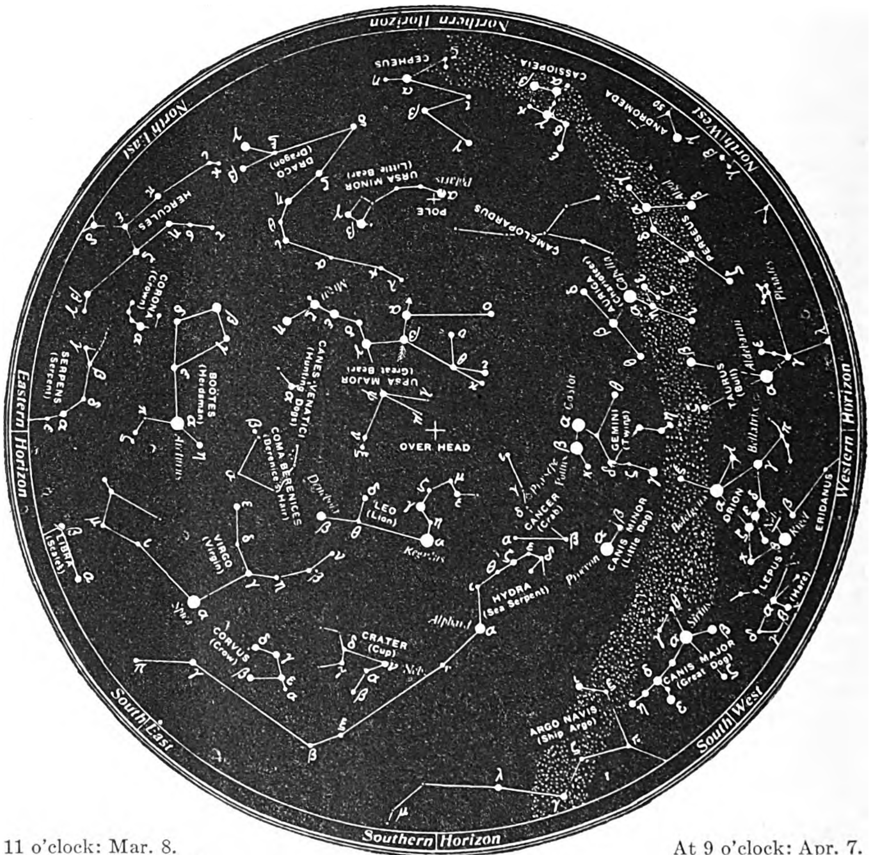
"The auto-collimation test is as simple to apply as the ordinary mirror test, assuming of course that a flat the size of the lens is available. I prepared the flat by the method given on page 37 of 'Amateur Telescope Making.'

"Since completing the three-inch refractor, I have been using it for observing variable stars. Under ordinary conditions of seeing it will show stars slightly fainter than magnitude 11. In this locality, the theoretical limit of a telescope can be reached on exceptionally good nights only. At least that has been my experience with the 10-inch Clark refractor of the Haverford College Observatory."

The fourth refractor shown is apparently one of the synthetic type. The photograph reached us without accompanying letter and bore on its back only the name of the sender, Mr. George E. Stephenson, Roosevelt Avenue, Roosevelt, Long Island.—*A.G.I., Tel. Ed.*

The Heavens in March

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Mar. 8.
At 10½ o'clock: Mar. 16.
At 10 o'clock: Mar. 23.
At 9½ o'clock: March 29.
At 9 o'clock: Apr. 7.
At 8½ o'clock: Apr. 14.
At 8 o'clock: Apr. 22.

NIGHT SKY: MARCH AND APRIL

MERCURY is a morning star, rising a little before 6 A.M. during the early part of the month, but lost to the sunlight long before its close. Venus is an evening star and is coming out gradually from the twilight. By the end of the month she sets at 7.10 P.M. and is fairly conspicuous. Mars is a morning star rising between 5 and 5:30 A.M. and is still far off and faint. On the first he is in conjunction with Mercury, the two planets being only half a degree apart. Jupiter is an evening star in Taurus, but is so far north that he remains in sight until after midnight. Saturn is a morning star, rising at 2:40 A.M. on the 15th, and can be observed before daybreak, though only at a low altitude. Uranus is an evening star too low in the west to be easily observed, but Neptune is just past opposition and is visible telescopically almost all night. On March 15th its R. A. will be 10h 16m, and its Decl. 11° 31′ N.

The moon is in her first quarter at 11 P.M. on the 7th; full at 2 P.M. on the 14th; in her last quarter at 10 P.M. on the 21st; and new at 1 A.M. on the 30th. She is nearest the earth on the 12th and remotest on the 24th. As she completes her orbit she passes through conjunction with Uranus on the 2nd, Jupiter on the 7th, Neptune on the 13th, Saturn on the 22nd, Mars on the 27th, Mercury on the 29th, Uranus again on the 30th, and Venus on the 31st.

Chemistry in Industry

(*Continued from page* 237)

preciably beyond a certain thickness, as is shown by the test of a piece of aluminum foil 0.001 inches thick:

Time, Minutes	Thickness, Inches
15	0.0017
30	0.0018
60	0.0020
240	0.0024

Upon analysis, the coating on a ¼-mil foil was found to consist of Al_2O_3, 54.5 percent; CaO, 5.75 percent; SO_3, 10.7 percent; and water expelled at 300 degrees, centigrade, 29 percent. The coating is always hydrated as formed, but the water may be removed by baking at 300 degrees, centigrade.

Edible Oil from Nut Shells

PECAN oil, described by chemists of the United States Department of Agriculture as of very mild, agreeable, and characteristic flavor, is one of the latest additions to the long list of products manufactured from what were formerly farm wastes.

Fine nut fragments accumulate at the pecan-shelling plants. Chemists have made experimental pressings of this waste and determined the properties and composition of the oil, which is of excellent quality and can be used for making salad dressings or other edible products. It is necessary to express the oil before the nut waste becomes rancid, as otherwise the oil would not be edible.

Fuel Gas From Farm Waste

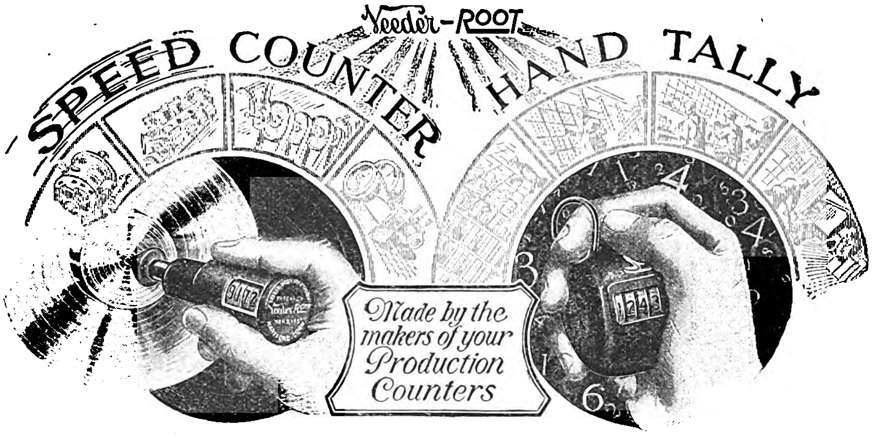
CORNSTALK gas to light and heat cities was announced recently by the American Chemical Society. Ordinary sewage and plain cornstalks are allowed to decompose, forming the gas. From these two wastes, University of Illinois chemists are recovering large quantities of methane gas, usable for heating, operating autos in place of gasoline, and driving generators producing electricity. They also are recovering carbon dioxide which they propose to utilize by converting it into "dry ice."

The chemists believe they have an apparatus so simple that it can be installed by the farmer to make his family sewage turn his cornstalks into cheap cooking gas. It requires no machinery; bacteria from sewage do the necessary work.

The author of the discovery is Dr. A. M. Buswell, Professor of Sanitary Chemistry at Illinois, assisted by C. S. Boruff. Dr. Buswell said "The material used is dried cornstalks after husking. The stalks are shredded with an ordinary shredding machine, boiled, soaked in water or soaked in lime.

"The apparatus is simply a small tank provided with a cover to collect gases. A farmer could produce enough gas to supply the needs of a family of four or five from the material which could be fermented from a gas tank eight feet in diameter and eight feet deep."

The authors estimated that a circle of corn land eight miles in diameter would produce enough cornstalks to meet the usual gas consumption of a city of 80,000.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2358

Our Point of View

Our Limitation Conference Delegates

(*Continued from page* 189)

1928, and is the natural successor to Lowden as the representative of the mid-west agrarian movement. Mr. Dawes has a certain impatience for detail, and a small tendency to picturesque but inexact phraseology that somewhat impairs his large abilities. As ambassador to The Court of St. James, he plunged boldly into European diplomacy with which he had had no previous experience, depending entirely upon his good intentions and his native ability; even his short experience at London must have taught him that international relations cannot be hastily adjusted nor treaties between great states compressed into friendly epigrams.

Mr. Hugh Gibson, American Minister to Belgium, one of the youngest members of the delegation, a Californian by birth, graduated from the Ecole Libre des Sciences Politiques, Paris, and began his career in the diplomatic service in 1908. He served as Secretary of Legation at Brussels from 1914 until our entrance into the World War. During the trying days of German occupation of Belgium he was Brand Whitlock's trusted assistant and greatly assisted Mr. Hoover in his work of Belgian relief. In company with the Spanish Ambassador, he made the final useless appeal to the German Governor General to reprieve Edith Cavell.

He showed conspicuous ability as Chairman of the American Delegation to the Conference for Limitation of Naval Armament in 1927, in resisting British claims to a superiority in cruiser strength over our own navy. If the British public harbors any resentment to Mr. Gibson on this account it should recall that he as fearlessly faced the Germans in behalf of Nurse Cavell. Mr. Gibson brings to his task a fine mind ripened by long experience in world affairs. He knows too much of the horrors of war to be a militarist and knows too much of the ways of the world to weaken the defenses of his own country.

MR. Dwight Whitney Morrow comes from West Virginia, was educated at Amherst with ex-President Coolidge, studied law at Columbia and began the practice of law in New York City in 1899. He joined the firm of J. P. Morgan and Company in 1914 where he remained until he resigned to become Ambassador to Mexico in 1927; he found time from his business affairs to serve on numerous charitable and welfare boards.

Mr. Morrow has a talent for reconciling apparently irreconcilable ideas, and has shown great aptitude in finding a basis of agreement for people with divergent but not necessarily conflicting interests. He served during the war as Adviser to the Allied Maritime Transport Council.

He first attracted the nation's attention by his judicial conduct as Chairman of the President's Aircraft Board in 1925 when, under his guidance, the board thoroughly explored the aviation situation in our country and laid out the comprehensive program of aviation development that is rapidly placing our country in the forefront of world aviation.

In 1927 President Coolidge sent Mr.

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Morrow to Mexico as Ambassador to that insurrection-torn country where he made an almost instantaneous appeal to her proud people and gained their respect and almost their affection. He is no miracle worker and would be the first to disclaim some of the complimentary statements made about his efforts in Mexico, but it can be said in all moderation that he has dispelled much of the prejudice against our country previously current in Mexico. The causes of unrest in Mexico are too deep-seated to be removed in two years and Mr. Morrow's reputation as Ambassador will be longer lived if his remarkable work is not exaggerated by over-zealous friends.

Mr. Morrow's long business experience, his broad outlook, and his veritable genius for conciliation fit him for his new task. His previous services have brought him the respect of his countrymen and it is fair prophecy that at London he will again serve them well.

MR. Charles Francis Adams, the great-great-grandson of John Adams, departed from Harvard in 1888 with his A. B. degree, but soon returned as Treasurer of the corporation, and the present flourishing state of Harvard's finances attest his business ability. He is better known to his countrymen perhaps as the amateur skipper who sailed the *Resolute* to victory in the international races of 1920. Since his appointment as Secretary of the Navy he has diligently applied his fine understanding to the problems of the Navy Department. His love for the sea formed an immediate bond between him and the navy personnel.

John Adams established the Navy Department in 1798; his son, John Quincy Adams, formulated the Monroe Doctrine which is only as strong as the United States Navy; Charles Francis Adams, the son of John Quincy, during our Civil War vigorously reminded the British Government of its obligations as a neutral state; and now Charles Francis Adams 2nd returns to London to present his country's reasons for a navy second to none. Certainly the spirits of his sea-minded ancestors will hover sympathetically over the latest member of the family to enter the lists as champion of his country's rights on the ocean.

Senator David Aiken Reed is a product of Princeton and the University of Pittsburgh. He commenced his career by practicing law in Pittsburgh in 1903. The World War interrupted his legal work and he went to France as a Major in the 311th Field Artillery. His service overseas earned him our own Distinguished Service Medal and caused the French Government to make him a Chevalier of the Legion of Honor.

Senator Reed for two years has been Pennsylvania's sole representative in the Upper House, and although a comparative new-comer, he has ably carried the added responsibility. He has an aggressive personality and when he raises his long form from his seat in the Senate the listener is sure to hear some unqualified statement. His Princeton training makes him abhor a solecism and amid the bustle of affairs he is not too busy to call the Senate's attention to the faulty construction of a sentence. He is a leading member of the Military Affairs Committee and has shown unusual interest in questions of national defense. His influence among his col-

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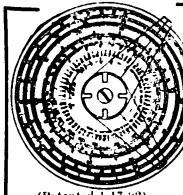

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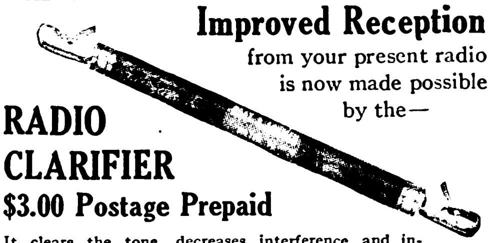

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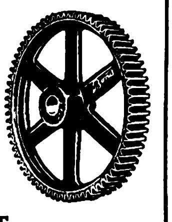

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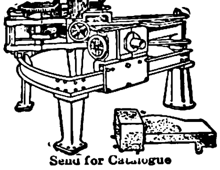

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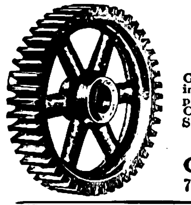

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leagues, both Republican and Democrat, will be of great assistance to President Hoover in getting the Senate's approval to a limitation pact.

Senator Joseph T. Robinson, Democratic leader in the Senate and Democratic candidate for Vice President in 1928, represented the 6th District of Arkansas in the House from 1903 to 1913; was elected Governor of Arkansas in January, 1913; and during the same month was sent by his state to the Senate where he still continues to serve.

Senator Robinson became generally known to his countrymen as a virile campaigner when he swung 'round the circle during the 1928 campaign. His selection as a delegate reminds the world that domestic politics in the United States ceases at the water's edge and assures the Democratic party that the Administration is not seeking to monopolize any prestige it may acquire in its conduct of foreign affairs.

If Senator Robinson approves of a naval pact he will be of much assistance to Mr. Hoover in getting it approved by the Senate; if he does not, as minority leader he can almost certainly prevent its acceptance by the Senate, so he wields a greater power than any other delegate.

REAR Admiral Hilary P. Jones, Retired, entered the navy as a Midshipman from Virginia in 1880. He has served in all the grades from Midshipman to Admiral, having commanded the United States Fleet with temporary rank of Admiral, 1921–1922. During the World War he commanded a division of the Cruiser and Transport Service. Despite his services on the active list as Vice Admiral and Admiral, in accordance with the provisions of an ungenerous naval law he retired as a Rear Admiral in 1927.

Rear Admiral Jones has been again recalled to active duty as a naval adviser largely because of his familiarity with the entire question of limitation of naval armament—he attended the 1927 Conference for Limitation of Naval Armament at Geneva, as a delegate. He brings to this problem a knowledge of naval matters and world affairs, and although he may be relied upon stoutly to defend American interests, he is no saber-rattling chauvinist and knows enough of war to prefer peace.

Admiral William V. Pratt, Commander-in-Chief of the United States Fleet, knows from the very latest fleet maneuvers the needs of our navy for cruisers. Like Admiral Jones, he has served in all the naval grades. During the World War he served as Assistant Chief of Naval Operations, and during Admiral Benson's inspection trip to Europe, Admiral Pratt acted as Chief of Naval Operations although only a Captain in rank. He had previously graduated from the War College and therefore brought to his position a theoretical knowledge of modern war that stood him in good stead. He acted in an advisory capacity to the American delegates in the Disarmament Conference of 1921 that scrapped American battleships.

Since the war he has been President of the Naval War College, Commander-in-Chief of the Battle Fleet, and is now Commander-in-Chief of the United States Fleet.

Rear Admiral William Adger Moffett, Chief of the Bureau of Aeronautics, has had many thrilling moments in the air but he probably got his greatest thrill on April 22, 1914, when he steamed into the inner

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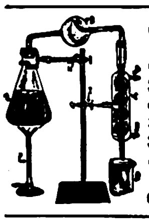

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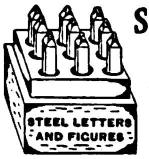

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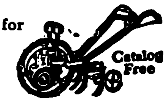

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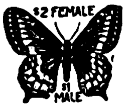

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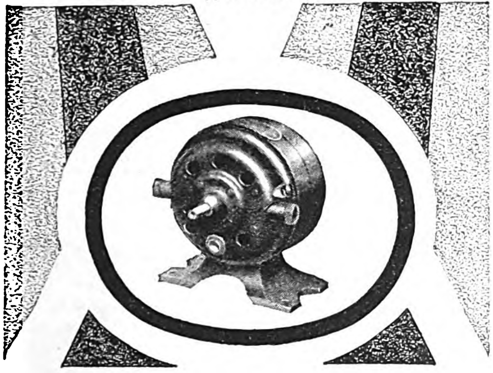

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harbor of Vera Cruz with the light cruiser *Chester* and by her destructive fire on the buildings sheltering Mexican snipers, opened the way for the American landing force. His prompt action and conspicuous initiative on that occasion saved the lives of many American sailors.

In an unusual sense, Admiral Moffett is Chief of Aeronautics, for the office was almost created for him and he has been the sole incumbent since its establishment in 1921. Caught on shore during the World War, he threw his enormous energy into the task of expanding the Great Lakes Training Station into the largest naval training station in the world. He accompanied Commander Lansdowne on the transcontinental flight of the *Shenandoah*, and is an enthusiastic believer in both heavier and lighter than air craft. His presence among the advisers should insure that the interests of naval aviation will not be forgotten in any limitation agreement.

Rear Admiral Joel P. R. Pringle is at present President of the Naval War College at Newport. During the World War he was Chief of Staff for the American destroyers based on Queenstown and as the senior American naval officer present at Queenstown, was in virtual command of the American forces serving at that important station.

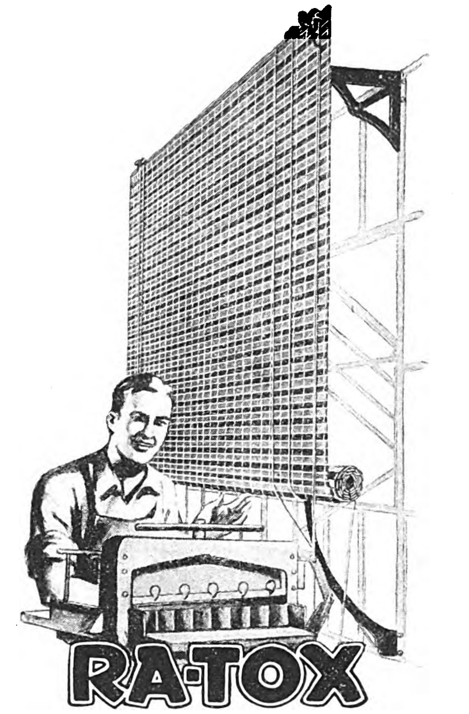
Admiral Pringle maintained most cordial relations with Admiral Sir Lewis Bayly, British Commander-in-Chief in Ireland, and in consequence there was a unity of action between British and American naval forces rarely found among allied forces. Since the war, Admiral Pringle has served at sea in command of the battleship *Idaho* and as Chief of Staff of the Battle Fleet.

Rear Admiral Harry E. Yarnell is Chief of the Bureau of Engineering and as such is intimately acquainted with the most recent developments in marine engineering. His knowledge will be most useful to the board in considering the relative values of cruisers.

During the World War he commanded the *Nashville*, but was soon summoned to London by Admiral Sims to serve on the War Plans Committee.

After the war he went into naval aviation and is still a qualified aviation observer. He commanded the Aircraft Squadrons, Scouting Fleet, in 1924-25, and in 1928 commissioned, and later commanded, our latest aircraft carrier, the *Saratoga*. He is a War College graduate and has also served on its staff, and as a member of the War Plans Division, in Naval Operations. Throughout his career, Rear Admiral Yarnell has been noted for his sound judgment.

REAR Admiral Arthur J. Hepburn is the youngest Admiral in the Navy. At present he is Chief of Staff for Admiral Pratt, Commander-in-Chief of the United States Fleet, and brings to the Conference a thorough knowledge of the operating needs of our fleet. During the World War he organized and commanded the American submarine chasers operating in Ireland, and subsequently served as Director of Naval Intelligence. His sea experience in the United States Fleet has been unusually extensive, for he commanded our largest superdreadnaught, the *West Virginia*, then served as Chief-of-Staff, Battleship Divisions and of the Battle Fleet, before becoming Chief-of-Staff, United States Fleet.



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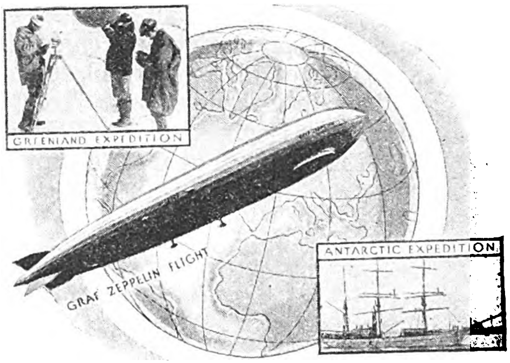

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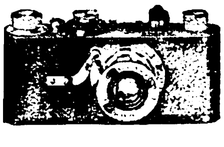

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Rights to Fruit Spray Removal Process Contested

RIGHTS to a process of vital interest to the fruit industry of the country, claimed by the Department of Agriculture and the California firm of Brogden and Trowbridge, are involved in litigation now pending in the Patent Office. According to the claims made by the Department of Agriculture, the process using a dilute solution of acids or alkalis in removal of spray residue from fruits and vegetables was conceived and put into practice by employees of the Department. However, application for patent submitted by the Department in the name of Arthur M. Henry, government chemist, was declared by the Patent Office to be in interference with the application of Brogden and Trowbridge.

The process has been extremely useful in preparing fruit for market, and has been in almost constant use in various fruit-producing regions since 1925. It has been stated publicly by the Department of Agriculture that if the Henry application is granted, it will be dedicated to the service of the public and may be used by anyone without royalty charges or other costs. Mr. Henry is a chemist of the Philadelphia station of the Food, Drug, and Insecticide Administration of the Department of Agriculture.

Copyright Denied Because of Disclosure in Patent

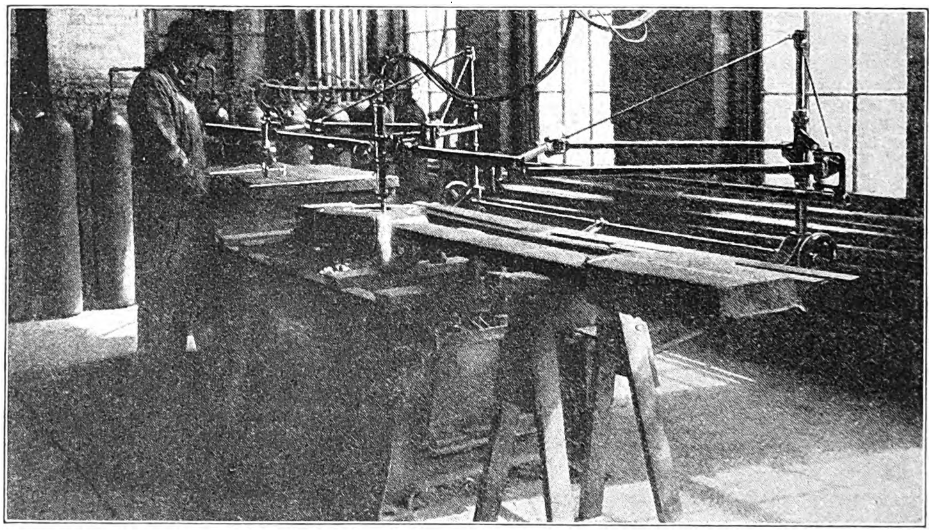
WHEN an inventor has applied for and obtained a patent on a certain model or relief diagram, he cannot extend his monopoly by taking out a copyright on what he has already diagramatically disclosed, according to the Circuit Court of Appeals for the Second Circuit. In the case of Alfred Korzybski *vs* Underwood and Underwood, Inc., it was found that Korzybski had made a full disclosure of his invention in his patent application. Later he sought to obtain a copyright on the design involved, with no substantial distinction between the disclosure of the patent and the design of the copyright, and no real question of merit of a particular design as compared with the drawings of the patent.

Quoting from Weil on copyrights, the Court said: "While in doubtful cases the Court will hold that presumably the fact that a given work is patentable is ground for holding it is not copyrightable and *vice versa*, it seems that there is no rule of law nor is there any consideration of public policy which will prevent the issuance of both a copyright and a patent to cover the same work in its different aspects in a proper case. . . . A novel household utensil may be modeled by a great sculptor. Its form may be artistic in the highest degree, its machinery may show the qualities necessary to patentability, its use may be purely utilitarian and it may be so constructed as to be one inseparable unit. In such event it should be both copyrightable and patentable."

However, it also was pointed out, such a situation does not arise on the facts of the present case, when there seems no room for distinction in design. Section seven of the copyright act provides: "That no copyright shall subsist in the original text of any work which is in the public domain." The defendant had done no more than photograph the device in question, which it had a full right to do, because the subject matter of the patent had become public property.

Patent Sustained for Combination of Pantograph and Blow Torch

DECIDING on the validity of the Worthy C. Bucknam patent (Number 1059329) covering the combination of a cutting torch with a pantograph by which the torch is guided, the District Court for the Northern District of Ohio has ruled the Bucknam claims valid and infringed. The case in suit was instituted by the Air Reduction Company, Inc., against the White Tool and Supply Company. In the decision of the Court, it was noted that the patentability of the combination was substantiated by the fact that the devices of the plaintiff based on this invention have gone into wide use, supplanting earlier devices and methods.



Courtesy Air Reduction Sales Company

Cutting a locomotive side rod with an oxygraph, one of the numerous industrial applications of W. C. Bucknam's combined pantograph and blow torch

In the description of the invention, the Court said: "Bucknam devised a pantograph frame pivoted to a post at one corner of the parallelogram; one of the arms carried a torch or blow pipe with the nozzle pointed down to the surface of the metal to be cut; and to the end of an extension of another of the arms was attached a swiveled roll tracer, which, being set in motion either by hand crank or electric motor, traveled over the lines of any pattern or blue print that might be put under it, and so moving, caused the torch to move with precision and regularity over the same course, and cut the metal cleanly, with astonishing accuracy, and exactly in conformity to the pattern."

The prior art had associated the pantograph with various devices, such as a pyrograph for burning designs on wood, sewing machines for placing stitches in designs on cloth, and electric welding apparatus. However, the Court held, it was new and patentable to combine a pantograph with an oxygen blow torch for cutting metal along various lines to leave a smooth edge. The arts are so remote, and the construction so different and altered, that invention was involved in the transposition, mere double use not being involved.

It also was held by the Court, with respect to the defense of double patent, that where two patents issue the same day, there is no presumption that the lower number is the prior patent. In such instances the higher number will not be held void for double patenting even if the lower number accidentally contains a claim similar to those of the higher number. This notation referred to Patent Number 1059271, issued the same day as the other Bucknam patent noted above. In the trial, the plaintiff relied solely on certain claims of Patent Number 1059329, covering, in effect, the same invention.

By means of the pantograph attachment, cutting by means of a blow torch has been improved materially. This apparatus has gone into widespread commercial use, to meet the need for cutting shapes from steel plates and billets according to drawings or templates. Large and small devices based on this principle are made and sold by the plaintiff, holder of the Bucknam patents and others of similar nature.

This apparatus, in both sizes, consists of an oxy-acetylene cutting torch mechanically supported on a pantograph, actuated by a tracing wheel driven by a small electric motor. The tracing wheel may be guided by hand over the lines of a drawing, or it can be guided automatically by means of a metal template. Metal up to 20 inches in thickness is cut by this means into any desired shape or design. In the smaller apparatus, the torch operates on a one-to-two ratio with the tracing wheel, following the movements of the tracer on a reduced scale. The larger apparatus cuts an exact reproduction of the path traversed by the tracing wheel, thus producing the large cutting area necessary for locomotive, forge, boiler, tank, and heavy machine-shop work.

Advertisement Admitted as Evidence

WHILE advertisement is not proof of trademark use, it is evidence of contemplated use and is entitled to weight with other testimony of use, in the opinion of the First Assistant Commissioner of Patents. This decision was made in ruling that the trademark "Primfit" is deceptively similar to "Trimfit," both marks being used as designations for hosiery.

Considering it obvious that the marks were so similar in sound and appearance as to cause confusion if both products were to appear in the same market, the only point to be decided was whether the holder of the first registered mark, "Trimfit," had proved prior adoption and use. Unsigned copies of typewritten statements, not properly identified, were not considered proper evidence showing that the mark was in use. No explanation was offered as to why the originals were not produced.

A page said to be a copy of an advertisement of his firm was offered by the witness, showing that in the February 1923 edition of the *Hosiery Retailer* use had been made of the "Trimfit" trademark for advertising purposes. The Commissioner held it obvious that the company would not insert in a publication an advertisement of that type unless the company were intending or in a position to offer its goods under the trademark. Additional proof of prior use of the mark was presented in testimony showing orders for labels and their printing and delivery with copies of orders, and samples of hosiery bearing the trademark. The conflicting mark was ordered cancelled.

Contributory Infringement of Process Patents

THE Circuit Court of Appeals for the Second Circuit, in Novadel Process Corporation *vs* J. P. Meyer and Company, has recently decided an interesting case involving the infringement of a process patent by one who sells the ingredients for use by the purchaser in performing a process of bleaching flour. The patent sued on was what is known as a "process patent," that is to say, one covering a step or a series of steps whereby materials and things are changed either physically or in their chemical characteristics, producing a new article of manufacture.

The particular process involved in the suit consisted in adding certain chemicals to flour for the purpose of bleaching the flour. No one can infringe such a patent who does not actually perform the process or assist another in performing it. A process for manufacturing soap or preserves, or for bleaching flour would not be infringed by one who sold soap, preserves, and flour prepared and treated by a patented process if the seller had not actually performed the process whereby the products were produced.

In this case, both parties sold under certain trademarks the chemicals which when added to flour constituted the patented process. The owner of the process patent not only had the right to carry out the process of bleaching flour, but also the right to sell the required chemicals to millers to enable them to carry out the bleaching process.

While the infringer does not appear to have been engaged in performing the bleaching process, the Court ruled it nevertheless sold to millers the necessary chemicals—substantially those chemicals employed in the patented process. In so doing, the defendant knew that the millers were to use the chemicals in bleaching flour, and intended and directed that the chemicals should be so used, instructing the millers how to use them.

The millers, using the chemicals purchased from the defendant, performed the patented process and thereby infringed the plaintiff's patent. As the defendant had instigated such infringing acts, even though it had not itself performed the infringing process, the court held that it was a contributory infringer. The defendant was enjoined from selling its chemicals when knowing that they would be used in a process which infringed the plaintiff's patent.

Infringement of Registered Trademark in Foreign Commerce

A RATHER unusual infringement case has been decided by the Court of Appeals for the Second Circuit. The suit was instituted by Hecker H-O Company, Inc., against Holland Food Corporation. The defendant had made no sales apparently, in the United States, but it purchased cereal products in this country from various manufacturers, packing the products in packages, boxes, and barrels, and applying thereto the trademark "Hofood." The goods were shipped from American ports to foreign countries, including England, Holland, Belgium, Switzerland, and Greece, where they were sold. Although no sales had been made in the United States, where plaintiff's registration was in force, the court nevertheless held that "labeling packages, boxes, and barrels with the mark 'Hofood' and sending them into foreign commerce for sale in foreign countries was a violation of the trademark act."

The defendant raised the question as to whether, if the labels showing the infringing trademark were affixed in foreign countries where its product was sold, it would constitute an infringement and violate the provisions of the trademark act. The court declined to decide that question, on the ground that it was sufficient, for the disposition of the present case, to hold that the act of the defendant in affixing its infringing mark in this country was a violation of the act.

In a similar case, tried in the District Court in the Southern District of New York some years ago, the court held it to be an infringement to place an infringing trademark on certain textile fabrics in this country and ship them to Turkey for sale. In that case there was ample proof that the owner of the trademark had established a large business in Turkey for exactly the kind of fabric on which the defendant had placed the infringing mark. The defendant was held to have infringed not only by applying the mark in this country but by selling the merchandise in the plaintiff's market in a foreign country, and was enjoined and forced to pay damages as well as the costs of the suit.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co.; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

Wing - Structure - Varying Device for Aeroplanes—Whereby the wing structure, and the curvature of the profile of the wings, may be changed from a monoplane to a biplane, for varying the amplitude of the lifting surface, at the will of the pilot, even during flight. Patent 1738463. Aldo Tammeo.

Pertaining to Apparel

Corset—Of substantially conventional type, having elastic side sections, but having a normally permanently positioned section at the front, which may be removed, and a plurality of fastening means adjustable to take up stretching of the various parts. Patent 1738434. Joseph J. Kispert.

Shawl Coat—For children, formed from a one-piece rectangular fabric folded together and secured so that it will remain in position to act as sleeves, a body and a muffler, without cutting or materially creasing the garment. Patent 1739433. Helen B. Young.

Glove and Method of Making the Same—A glove of the slip-on or gauntlet type, having an opening at the side and an integral inwardly turned hem joined to a finishing strip in such manner as to provide an attractive appearance, with strength and durability in use. Patent 1740218. Schuyler E. Benjamin and Wendell P. Murray.

Binding—Especially adapted for gloves, being composed of superimposed flexible strips of contrasting colors, the outer of said strips having longitudinal perforations to enable the double thickness to follow the contour of the binding edge. Patent 1742117. Albert Aaron and Schuyler Benjamin.

Designs

Design for a Doll or Similar Article—Patent 80030. Adolph Gramlich.

Design for a Toy Glider—Patent 79978. Andrew A. O'Brien.

Designs for Radiator Ornaments—The inventor has been granted three patents for ornamental figures for vehicle radiators. Patents 80122, 80123 and 80124. Biagio Intingaro.

Design for a Coat—Patent 80132. Dorothy Long.

Designs for Dresses—The inventor has been granted three patents on designs for dresses. 80131, 80133 and 80134. Dorothy Long.

Design for a Combination Curtain Pole, Curtain-Rod Bracket and Suspending Means—Patent 80184. Bror G. Norberg.

Electrical Devices

Automatic Circuit Closer for Electric Signal Lights and Signs—Of the disk type flasher, intended for use in alternately changing colored lights at definite intervals to suit the needs of traffic, or may be used for other signaling requirements. Patent 1738444. William E. Nagem.

Circuit Breaker—For the ignition and lighting circuits of a motor vehicle when its motor ceases operation, so that in parking, should the operator fail to turn off, the device will automatically disrupt their circuits and prevent injury to the battery. Patent 1737961. Frank P. Ellis.

Vacuum Tube—An electrode support comprising an annular body having layers of insulating materials of different dielectric strengths and permittivities in such manner that the permittitivity of the layers descreases in value inversely with the distance from the electrode. Patent 1739513. Ralph W. Lohman.

Electric Defroster for Refrigerating Coils—Whereby electric heat will be automatically applied to the cooling units of a refrigerating plant at predetermined intervals, and the accumulation of any appreciable amount of frost on said units will be prevented. Patent 1742062. William B. Day.

Of General Interest

Holding Device for Ironing-Board Covers—By means of which a cloth or other form of covering can be securely held in a taut condition thus presenting a smooth surface for ironing operations, the device is adjustable to boards of various widths. Patent 1737300. Joseph H. Dayton.

Weather Strip—Composed mainly of metal and having a rubber or flexible portion, may be cut to fit any window-frame or casement and attached by merely pressing the strip into its support, will be absolutely weathertight. Patent 1738350. Frank B. Buckhout.

Follower for Filing-Cabinet Drawers—For holding filed articles in a substantially upright position in the drawer, the bottom being equipped with longitudinally spaced keepers, the followers having dentent means engaging with the keepers to lock the followers against movement. Patent 1738419. Alexander Burger.

Valve—Of the quick-acting type, employed on boiler blow-off lines, on lines carrying viscous fluids or gritty matter, which will be tight when closed, and have a free waterway, equal to the size of the pipe. Patent 1738450. Edward F. Ryan and Edward T. Adams.

Cable Guard—Adapted to be secured to a post by a simple means, which also serves to connect a pair of similarly formed sections, said sections having slotted flanges which overlap to receive and support the cable. Patent 1738447. Irving E. Quist.

Lighter—Such as are commonly known as cigar or cigarette lighters, in which the lighter mechanism is movable relatively to the container, so as to either enclose the lighter or project it in position for use. Patent 1738451. Karl Schreer.

Whistle Cup—So constructed as to induce a small child to drink the milk or other contents of the cup in order to blow the whistle, which can only be operated when the cup is empty. Patent 1739451. Clarence B. Fowler.

Method of Flowing Oil—By introducing a current of heat around the perforated tubing at the well bottom, to break down the heavier constituents and reduce the viscosity of the oil thus accelerating its flow from the well. Patent 1737894. Edward P. Reynolds.

Disappearing Picture Illuminator—By virtue of which a lamp and reflector may be instantaneously moved from a concealed inactive position at the rear of the picture to an exposed projecting position for flood-lighting the picture face. Patent 1739320. Herbert D. Lloyd.

Fountain Pen—So constructed that the filling operation is very much simplified, permitting any required amount of ink to be drawn into the barrel and the pen filled with facility. Patent 1739235. Thomas Pearson.

Spout—For dispensing devices, which may be readily moved from an active to an inactive position for forming a closure, is particularly adapted for use with syrups served on a table, the receptacle being kept clean on the outside. Patent 1738077. Thorvald Petersen.

Toothbrush—Embodying a flexible brush element, which is readily removable from the holder, and may be spread apart so that its entire surface may be cleansed, thus preventing bacteria lodging between the bristles. Patent 1739324. William M. Neissl.

Bottle Stopper—Which may be readily manipulated when it is desired to discharge the contents of the bottle, but so constructed as to render it impossible to refill the bottle. Patent 1739393. Robert H. Harmon.

Shower-Curtain Ring—Constructed with rollers shaped to conform to the supporting rod so that when the curtain is moved to an operative or inoperative position the ring will slide freely along the support and will not become jammed. Patent 1739382. Louis Auster and Marie Auster.

Pedestal Support—Having a fixed standard supporting base, and a rotatable or turn-table top surface, which is particularly adapted for use in supporting an electric fan, or may be used generally. Patent 1739466. Henry C. Kihneman.

Built-in Bed Lamp—Having incorporated in the head-board framework a unitary construction of a lamp, the lamp being so embodied in the decorative portion of the framework that it appears a part of the bed frame. Patent 1739337. James B. and James F. Von Canon.

Device for Mixing and Straining Liquids—The device having a wall slotted in such manner as to cause the liquids poured therethrough to be subdivided into converging intersecting streams thereby insuring a uniform mixture when poured into separate receptacles. Patent 1740223. Benjamin Burvenick.

Fire Life-Saving Device—Embodying an endless cable having means for lowering persons from a building by means of a friction block, and means permitting ready insertion of the cable in a tortuous channel formed within the block. Patent 1740317. Carl Romson.

Carrying Device—A simple construction with which a person may lift a heated vessel, pot or pan with its contents from a stove or oven, carry it to any desired point, and there release it, without being burned. Patent 1740211. Sarkis Vahouny.

Sample Card—Including a plurality of cards each differing in shade and having an exposure area through which the skin may be compared with the card so that a face powder of the desired tint may be selected. Patent 1741080. Bernard F. Stenz.

Container and Server for Spreads—Which includes a hollow receiving body protected against dust, for holding spreads such as butter, jelly or analogous edibles, and for facilitating the uniform spreading over the surface of a slice of bread or its equivalent. Patent 1741089. Jacob Zitzerman.

Means for Safeguarding Concrete Structures Against Leaking Fractures—By forming on the upper surface grooves to form false joints, and filling said grooves with a non-hardening waterproof filler, and laminations of flexible material superimposed to allow for expansion and contraction and prevent leakage. Patent 1740110. Eugene R. Oden.

Life Preserver—Wherein a single piece of material is folded upon itself to form pockets, the bottoms being entirely seamless there are no stitches to rot, and therefore no danger of losing the buoyant material after long periods of disuse. Patent 1742104. Ernest W. Skoldberg.

Method for Varnishing Leather and Like Material—To impart a glazed and brilliant surface but without changing the appearance of the leather, by gelatinizing the surface with a suitable acid, and then applying a varnish having cellulose ester as a base. Patent 1742146. Jean Paisseau.

Inked Ribbon and Method of Making the Same—For typewriters, which includes an endless strip of tubular fabric, inserting a strip of cardboard between the runs of the fabric, passing the same between inking rollers, then reversing and repeating the operation to thoroughly impregnate the ribbon. Patent 1742093. Bertrand Paradise.

Visible-Card Index File—Comprising a transparent pocket secured to the card body for receiving a record slip, and means whereby the operator may easily insert a card in front or to the rear of the record slip. Patent 1742087. Luigi Lombardini.

Window Box—Which may be used as cold weather ice box, may be readily mounted on window sills of different shapes and sizes, and will be closed or opened with the raising or lowering of the lower window sash. Patent 1742051. James C. Young.

Juice Extractor—For extracting juice from citrus fruits, whereby a maximum amount of juice will be obtained from fruit halves, a funnel directing the extracted juice into a container. The device may be readily disassembled for cleaning. Patent 1742089. Charles Meyer.

Hardware and Tools

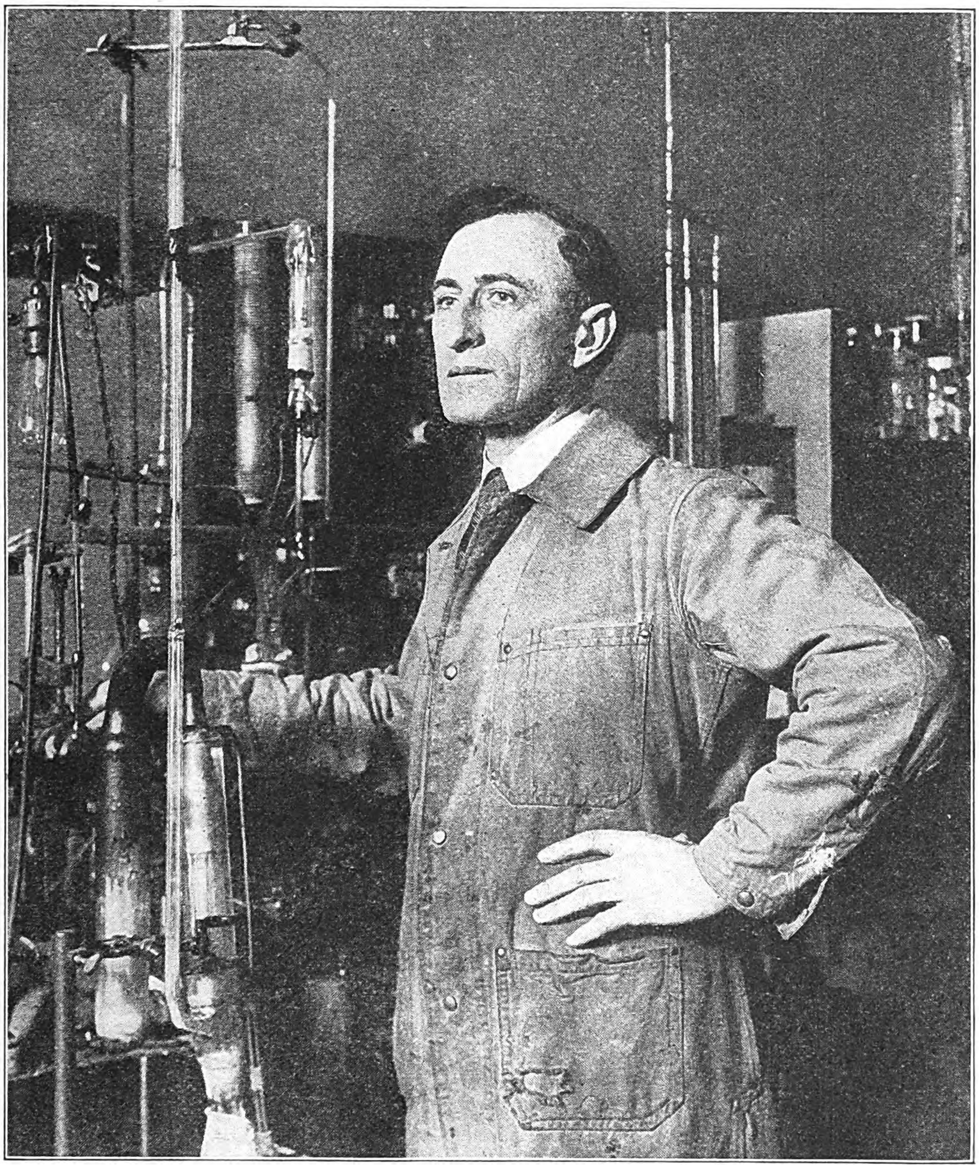
Cylinder-Bore Polishing and Finishing Attachment—A machine tool attachment, for finishing and polishing any cylinder bores after they have been bored with the rack tool, the device produces an absolutely smooth finish, and may be adjusted to cylinders of different sizes. Patent 1738443. Robert L. Meaux.

Metal-Bending Tool—Particularly adapted for the straightening of bent or otherwise distorted automobile fenders and running board brackets, to restore them to their original form without the necessity of removing them from the vehicle and without scratching. Patent 1737084. John R. Hilstad.

Grapple for Handling Hot Castings—Of the crossed lever type, commonly used to lift and transport heavy castings, so constructed that the hands of the operators do not come in close contact with the block, thus eliminating bad burns. Patent 1740383. Isaac L. Wessel.

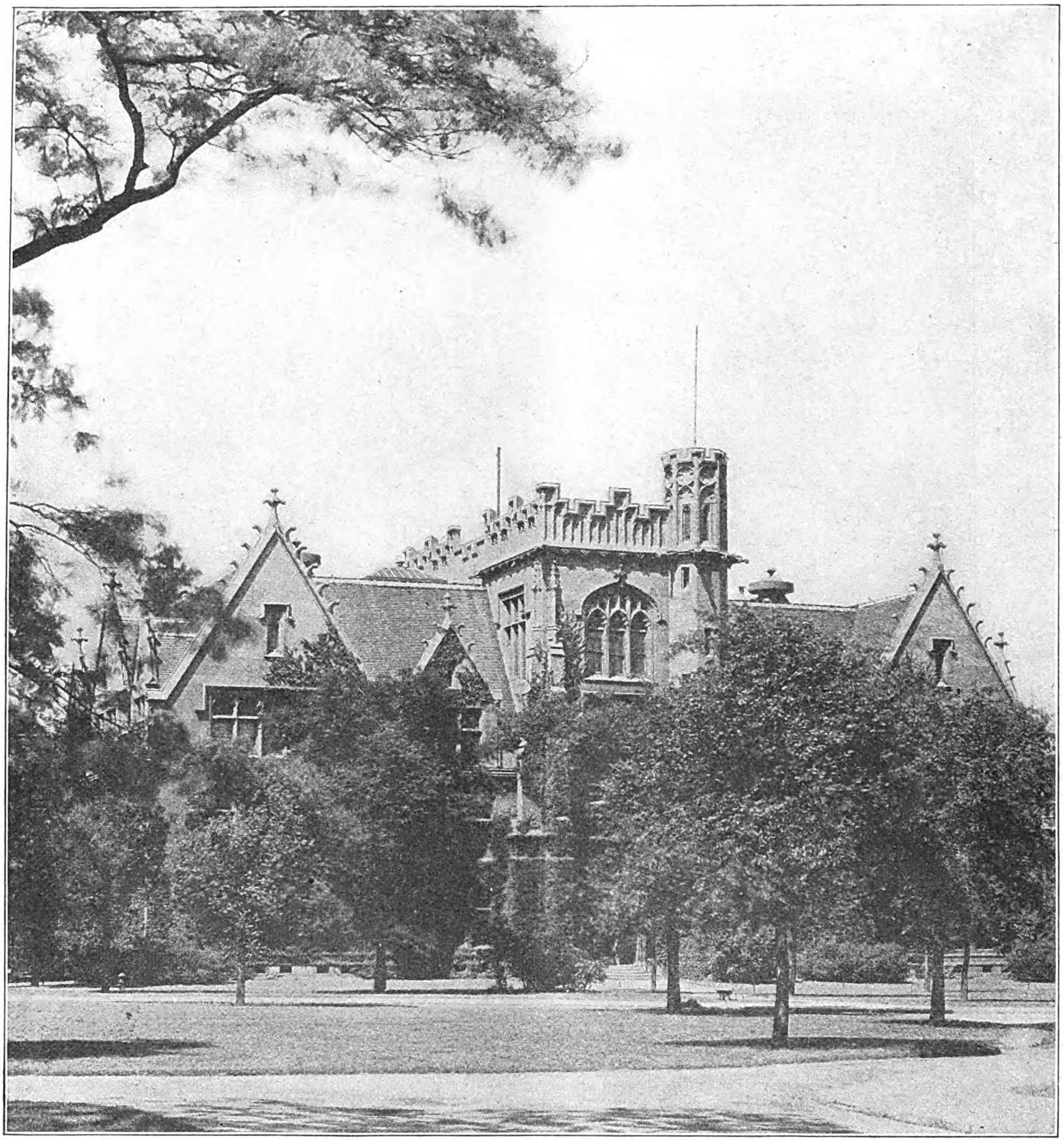
Lid-Supporting Means for Cabinets or Boxes—A stay which allows of the lid being raised to a certain position and supported, but if an additional upward movement is given the stay becomes automatically released and allows the lid to close. Patent 1741081. Joseph A. Stone.

Latch for Pivoted Handles—A latch for hand implements, such as pruning shears, for holding the handles against relative movement when not in use, but which may be readily released to free the handles for operative movement upon gripping the same. Patent 1741109. William G. Heimer-Dinger.



Arthur Jeffrey Dempster

THE Thousand Dollar Prize of the American Association for the Advancement of Science has been awarded this year to Professor A. J. Dempster of the famous Ryerson Physical Laboratory at the University of Chicago, for his "noteworthy contribution to science" in proving that the proton has wave characteristics. In the words of Professor Arthur H. Compton, Nobel Physics Prize Winner, also of Ryerson Laboratory, "the most important contribution of 20th Century physics is that the physical world can be reduced to three kinds of particles—protons, electrons, and photons, [see Professor Compton's article, SCIENTIFIC AMERICAN, February, 1929.—Editor], and that each of these particles has also the characteristics of waves. The last stage is the proof that the protons, the positively charged parts of matter, have wave characteristics. It is this completion of the great work of 20th Century physics which has been accomplished by Professor Dempster." In that Dr. Dempster's discovery demonstrates the dual nature—particle and wave—of the proton, it is one vindication of the prediction of the French physicist de Broglie, mentioned on this page last month. Following de Broglie's prediction Davisson and Germer of the Bell Telephone Laboratories proved the wave nature of the electron; Dempster's research does the same thing for the proton.



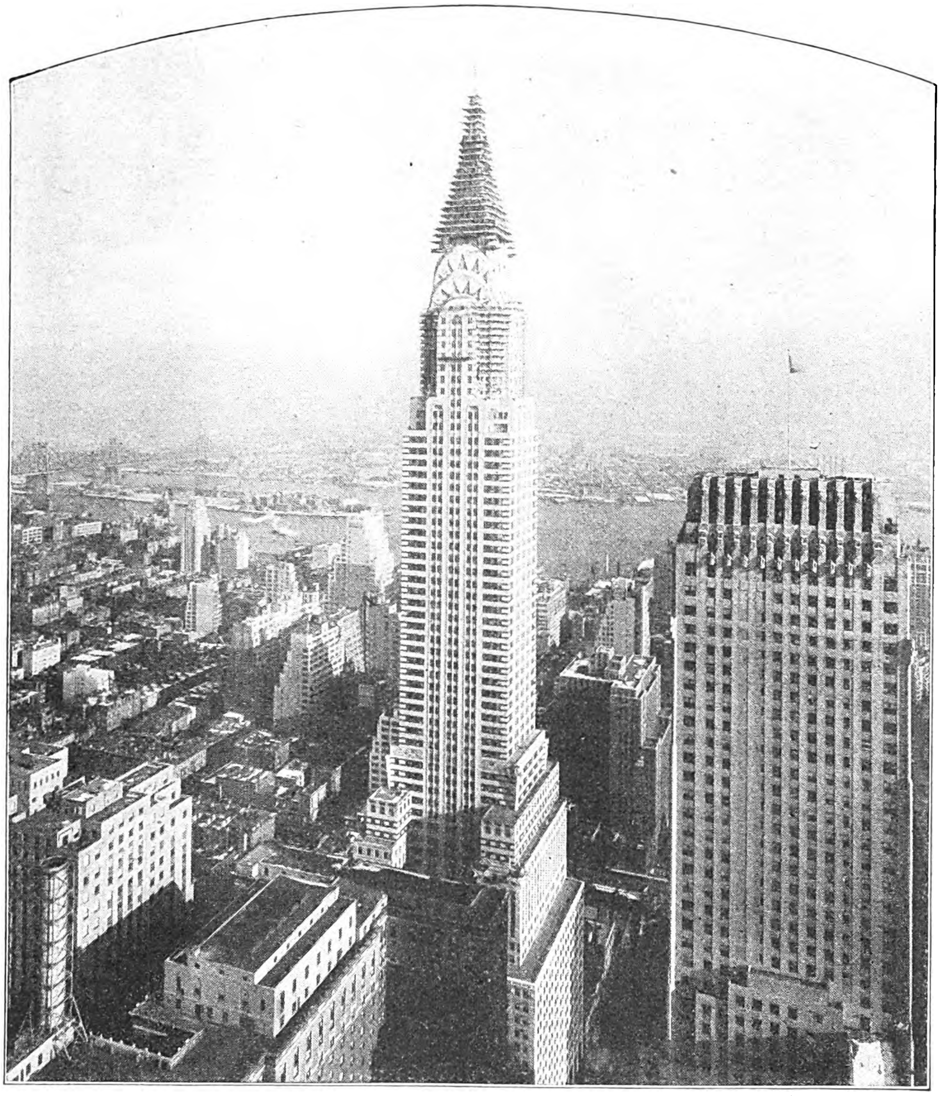
America's Foremost Physical Laboratory

THERE is no formula for determining which is the "foremost" physical laboratory, but the Ryerson Laboratory at the University of Chicago has given the world so many famous physicists that the majority of those who are qualified to judge would perhaps so nominate it.

How is such a choice as this arrived at? What makes a scientific institution a leader? That which is most likely to assure advance is the strong inspiration and leadership of an outstanding personality, and it is therefore not a far cry to attribute Ryerson's supremacy mainly to the leadership of the great physicist Michelson who has been its head from 1892 until recently.

Michelson, Millikan, Compton—what a trio this center of physical research can boast! Professor H. G. Gale whose name is linked with Michelson's in connection with ether drift experiments; Samuel G. Stratton, President of the Massachusetts Institute of Technology; Professor A. J. Dempster, whose picture is on the previous page; Dr. W. F. G. Swann, Director of the Bartol Research Foundation; Dr. Frank B. Jewett, President of the Bell Telephone Laboratories; and Dr. C. J. Davisson of the same great laboratories, who proved the wave-atom theory —these and some 130 other physicists are all "descendents" of the Ryerson tradition.

In an address before New York business men, the physicist R. A. Millikan, now of California Institute of Technology, spoke on "Michelson's Economic Value." He proved that Michelson was a bigger world asset than any billion-dollar corporation, or all of them in existence. Thus much can one simple man accomplish for the world by the right kind of leadership in science.



ON AN OLD GOAT FARM

According to an old drawing, a copy of which we saw a few days ago, the site occupied by this already famous structure, the Chrysler Building, was a goat farm only 55 years ago. The section beyond it, one may well imagine, must have been open farm land with a residence here and there. In the distance is the East River and one of the bridges spanning it. In this view, taken a short time ago, the tower is not quite complete

Manhattan's Mightiest "Minaret"

Many Unique Features and Engineering Problems Involved in Building the World's Tallest Structure

By F. D. McHUGH

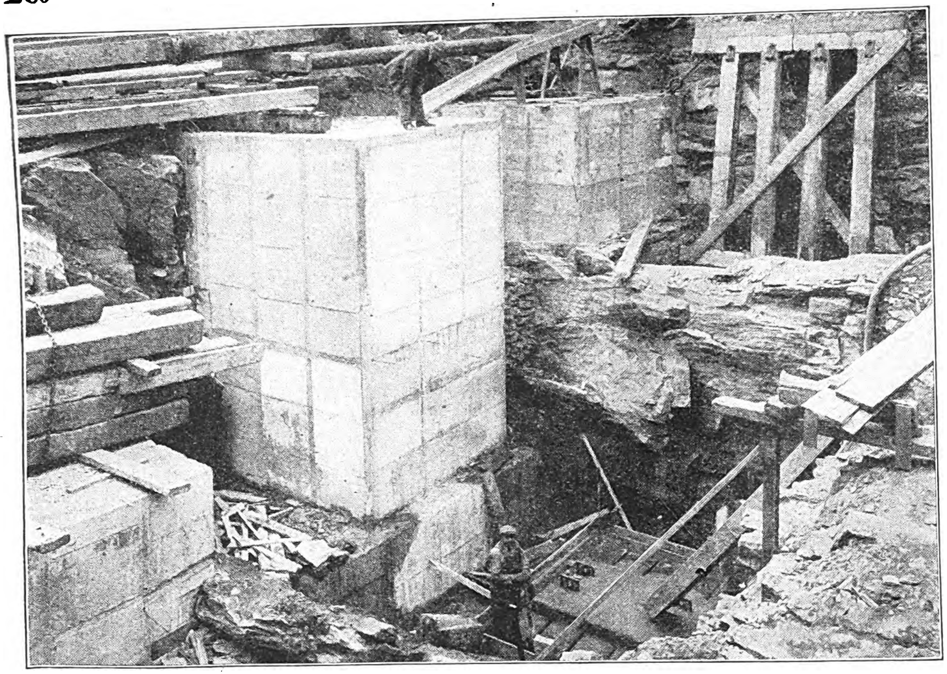
STANDING out like some shiny new minaret among many squat mosques of business, a needle-pointed tower building has been added to the mid-town skyline of New York City. And if one is fortunate enough to view it from the exact angle at which the sun is reflected directly, then he will be treated to a sight that will impress him with its unique quality: he will see what appears to be a towering sword of fire topping the structure. Perhaps he will be puzzled, and upon inquiring will learn that the finial spire of this newest of New York's new edifices, the Chrysler Building, is entirely covered with stainless steel and, furthermore, that this metal is used generously on cornices, arches, and other parts of the upper tower structure.

The Chrysler Building is the tallest building, and, in fact, the tallest man-made structure in the world. It tops the Woolworth Building, holder of the first record for many years, by more than 200 feet and beats the 1000-foot Eiffel Tower of Paris, holder of the second record since 1889, by 44 feet. It rises 1044 feet above the street curb line.

FROM a base approximately 200 feet square occupying the plot on the east side of Lexington Avenue between 42nd and 43rd Streets, this structure rises through several set-backs to the 31st story at which point the tower starts. The tower at this level, and continuing to the 59th story where there is another set-back, measures about 88 feet by 107 feet. The 59th story set-back changes the plan of the tower so that it measures 88 feet by 88 feet. Then from the 61st floor setbacks, the contour starts changing into the multi-arched dome which finally converges into the needle-like finial. Below ground there is a basement, a cellar, and a sub-cellar; and above ground, running into the dome, there are 71 stories, plus the final 34 feet of the dome itself, plus the 185-foot finial. The total floor area is approximately 1,200,000 square feet. In the basement will be a restaurant, stores, and bank vault; and it will be accessible, through corridors, to both the Grand Central Station and the subway.

Besides the stainless steel, which is so strikingly effective in appearance, there are many other unique features about this building and it is the holder of other records in addition to the height record. Also several unusual problems were encountered in the work of construction.

It has been the accepted, although



TO SUPPORT A TREMENDOUS LOAD

One of the huge column foundation pillars of concrete. This supports a column which runs directly through to the top of the building, its total load being approximately 3700 tons

tragic, belief that, in erecting the steel for a modern building, one workman will be killed by accident for every floor of the structure above the fifteenth. On the Chrysler Building 2500 to 3000 men were employed at all times and a number of accidents occurred, but not one resulted in death outright and only one of those injured died later. This splendid record of safety was due to the many precautions taken by the builders and to the general systematization of the work.

GENERAL construction methods usually allow piles of structural materials of various kinds to be stored in any available place awaiting the opportunity to be carried to the point needed, after the foreman concerned with their disposal is located. This is conducive to confusion, and confusion, where hundreds of men are continually active, increases the danger. In going about their individual tasks, men stumble over this stored material or step on loose ends and fall perhaps many floors.

This condition did not obtain in the Chrysler Building. When a truckload of material—sand, cement, steel, et cetera—arrived at the street office, the man responsible for its disposal was immediately called on the telephone. No matter in what part of the building he may have been at that moment he would receive the call, for the temporary telephone line extended throughout, and all this man had to do was to listen for his particular number of rings, or code call, for bells rang on all floors. Upon getting the message, he gave instructions for placing the material at once where it would be used.

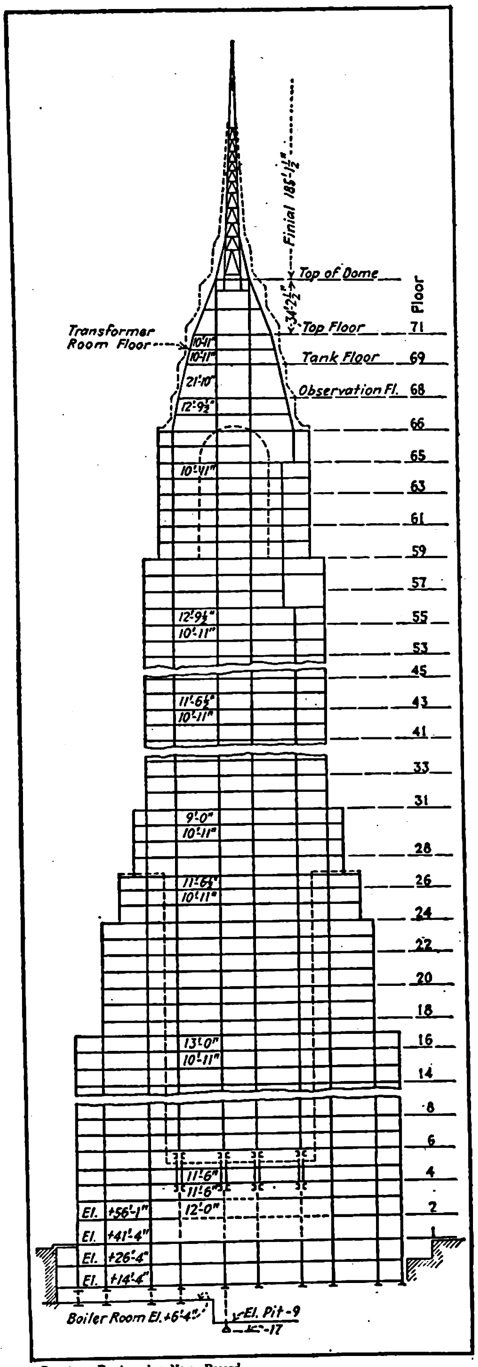
Other safety measures adopted were the use of guard rails with locked doors around the construction elevator shafts where they pass through each floor, and the use of a minimum amount of scaffolding on the outside of the building at all times. In fact, the materials-hoisting elevator shafts and their necessary scaffolding, composed primarily of steel tubing, were all grouped in the rear of the building.

Another record held by the Chrysler Building is that of possessing three of the longest continuous elevator shafts in the world. Indeed it is said by some that in this building the ultimate limit of practicable elevator operation and therefore the most economical building height has been reached. This belief is based upon the claim that it would be impracticable to attempt to support an elevator car and its cables for a direct run of more than approximately 1000 feet, and furthermore that shafts in a number of relays would take up too much revenue-producing space.

ON the other hand, the American Institute of Steel Construction reports as a result of an extensive study of the height question that while 1000 feet seems to be the maximum economic height, the maximum physical and engineering limit is 2000 feet. It is interesting to note their reasons for this figure; namely, the enormous weight of the elevator cables that would be required, and the capacity of the human ear drum to withstand the vibration in an elevator car traveling at a speed that would have to exceed 1500 feet per minute.

One of the most important factors in the design of a building of this character is the problem of wind stresses and the general stiffness in the joints of the multi-story rigid frame. Wind bracing is necessary primarily to prevent occupants from getting seasick or frightened. In the Chrysler Building special care was taken in selecting column sections in the center of the building to get continuous framing throughout and enable rigid bracing to be attached. This required a great deal of special study inasmuch as grouped in this part of the building are the elevators and stair openings which were arranged as compactly as possible in order not to use any more rentable space than absolutely necessary.

Structural steel was so designed and erected as to distribute wind stresses throughout the structure. There are



Courtesy *Engineering News-Record*

SCHEME OF THE BUILDING

Sectional diagram of the building showing the general layout, set-backs, pipe galleries, tower, observation floor, et cetera no "soft" spots but a harmonized balance of members so that neither a steady wind nor a sudden gust will distort the building or cause jarring vibration. It is expected that the building will vibrate, but this vibration will be rhythmic. The writer visited the building a short time ago on a fairly windy day and was not aware of any vibration in the tower stories. This was due perhaps to an unconscious physical accommodation to sway. For the purpose of further study of this question, wind stress indicators may later be installed at all telltale points in the building.

The erection of approximately 21,000 tons of structural steel offered several unusual problems, although the general framing does not differ radically from that of other skyscraper buildings.

The great elevator hall extending through the building made it necessary to carry four columns on two-story trusses. These trusses extend through the fourth and fifth stories, the columns extend to the 58th floor, and each carries the tremendous weight of 3,800,000 pounds. The section of one of the columns supporting the truss has an area of 532½ square inches, and its total weight per lineal foot is 1770 pounds!

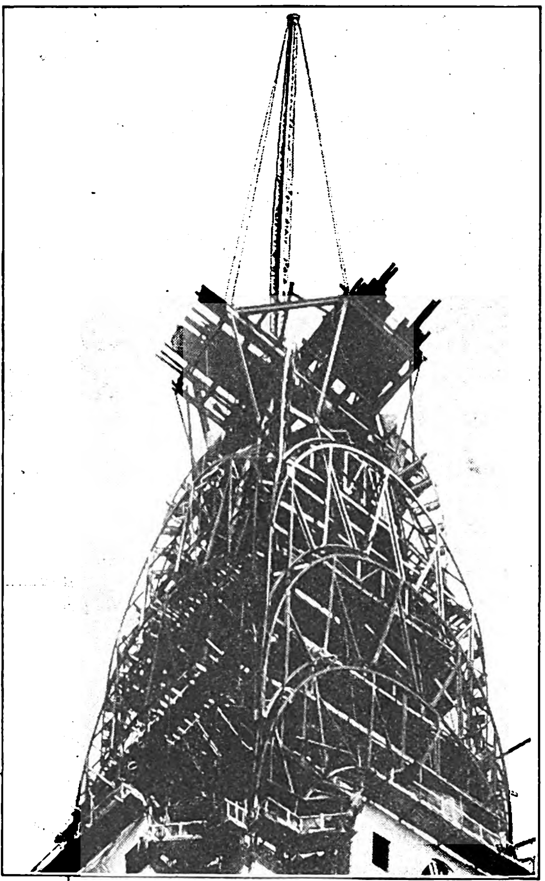
THE four center columns are in an unbroken line to a point 30 feet above the 74th floor, from which level the spire starts. In the dome-like part of the tower the 12 wall columns are sloped, following as closely as possible the exterior walls. Structural steel angles, bent to follow the architectural outline of the dome part of the building were of such unusual construction that they were fabricated by a ship-building company.

It is interesting to note that the total load of the building, including all live and dead loads, is equal to the combined tonnage of three large battleships—that is, 112,000 tons!

In the erection of the finial, the Chrysler Building scored a triumph which for daring conception and unique execution has not been equalled for many years, if at all, for the interest it aroused among engineers and laymen alike. The architect, William Van Alen, originally designed the structure to be 808 feet high, surmounted by a dome composed of a series of gradually decreasing arches, and, finally, by a cupola-like dome.

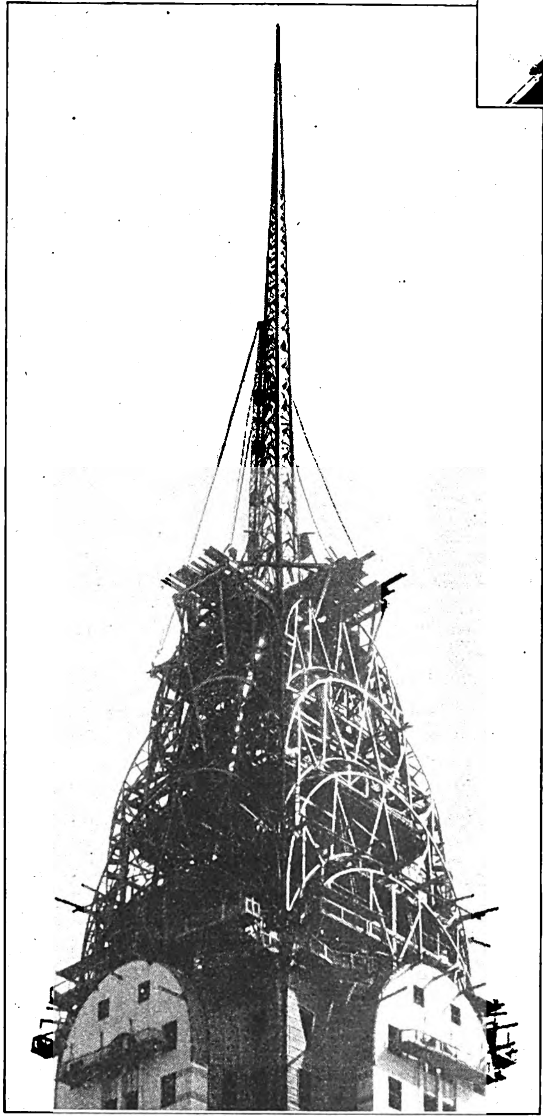
Construction work started in October, 1928, and by the fall of 1929 the steel structure was rapidly nearing completion. In the meantime, the design of the upper part had been changed, the finial being designed to take the place of the cupola-like dome, but this fact had been kept secret. Then suddenly on a day in November, 1929, passersby were amazed to see the finial, a lattice-like structure, emerge full grown from the top of the steel and push skyward a distance of 185 feet.

Since it was expedient to erect this finial as a unit and its weight of 27 tons precluded the possibility of lifting it all the way from the street, and since, furthermore, it would have been difficult to up-end into position, it was assembled vertically within the building frame. Fortunately, a fire tower existed in the top section of the main structure and so the finial was built therein of formed and numbered sections. Since its base measured only 8 feet on a side, this operation was simply done by providing a support at the 65th floor level and temporarily omitting some minor sections of the building frame.



FOR RAISING THE FINIAL

The platform and the 20-ton derrick that was used, its boom being held practically vertical



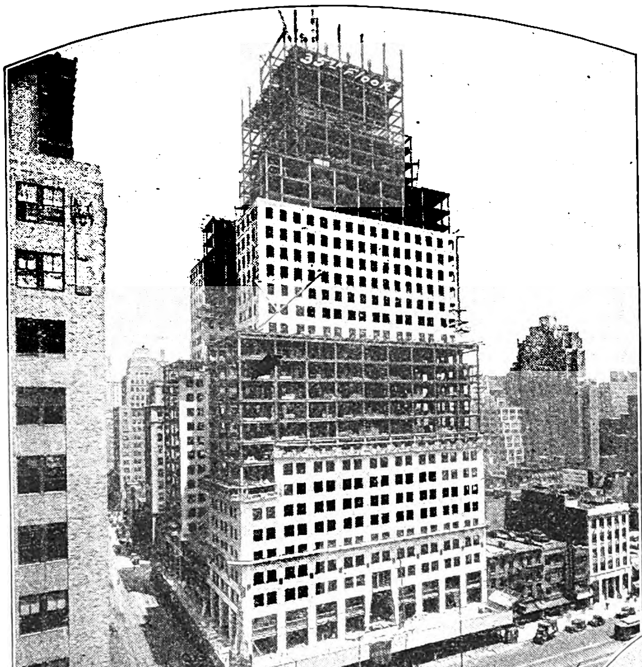
THE LATTICE-WORK FINIAL

This unique spire was assembled within the building and erected in place by lifting it out vertically. Note intricate framing for the tower

An outrigger platform was erected all around the top of the dome and a guy derrick was mounted on this. A line from the derrick was then attached to the completed finial and it was pulled out vertically, inched slowly upward until finally its base was in position for bolting and riveting into place permanently. In passing, it may be said that this unique operation may never be necessary or desirable in any future building.

SEVERAL floors of the completed structure will be devoted to operating equipment. The cellar and subcellar will be used for the installation of mechanical equipment, mechanics' shops, main switchboard room, transformer vault, telephone room, and store rooms. The 30th and 60th floors will be pipe galleries, the entire space of both being taken up by steam mains and distributing lines, electrical apparatus, and general operating equipment. The 68th floor will be used for observation purposes, the 69th for water tanks, and the 70th as a transformer room.

One of the striking features of the building is the manner in which electricity at a voltage of 13,200 was brought directly into the building. High-tension cables carry this current to four transformer vaults located at different levels. These four transformer banks are treated as regular transformer sub-stations and the fact that they are located vertically one above the other, instead of horizontally, as along a highway, in no way changes their functioning.



AS THE WORK PROGRESSED

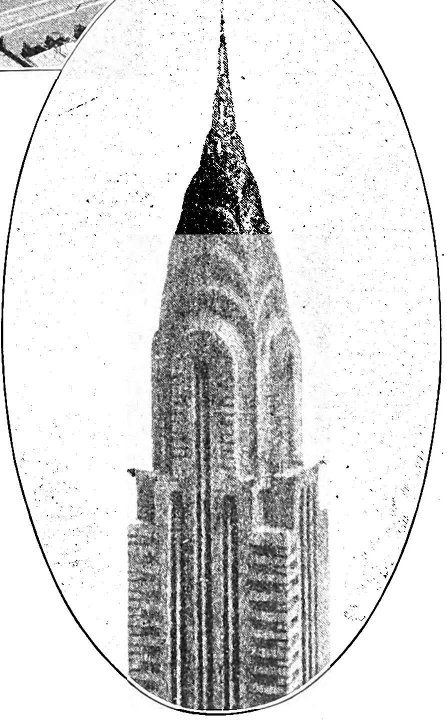
It will be noted that the structure was kept comparatively free of scaffolding

The secondaries of these transformers are brought out to switchboards where they become the points of origin of the various customers' feeders. The high-tension feeders which are brought in from the street to supply the primary energy for the transformers are kept isolated from the building in raceways embedded in concrete.

Another feature of the Chrysler Building's electrical design is the full recognition of the arrival of the electrical era expressed in the facilities provided on every floor for the application of electricity to every office need. This is done by the installation of underfloor raceways by means of the Orangeburg duct system, sections of which are spaced at sufficiently close intervals to allow an electrical connection to be made at any point within the extensive floor area of the building.

Seasonal and even hourly demands for heat may be taken care of due to the effective arrangement of the heating system. That is, during seasons in which the sun heats up offices with a southern exposure and leaves those on the northern side cold, during the morning when the offices on the western side are cold, and during the afternoon when offices on the eastern side are cold, steam may be turned into the pipes feeding the radiators of the cold tiers of offices. To make this possible, the entire heating system has been divided into four zones.

Steam for heating the building will be purchased from the New York Steam Corporation. For the benefit of those unfamiliar with this system, it should be explained that this corporation has several steam plants at locations convenient for the reception of coal shipments and sufficiently far removed from busy sections of the city to prevent their throwing over the city quantities of smoke and soot. Among the advantages of this system may be listed the facts that a cheaper grade of coal may be burned, fuel does not have to be trucked through heavy traffic, and the building purchasing steam in this manner does not have to install machinery and equipment.



THE COMPLETED TOWER

An artist's rendering of the tower with its finial, as it will look when complete

The steam mains of this corporation extend over a wide area of the city, constantly carry live steam, and may be utilized in the same manner in which electrical power lines carry current and are tapped. For the Chrysler Building, the steam mains are tapped at two points, one on the 42nd Street side and one on the Lexington Avenue side, so that steam may be supplied from one or two of the steam company's stations. The entering steam is metered and then taken through a pipe gallery to a main supply riser which carries it, at a pressure of 40 pounds per square inch, as far as the 60th floor.

In the pipe galleries at the 30th and 60th stories, the steam pressure is reduced to feed a set of secondary supply mains. From the mains on the 60th floor, steam pipes are carried up to the top floor and down to the 31st floor. From the mains on the 30th floor, steam is carried down to the 17th floor. Finally, steam is carried from the cellar pipe gallery upward to the 16th floor. Welding was adopted for joints and connections wherever practicable — in the sub-cellar level, throughout the main supply riser, and in the 30th and 60th floor mains.

TWENTY-EIGHT passenger elevators, two service elevators, two to the tower, one for the restaurant, and a sidewalk lift have been installed. The passenger elevators and the two tower elevators are Otis electric, gearless, machine type, with full automatic signal control and automatic leveling. This type is practically self-operating since the operator simply pushes buttons for all the floors desired on any one trip, and the mechanism stops the car at those floors as they are reached, levels off, and opens the doors. Likewise, a signal from any floor automatically stops the car as it reaches that floor. The passenger elevators have a capacity of 2500 pounds and a speed of 1000 feet per minute—or about 12 miles an hour, vertically!—but will be run at 700 feet per minute until the city code allows the higher speed.

Cold water for fire and sanitary purposes throughout the building is pumped to the upper floors in three stages by means of house pumps and fire pumps. By installing brass pipes in the hot water system throughout and on the cold water system for all pipes up to and including 2½ inches, the owners have exercised forethought to obviate the trouble of rusted and clogged pipes in the future.

Other problems were encountered and other unique practices or adaptations than those described here were involved in the building of this structure, but they were of such a specialized or general nature as to fall without the scope of this article. W. R. Squire & Son and H. G. Balcom designed the steel, and Post and McCord were the steel contractors. William Van Alen was the architect; Fred T. Ley & Company, the general contractors; and Louis T. M. Ralston, the consulting engineer.

OUR POINT OF VIEW

Safety Needed

THERE is quite a contrast between the remarkable record of safety achieved by the builders of the Chrysler Building, and the apalling death rate suffered during the past year by house wreckers. Only one death resulted from accidents sustained in construction work on the above mentioned building, but 20 deaths are reported as the result of house-wrecking operations in New York City in 1929, primarily because of the method of demolition.

Prior to last year, buildings and houses being destroyed to make way for larger, more modern structures, were demolished floor by floor. House-wrecking contractors then conceived the method of breaking through all floors of a building, regardless of height, and dumping all material directly to the basement for removal. This did speed up demolition, but at the same time it subjected the workmen to far greater danger than before because, with floors broken through, nothing is left of a building but a mere shell of walls on the top of which laborers must work. Practically all the men killed while working in this way, fell from these walls directly to the basement, in many cases 10 to 15 floors.

Today there is necessity for speed in all industry and construction work but this speeding up in all cases increases the hazard and the demand for more effective safety measures. Whether, in house wrecking, this points to a resumption of old methods or to the adoption of positive accident-prevention measures, we can't say; but something must be done, for time-saving is no excuse for taking human life.

Business and the Individual

THAT the responsibilities of American business to the individual, the nation, and the world, are increasing more rapidly than ever before was pointed out in an address given some time ago before the Chamber of Commerce of the United States by Julius H. Barnes.

"In this present era of applied invention," said Mr. Barnes, "of trained intelligence, of old industries expanded, checked, or displaced, of whole new industries rising with the magic wand of invention, and of high speed in the creation of wealth and possessions, we have a fluid economic structure that challenges the imagination. The social habits, indeed the individual character of our people, are under the influence of new and vast forces. The scene shifts hourly. The world of everyday has become a fairyland."

In 17 years our national income has increased from 32 billion dollars to 90 billion dollars annually. This is significant because, as Mr. Barnes said, "America has learned that national wealth is the aggregate of individual possession and attainment and that the stimulated production of the individual inevitably builds higher the aggregate of national possession." It is significant also that the relative national wealth of the United States against that of Great Britain is almost the exact relationship of the relative per capita horsepower: 4½ to 1. America possesses two thirds of the world's banking capital and heads the list in per capita ownership of prosperity-producing machinery. Contrast our machinery equipment of 24 dollars per person against, for example, that of Russia of one dollar per person.

Who Says Hard Boiled?

THE world of science will give a good round cheer when it learns that a public utility company has surrendered five thousand good hard round dollars for the sole purpose of enabling some archeologists to dig up areas behind a newly constructed dam, because these areas are believed to contain Indian artifacts and are about to be flooded. Louder cheers will be added when it is learned that the money was forthcoming without a struggle; in fact, it was voluntarily contributed.

The company in question is the Pennsylvania Water and Power Company, the dam is at Safe Harbor in that state, and the official recipient of the excavation fund is Mr. Frederick A. Godcharles, Curator of the State Library and Museum.

When supposedly "hard-boiled" money-making concerns do things of this kind, and especially when their stockholders permit such diversion of funds without promise of a cent's return, we think it signifies that things are looking up. Enlightenment is spreading, even to the pocketbook.

Business, in days gone by, may have been ruthless and savagely unjust; nevertheless it is the basis of a public and individual welfare unequaled anywhere in the world. Having outlived the ethics—or lack of them—of past days, American business now has many duties to perform. It must maintain its present high standards and must appraise the background of those forces that induce economic, political, and social changes; for they influence the markets of the world, therefore the wealth of the nation and, consequently, individual welfare. In short, business has responsibilities, the ramifications of which touch every phase of human endeavor, and it must, therefore, maintain public confidence by continued research and progress, service, and unimpeachable ethical standards.

Naval Conference Problems

AMID surroundings most appropriate for an epochal event, the London Naval Conference came to order; delegations from five great naval powers, assisted by the cordial welcome of King George and the British Government, quickly established a friendly atmosphere conducive to the solution of the various intricate problems confronting them. The leader of each delegation in turn indulged in optimistic generalities, made guarded reference to the naval needs of his state and truthful disclaimers of hostile intent. No new facts were developed or, by the initiated, were expected to be developed; the press of the world had been discussing for months the critical points confronting the delegates; and literally no new facts remained to be revealed.

It is well that these friendly formalities increased the understanding begun by the Hoover-MacDonald conferences on the Rapidan, for as soon as the delegations attempted to translate genial generalizations into concrete categories of ships, the carefully concealed but well known frictions exposed themselves to view. After our long struggle with Great Britain over the cruiser parity it will surprise most Americans to learn that Europe still suspects a secret Anglo-American understanding. Yet such is the persistent European suspicion.

After the conference opened, there was considerable maneuvering for position, similar to the preliminary moves often observed at our national presidential conventions. France seemed to have all the advantage at this stage, until Mr. Stimson stated the American position and Mr. MacDonald followed with the British reaction. Unfortunately the American and British statements appeared to confirm the European impression of an American-British understanding and irritated the French who still remember how they were isolated at the Washington Conference.

(*Please turn to page* 328)

Can the World Banish Malaria?

A Physician's Practical Plan to Rid the World of the Mosquito-Borne Disease; a Plan Which Nearly All Can Test

By THEO. KRYSTO, M. D.

Will You Take a Hand?

PROFESSOR DAVID STARR JORDAN, former head of Stanford University, famous naturalist, expert on mosquitoes in relation to malaria, and Corresponding Editor of this magazine, states that "Dr. Krysto's suggestions may prove of tremendous worth to the world. I think," he writes, "that you will be making no mistake in printing it." We hope to receive in Dr. Krysto's behalf communications from readers who may have noted the peculiar antipathy between the leguminous plants and the organism of malarial fever; also from any who may be led to try out this year the Krysto plan of elimination of the disease—*The Editor.*

I WISH to show the people a way to free themselves of malaria and of human blood sucking mosquitoes. I also want to show that this liberation could be effected easily, cheaply, and in a short time. This is the discovery of a sober physician, made 33 years ago, verified since by hundreds of cases in Europe, Asia, and both Americas, and confirmed by recent discoveries and observations of several authorities. To this I shall add another discovery made by a solid French scientist and confirmed by his conspicuous demonstrations—not in a laboratory but in real life.

Malarial fever is a dreadful, world-wide disease. If you look at the map in a medical geography, you will see that the whole space between 40 degrees north and 30 degrees south is flooded with malarial fever, with the exceptions of dry Australia, the dry western states of the United States, most of Arabia, and Egypt. In some localities almost the whole population is sick with the fever, like many places in Africa, Central and South America, Indo-China, the lowlands of India, and so on. There are in Africa many places where malarial fever kills in 48 hours if medical help does not come in time. Many of us remember a bold challenge of Ravanalona, queen of Madagascar, to the French Government: "I have very few soldiers, but my fevers will decimate your armies very efficiently!"

Millions are sick with malarial fever in acute form, millions are sick with the same fever in chronic form (paludism), and other millions are suffering from blood-sucking mosquitoes. All these sufferings are dispensable. The causes can—and must be—exterminated, eradicated. I know what malarial fever is, for I was sick with it during 19 years.

In fairy tales the treasures are often guarded by colossal genii, immense dragons, powerful goblins, but the treasures of the tropics are guarded by tiny fairies—mosquitoes. They are small, the smallest of them being almost invisible, but they perform their duty wonderfully well. They sting, annoy, and irritate; they poison with the germs of malarial fever, yellow fever, filariosis, elephantiasis, and what not.

The fight between men and mosquitoes is very old and until quite recently the mosquitoes were the conquerors. Some scientists are of the opinion that malarial fever—in other words, mosquitoes—greatly contributed to the downfall of the Roman Empire. At last the scales begin now to turn to man's side. Since the discovery of Sir Ronald Ross, in 1897–'98, that mosquitoes are the propagators of yellow fever and malarial fever, men have begun to fight them more energetically. The Americans have developed quite successful methods,

Courtesy of the United States Bureau of Entomology

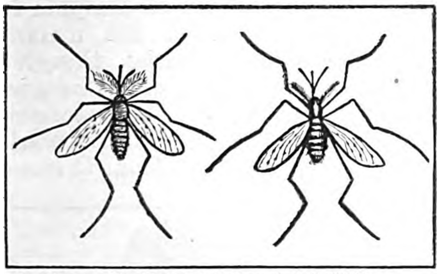
A MOSQUITO BREEDING POOL IN DALLAS, TEXAS

Oiling and draining have greatly reduced malaria, but the author of the accompanying article feels that the attempt thus to cope with malaria will prove impossible of general attainment which were demonstrated conspicuously at the Panama Canal and in cities of Ecuador and Brazil, the larger cities of the latter country being now almost completely free from mosquitoes and from the fevers.

UNFORTUNATELY these simple and effective measures can not be applied to rural conditions. The main reason for the impossibility is this: In the city every receptacle containing water can be inspected and protected from mosquitoes by wire nets, oil, emulsion, or fishes that eat mosquito larvae. In the country, especially during the rainy season, every small cavity and hole in the ground—imprints of the hoofs of animals, for example—contains water and serves as a breeding place for mosquitoes. Dr. L. O. Howard of the United States Bureau of Entomology relates the observations of W. E. Howorth in Tanganyika, Africa, that mosquitoes even breed high up in the crowns of cocoanut palms. He also cites several authors who observed breeding mosquitoes in tree holes, in cocoanut husks, in the hollows of bamboo stumps, and so on.

Thus it has so far been impossible to free rural localities from man infesting mosquitoes, and therefore from malaria. With the methods which I have the boldness to offer it should be possible.

When Sir Ronald Ross propounded a theory that malarial fever is propagated by mosquitoes, almost everyone laughed at him. Even General Gorgas laughed—the same Gorgas, who, afterward, having adopted the Ross theory, put it into practice with such success in Panama, making it possible to dig the Canal.



Drawings reproduced by permission from the 1929 Edition of the "*Encyclopedia Americana.*"

ANOPHELES

The *anopheles* mosquito carries malaria; when it alights its body slopes sharply

"The world requires," says Ross, "at least ten years to understand a new idea, however important or simple it may be. The mosquito theorem of malaria was at first ridiculed, and its application to the saving of human life treated with neglect, jealousy, and opposition."

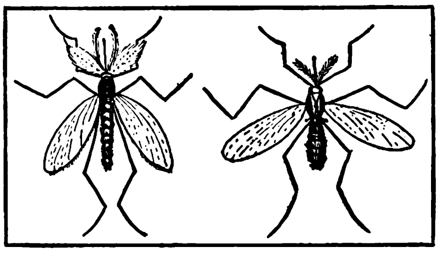
I offer a plan to free the world from malarial fever and from human blood sucking mosquitoes. It is possible that my plan will be also ridiculed. It is, however, so easy to put into practice, so certain to produce the desired results, that I am sure in less than ten years every planter and every farmer, even the least instructed, will make use of it. The use of this plan will assist the tropics in working out their inexhaustible riches.

Thirty-five years ago I lived in the village of Machindjauri, District of Batum, Caucasus, Russia. I noticed that out of 60 inhabitants of the village every one was sick with malarial fever, except four—Sahli Effendi, his wife, and their two children. Analysis of the conditions showed me that Sahli Effendi differed from the other inhabitants of the village only in this: he raised beans for sale in the market at Batum, and alfalfa for his horse. The beans and the alfalfa were grown around his house.

ANOTHER instance. One summer, when malarial fever was raging in Machindjauri, I moved my family to Kvishhety, near Suram, on the Transcaucasian Railroad. This village consists of two parts. The larger part is situated on the slope of a mountain. It is free from malarial fever. The smaller part is situated in the valley of the Kura River, and has a good deal of fever. One of the inhabitants of the lower part of this village, Misho Kipiani, sowed about six acres to alfalfa. As soon as the alfalfa grew up and began to bloom, malarial fever disappeared as if by magic!

These two cases were a point of departure in building my plan of attack. It is known that mosquitoes feed on the juice of plants; the males feed exclusively thus, and the females feed partly on the juice of plants and partly on the blood of animals and men. I found that when *Anopheles*, the malarial fever mosquito, feeds on leguminous plants, their juice neutralizes the noxiousness of the mosquito. It can no longer spread malarial fever. A locality known as the Marshes of Kará-Su (Black Water), near Tiflis, Caucasus, was uninhabitable on account of malarial fever. But the government performed some drainage, people began to come and to sow alfalfa, as alfalfa was in great demand on the Tiflis market, and malarial fever began to diminish. Local scientists and physicians ascribed this diminishing simply to the drainage and the clearing of the underbrush, but *Anopheles* still was present there as before. Many of the mosquitoes were, however, being neutralized by the juice of the alfalfa, and could not spread malaria.

When I was appointed Russian Government Agricultural Commissioner to the United States I had to travel a good deal. Incidental to my special agricultural work, I continued my observations pertaining to my belief. I spent one summer in the southern states, and here I found many facts that confirmed it. I am sorry to state that all my materials—notebooks, photographs, and so on, perished during the Russian revolution and my flight from the Bolsheviks, but I remember several facts like the following. In the midst of the marshes of Arkansas I found a little farm which belonged to an old man. He and his family were well, while all the people around were sick with malarial fever. The cause of this seeming immunity was clear. Beside a field of cotton he had, near his house, a field of alfalfa. His neighbors had only cotton fields.



CULEX

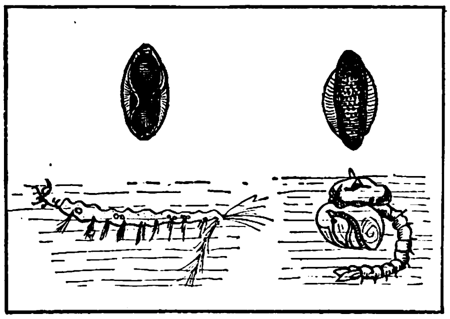
The common culex mosquito carries no malaria; its body rests horizontally

In 1911 I was sent by the Russian Government to Argentine to study some agricultural problems. I was greatly impressed with the remarkable extension of alfalfa growing in that country. Inquiries showed that as soon as alfalfa was sown in some malarial locality, the fever disappeared there at once. Just as in the Caucasus, the inhabitants of the localities explained the disappearance of malarial fever by the fact that these places were cleared. They were cleared, but the mosquitoes were present there as before, but now they were "sterilized" and could not inoculate human beings with the disease.

IN 1912 I was transferred from the Russian Government Agricultural Agency at St. Louis to the Department of Agriculture, Petrogad, Russia. In the summer of that year I was sent to Turkestan, Central Asia, to teach the farmers the California method of fruit drying. Here I also found innumerable facts in support of my discovery. Wherever there was alfalfa among the orchards and vineyards there was no fever; wherever there were only orchards and vineyards there was fever.

My good friend Mr. I. N. Klingen, former Principal Agriculturist of the Imperial Domains (Udély) in Russia, has communicated to me that by his order in the estates of the Grand Dukes, situated in the districts (*gubernii*) of Orel and Tambov, 60,000 acres were planted to red clover. Previously these localities had many cases of malarial fever, but as soon as clover grew up, malarial fever disappeared there completely. Clover, like alfalfa, is leguminous. Alfalfa, clover, beans—all these and numerous others belong to the leguminous family and have in common a substance called coumarine. "May coumarine play a rôle in the insects comparable to that which quinine plays in man," says the prominent Yale scientist d'Herelle.

The English edition (1924) of d'Herelle's book, "Immunity in Natural Infectious Disease," contains further confirmation of the theory. On page 187 the author says: "The greater portion of the Argentine Republic is completely free of malaria, in spite of the fact that the *anopheline* carriers abound in these regions where very frequently are to be found human carriers of the plasmodia, who have contracted the disease in the malarial districts."



ANOPHELES

Above: the eggs (top and bottom). Below: the larva or "wiggler;" at right, the pupa

Further, Dr. d'Herelle states, "We have seen that in all of the free regions there is a wild plant . . . called by the natives *'trebol de olor'* (scented clover), belonging to the genus *Melilotus*, probably a local variety of *Melilotus altissima.*

"FLOWERING takes place during the critical period of malaria, that is, from the beginning of summer to the end of autumn. The highly scented blossoms are continually frequented by insects of many kinds, and particularly by *Anophelines*, which feed upon the juice which, like all plants of the genus, contains a glucoside, coumarine. This plant is not present in malarial districts."

On page 188 we read this: "Recently, while living in Holland, I have sought the cause of the disappearance of malaria, as has been noted for about 20 years, from certain islands of Zealand and from northern provinces of Holland. In these two regions the disappearance of malaria coincided with the accidental introduction of plants of the genus *Melilotus* . . . Malaria has, on the contrary, continued to ravage certain of the Zealand islands where . . . the *Melilotus* has not been introduced."

I was equally much pleased to find in the *Literary Digest*, Volume 98, Number 4, page 17, the following abstract from the pamphlets of Sir William Willcocks, engineer of Cairo, Egypt: "Cultivated Egypt is mainly immune from malaria, and cultivated Egypt means Egypt with all its wealth of clovers, leguminous plants, wild melilotus, and trigonella. But where tracts of Egypt have been planted with fruits or other crops instead of clover, there malaria devastates the population as it does in Palestine and Greece, where there are few leguminous crops and in those parts of India where *gram*, a kind of chick-pea, is not cultivated."

You see that all three of us came independently to the same conclusion. And all three of us have traveled widely so that we could observe the confirmations of the theory in different localities of Europe, Asia, Africa, and America.

All this gives me a support to an affirmation that my theory could be applied *consciously* in any malarial locality, as it was applied *unconsciously* in the localities mentioned above. We can introduce leguminous plants, with the intention of disinfecting *Anopheles*, the malarial mosquito, either as fodder, as manure, or as decoration. Some of these leguminous plants are flowers and some are large, shady trees, but all of them have, as is well known, the property of gathering nitrogen from the air by means of the nodules on the ends of their roots.

THIS is the first part of my plan. The second part consists of replacing mosquitoes which suck the blood of human beings by mosquitoes which suck the blood only of animals.

In the *Comptes Rendus de l'Academie des Sciences*, Paris, France, for the year 1924, 1927*, and 1929, there are some very interesting articles by a French naturalist, J. Legendre. As he states, there are some mosquitoes that do not sting men. There are also some mosquitoes whose larvae eat the larvae of another mosquito, and in this way exterminate them from a given locality. M. Legendre has discovered in Brittany a mosquito—he calls it *Breton culex*—which crowds out another breed of *Culex* mosquitoes, and at the same time does not sting men but only animals.

In July 1923, M. Legendre transported eggs and larvae of *Breton culex* from the place of its habitation to Pons, where swarms of *Culex pipiens* and *Culex hortensis* annoyed the people. In the summer of 1924 M. Legendre did not find these mosquitoes there. They were replaced by *Breton culex.* These mosquitoes, hatched in proximity to the habitations, did not sting children or adults but only chickens and probably wild birds. M. Legendre continued his observations in 1928, and found out that *Breton culex* had held its own, and continued to be "man-hating" in the new locality.

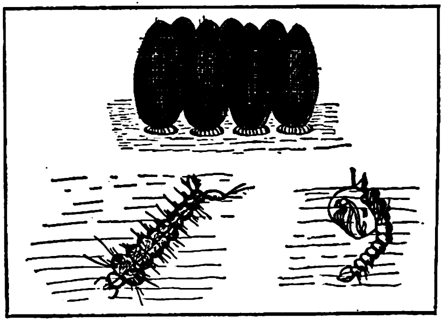
A proprietor of a farm near Pons asked M. Legendre to free him from annoying mosquitoes. M. Legendre introduced his *Breton culex,* and in one month they crowded out the aboriginal mosquitoes.

M. Legendre also discovered in several localities in France a variety of *Anopheles maculipennis* mosquito which does not sting men. Curiously enough, these mosquitoes and *Breton culex* live together in some localities as good neighbors, having no tendency to crowd one another out. M. Legendre thinks it would be well to introduce both of these races into localities where there are malarial fever and human blood sucking mosquitoes.

While the first part of the proposed method—the use of leguminous plants—is a novelty, the second part is a new departure from the ordinary use of insects to fight other insects which are injurious; lady birds against aphis and scales, for example. These natural methods are mostly far superior and preferable to artificial ones, and, especially, far less expensive. But the use of oil and emulsions in rural conditions is inadequate.

So, let us take leguminous plants and friendly mosquitoes and start our work of liberation. We may start our work on the island of Cuba. I choose it for many reasons, the main one having to do with the acclimatization of the mosquitoes themselves. Insects, like plants and animals, must be acclimatized gradually, step by step. Cuba could be followed by Paraguay, Brazil, and Central America.

I have outlined, rather briefly it is true, the salient parts of the plan for ridding the world of the malarial fever mosquito *Anopheles*, though I have not here touched on its humanitarian aspects or indeed on its economic aspects. It might be said that malarial fever costs the world millions in loss of productivity alone, but a definite estimate would force us to talk in terms not merely of millions but of billions.



CULEX

Above are the eggs of the *culex*, laid in masses, and below are the larva and pupa

I hope that among 120,000,000 Americans there will be found one who can lend a helping hand to this enterprise.

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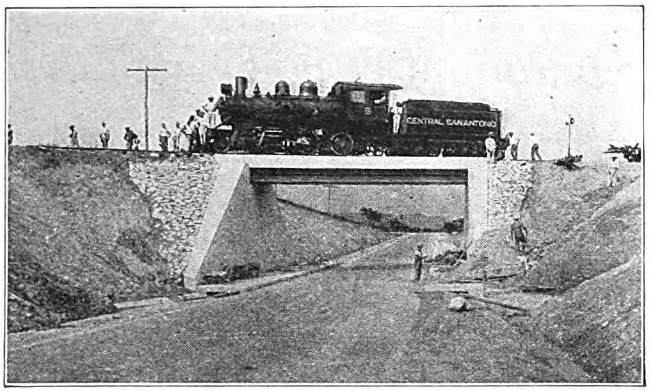
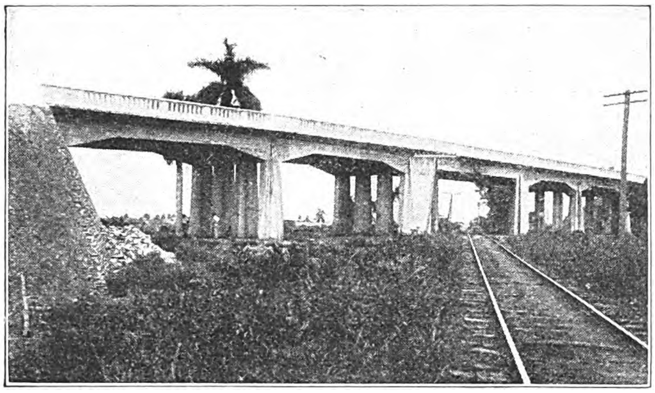
*The article of 1927 was abstracted in the *Literary Digest* for March 31, 1928.



THE NEW HIGHWAY AT AN UNDERPASS

The sub-grade is surmounted by 12 inches of heavy rock, then a layer of concrete from six to nine inches in depth. This is topped by a two-inch bitulithic covering of special composition



ONE OF THE 25 OVERPASSES

Outside the towns, the highway is about 20 feet in width with a 5.64 foot shoulder on either side. In towns the width is about 26 feet. Note the massive construction for withstanding storms

Cuba Builds a Model Highway

Work Is Progressing on This 700-Mile Highway, in Which All Grade Crossings Are Eliminated

By HAMILTON M. WRIGHT

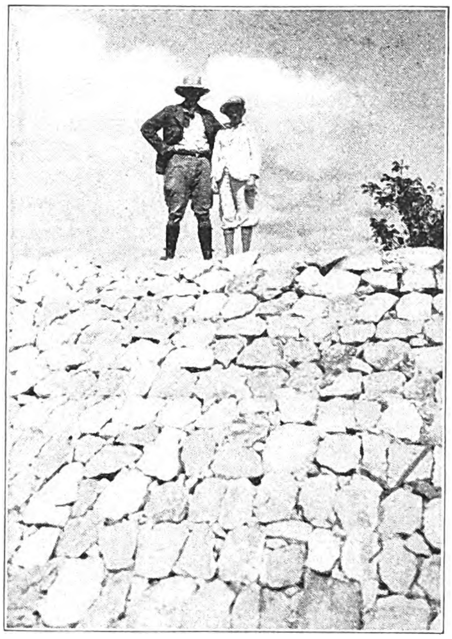
CONSTRUCTION on the 700-mile Cuban Central Highway is now 59 percent completed, according to W. C. McDonald, manager of the Cuban operations for Warren Brothers Company, of Boston, which is constructing 500 miles of the road. The remaining 200 miles, in the Matanzas and Santa Clara provinces, are being constructed by the Associated Cuban Contractors, Inc.

One of the outstanding features of this arterial highway is that there will be no intersections with railroads. It is believed to be the only great national highway on which grade crossings have been eliminated entirely. In seven instances, the highway passes beneath the railway tracks, and in 25 it crosses above them.

There are no grades exceeding 5 percent, and no turns with more than 4 percent curvature. A large number of costly fills and cuts have been necessary to maintain a direct route in the rugged country traversed. The total cost of the road was originally estimated at 75,680,000 dollars, but extensions since authorized have raised the cost to approximately 100 million. Already about 60 million dollars has been expended.

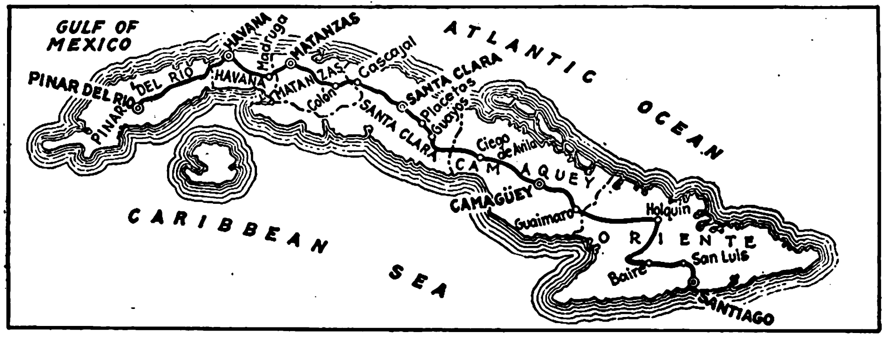
Approximately 11,000 men are employed in the winter season, when the work is not hampered by torrential rains. Of these, about 8000 are employed by Warren Brothers Company. This firm has introduced about 2,500,000 dollars worth of road-making equipment.

At present it is possible to ride about 75 miles east or west of Havana on the new highway. It is expected that the road from Havana to the city of Pinar del Rio will be opened on May 20th, the 28th anniversary of the establishment of the Cuban Republic. It will also be open from Havana to Santa Clara by that time, according to expectations. In the summer of 1930, the road is scheduled to be open from Havana to Camaguey. Mountainous sections of the road in Oriente Province have been completed, but the final opening of the road to Santiago de Cuba will probably occur late in the spring of 1931.



FLOOD PROTECTION >

This Tilford rock fill at Madruga passes over a valley which often is flooded



CUBA'S NEW HUNDRED MILLION DOLLAR HIGHWAY

This great highway follows the "backbone" of the island nearly from end to end. It will provide an outlet for 185 sugar plantations, and passes through country noted for its magnificent tropical scenery. American motorists will reach Cuba by ferry-boat from Key West

The Two April Eclipses

Astronomers Will Make Full Preparation, Even Though the Coming Solar Eclipse Will Last Only Two Seconds

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

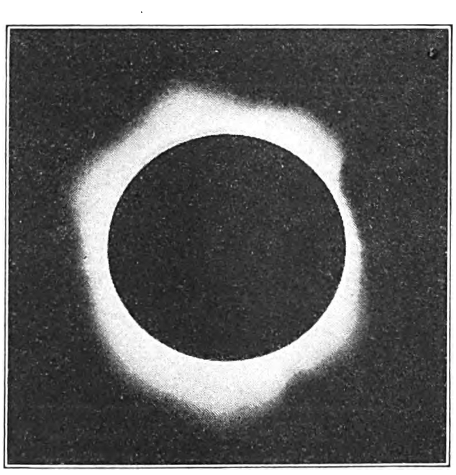
THE month of April is notable for the occurrence of two eclipses, one on the 12th-13th and one on the 28th, both of which are visible throughout the whole extent of the United States. The first is a partial eclipse of the moon which happens on the night of the 12th and early morning of the 13th. At this time the moon passes far to the north of the center of the earth's shadow, so that only one ninth of her diameter is immersed in it, even at the greatest phase. Were her track only 250 miles higher above the plane of the ecliptic she would escape eclipse altogether.

The moon enters the penumbra of the earth's shadow at 10:43 P.M., Eastern Standard Time. At this moment an observer at the proper point of the moon's surface, on what looks to us as her southeastern edge, would see the earth just begin to trespass on the sun's disk and cut a small notch in it. The terrestrial observer watching the moon will notice nothing at all, for at this first moment the brightness of the sunlight which illuminates the moon will be decreased by only an infinitesimal amount. Half an hour or so later, when the earth has hidden a considerable part of the sun from our hypothetical lunar observer, the gazer from the earth may notice that the southeastern side of the moon is not as bright as the rest, and before midnight this change will be conspicuous.

FINALLY, at 12:21 A.M. on the 13th, the moon's edge reaches the true shadow or umbra. For a lunar observer at this point the sun would disappear behind the earth, while the terrestrial watcher will see the dark shadow beginning to cut a notch in the moon's limb. To the naked eye the edge of the shadow seems sharp, but a field glass, and much more a telescope, will show that it is hazy and indefinite. This is natural since it is the shadow of the earth's atmosphere and not of its solid surface.

On the present occasion when only a small part of the moon's edge is shadowed, the obscured portion will be almost invisible, but this is mainly an effect of contrast with the bright part of the disk. In eclipses of greater magnitude, and especially in total eclipses, the whole body of the moon remains visible, illuminated faintly by light which has been reflected by the earth's atmosphere—just as a concave lens bends light inward. Our imaginary lunarian would at this time see the earth rimmed by a narrow but brilliant line of light, brightest at the point on the edge which was nearest to the hidden sun, tinged with the colors of the sunset, interrupted here and there by gaps where clouds impeded the free passage of the rays. Little of this will, however, be visible at the present time.

ECLIPSE RECORD-HOLDER
Professor J. A. Miller, Swarthmore astronomer, has never lost an eclipse because of cloudy skies. Nine times he has journeyed to witness total eclipses—nine times been rewarded. Other astronomers, joking, perhaps envious, accuse him of having a "pull" with the weather



ECLIPSE OF 1929
Taken with the Navy's telescope camera, Philippines, May 9, 1929. Furnished by Theodore Michelson, one of our readers

At 12:58 A.M. the eclipse area reaches its maximum and at 1:36 the shadow withdraws. The moon is not out of the penumbra until 3:15 A.M. but the last stages of its exit, like the first of its approach, will be imperceptible.

Of much greater interest and importance is the solar eclipse of April 28th. This is described in the *Nautical Almanac* as a "central" eclipse, since it is total at some points along the shadow track, and annular in others and can not therefore be called by either name.

It may be remembered that when the moon is nearest the earth her shadow extends beyond us. When it strikes the earth's surface it forms a small dark spot, never more than about 160 miles in diameter, from which all sunlight is excluded (Figure 1). An earthly observer anywhere within this region will see at the given moment the moon completely hiding the sun and outlined black against the corona.

BUT if the moon is farther off than the average her shadow tapers to a point before it reaches the earth, and there is no point on the earth's surface from which all sunlight is cut off. An observer right in line with the moon and sun will see the former centered exactly on the latter but exhibiting a smaller disk, so that a narrow bright ring of the sun sticks out all around and produces an annular eclipse. (Figure 2).

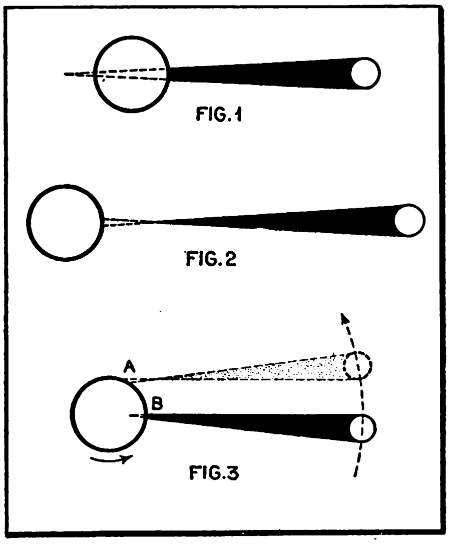
Once in a while, however, the moon's distance may be intermediate, so that the point of the shadow falls short of the earth's center but is nevertheless able to reach its surface which is almost 4000 miles nearer. In such a case an observer on the central line near the ends of the shadow track (A in Figure 3) will see an annular eclipse, while for one at B, near the middle of the path, it will be total. This is what happens on the 28th. The tip of the shadow cone reaches at most only about 70 miles beyond the earth's surface, so that the eclipse is annular over most of its course but total for a small part in the middle.

Starting far out in the Pacific the line of central eclipse passes some 500 miles south of Hawaii. The eclipse becomes total shortly before its track reaches the Californian coast which it attains at a point about ten miles north of San Francisco. Its motion here is almost due northeast and takes it diagonally across northern California, northwestern Nevada, the southeastern corner of Oregon and through Idaho and Montana into Canada. Shortly after crossing into Montana the eclipse loses its total character and the annular phase is visible along the rest of the track which crosses Hudson Bay and Labrador and leaves the earth in the Atlantic south of Iceland and west of Ireland.

A partial eclipse can be seen in a wide belt on each side of the central line extending northward to Alaska, Siberia, Greenland, and the Pole, southward to Yucatan and Cuba and eastward to Scotland and Ireland where the sun sets eclipsed.

THE magnitude of the greatest eclipse is of course more than 99 percent at San Francisco and is more than 80 percent along the whole Pacific Coast from Seattle to San Diego. Chicago sees a maximum eclipse of 64 percent, New York 54 percent, New Orleans 30 percent, and southern Florida only half as much.

The total phase is longest in Nevada, but even there it lasts only a second and a half. The moon's shadow has tapered to a diameter of less than three quarters of a mile at a point where it reaches the earth, and this goes by very quickly. For the same reason the eclipse track is so narrow that great care will be necessary in picking out observing stations. In spite of this almost absurdly short duration the eclipse is likely to be well observed.



ECLIPSE OF APRIL 28

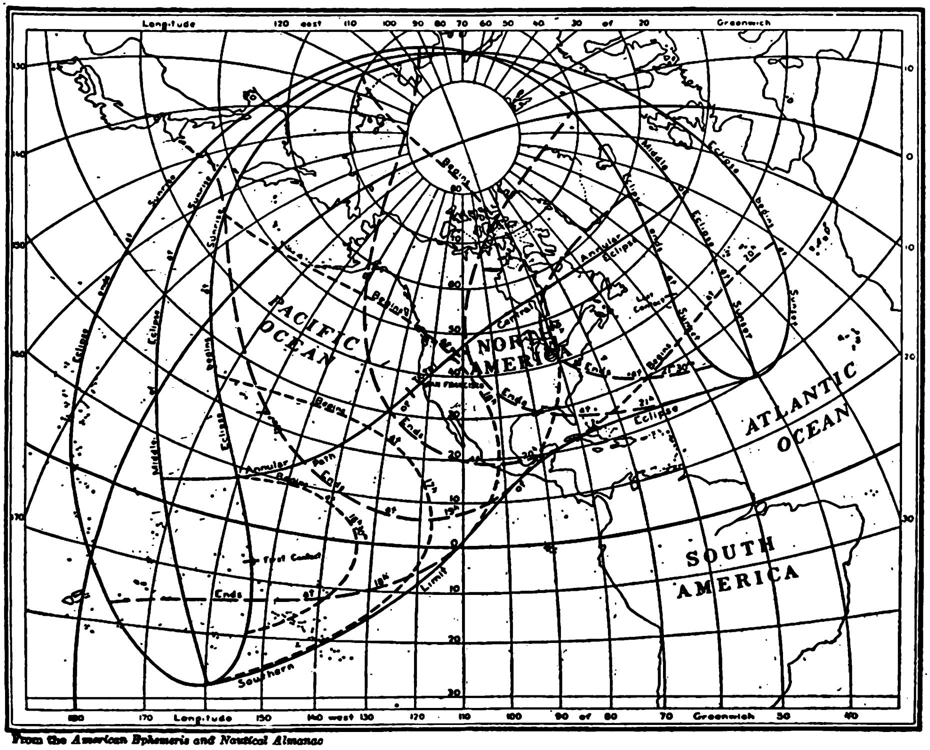
Figure 1 illustrates a common total eclipse, *Figure 2* an annular eclipse, and *Figure 3* peculiar conditions on April 28

Its track leads through a readily accessible country, near noon, when the sun is high, and it comes at a season when the chance of fair weather, especially in the Nevada deserts, is very good.

It may appear remarkable that anyone should go to the expense of a journey across the Sierras to spend less than two seconds in observation, but there are some problems for the study of which this eclipse is distinctly favorable.

At the moment of totality only the actual photosphere of the sun will be hidden—indeed it may even peep out here and there through the gaps between the lunar mountains. All the overlying layers of the sun's atmosphere will be fully visible, and spectroscopic observations taken with automatic photographic devices during the critical seconds may give data of much interest and importance.

Another problem which may well be attacked is that of the light of the part of the sun's disk close to its edge. It is well known that the limb of the sun is not nearly as bright as the center. To follow the fall of brightness up to within 1 or 2 percent of the distance from the center to the edge is not difficult, but in the last 2 percent of the distance the brightness falls off very rapidly and all sorts of complications arise when measures are attempted with a full sun. Scattered light in the instruments, and the trembling of the image due to "bad seeing," make the observations very troublesome. But, when the moon eclipses the sun, all that needs to be done is to measure the brightness of the remaining sunlight during the partial phases, and the problem is then one which the mathematician can easily solve. At the present eclipse the sun's light will fall off very fast indeed during the last few seconds before totality, and come back again with equal rapidity. Some automatic registering device, doubtless photographic, would have to be employed. If one is available we may learn much more than we know now about the brightness of the sun's edge; and this knowledge will be of much importance in testing the theories which are rapidly growing up regarding the sun's surface.



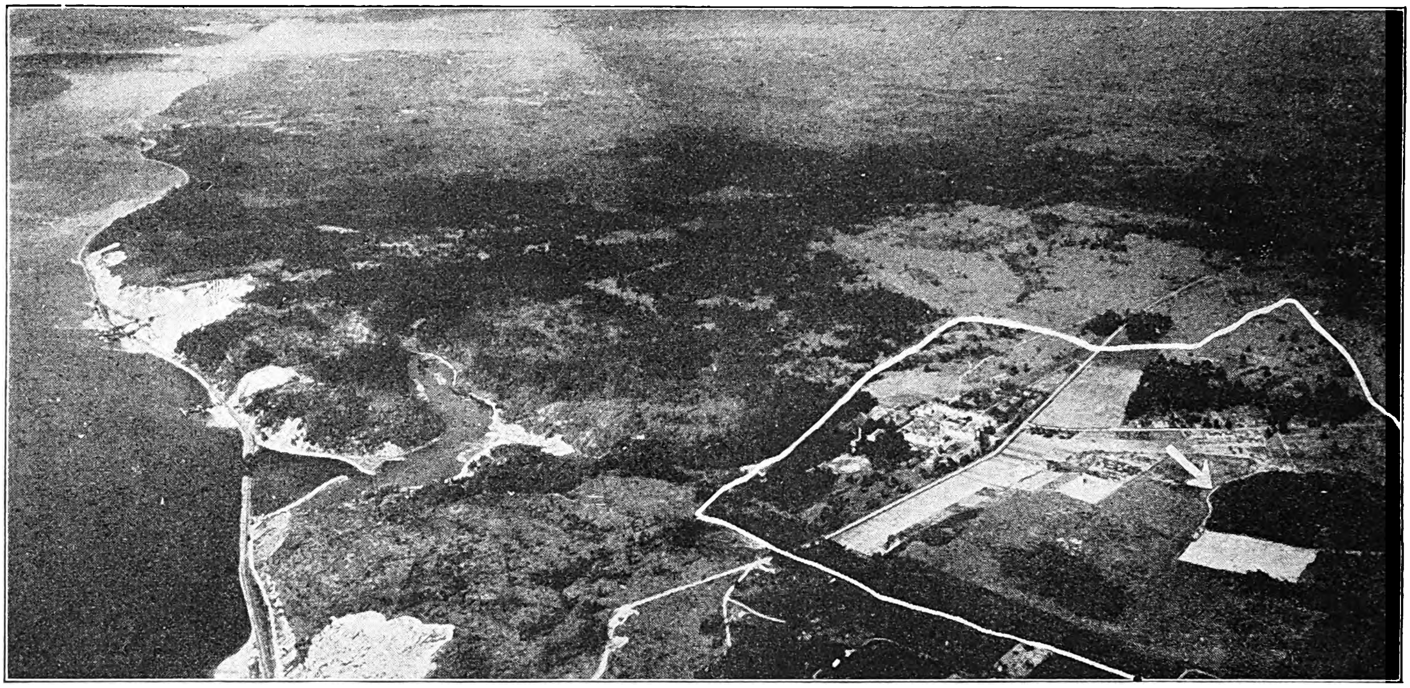
From the American Ephemeris and Nautical Almanac

DATA OR "ELEMENTS" OF THE SOLAR ECLIPSE OF APRIL 28

The center line of the eclipse extends diagonally from lower left toward upper right. The other elements may be studied out from the drawing itself, by the especially interested reader

SO much for the professional observer. But will it pay the sightseer to go out of his way to look at this eclipse? Most assuredly. There will be time for only a fleeting glimpse of the corona. Indeed there may be so much light in the sky as to drown out all but the inner portions of it. But the advance of the shadow, coming like a narrow beam of blackness from the southwest, should be spectacular. At the crowning instant when it passes over in a "flash of blackness" the sun may appear as a ring of dazzling points of light interrupted by the mountains along the moon's edge. Something of this sort was seen at the last similar central eclipse, the track of which passed near Paris a year or two before the war. We may trust Californians not to miss the sight when they have the chance.

The location of the track along which this phenomenon was visible should fix with great precision the line of central eclipse, and this again will give precious information to the theoretical worker. All told, the eclipse will abundantly repay both the observer and the sightseer, and it is to be hoped that it will be well watched.—*Rome, Italy, December, 1929.*



SITE OF THE EXPERIMENT IN RECLAMATION-FERTILIZATION

The irregular area outlined in white in the lower right hand corner is the Western Washington Hospital grounds. The arrow points to the small lake, the bed of which was covered with a heavy vegetable humus. Tacoma is in the haze of the background

Land Reclamation By Silting

Natural Humus Is Pumped, in Suspension, From Lake Bed Onto Gravelly Soil, Resulting in Extraordinary Fertilization

By CHARLES F. A. MANN

A UNIQUE and one of the most successful of the many reclamation schemes in use on the arid lands of the west was originated by Dr. Charles E. Taylor, superintendent of the Western Washington Hospital, located near Tacoma, Washington, on the farm lands of the institution.

This hospital, the largest operated by the State, was established shortly after Washington was admitted into the Union. Because of its proximity to the densely populated area bordering on Puget Sound, this location was chosen despite the fact that the entire area is part of an immense glacial moraine, left by a mighty glacier that at one time swept southwesterly down the slopes of Mt. Ranier-Tacoma and emptied its icebergs into the deep waters of Puget Sound. Cultivation of crops on the loose sandy soil of this area has long been a hopeless task, requiring excessive application of black dirt and water to form a soil that would nourish plants as well as hold moisture.

Some idea of this peculiar formation may be gained by consideration of the fact that one of the world's largest gravel pits is operated at tidewater, just two miles below the hospital, which is at an elevation of about 400 feet. Test borings indicate that this glacial deposit, on which part of the city of Tacoma, as well as the institution, is situated, is from 300 to 900 feet deep and of unusually uniform size. The sand is nearly all of white quartz-silica composition.

UPON assuming charge of the institution several years ago, Dr. Taylor at once set about to discover means to improve the general productiveness of the 700-acre farm operated by patients of the institution, from which a major portion of its food supply is derived. For years the institution had taken many prizes from its displays at local agricultural fairs, but these prize crops were all grown by a patient in his small garden situated near the shores of Waughop Lake, from whence comes the irrigation water supply used during summer months. Dr. Taylor found that this man was mixing his garden soil with a blackish pasty substance which he dug from the shores of the lake when excessive pumping had lowered its surface during summer months.

Tests of the composition on this deposit showed it to be a pure vegetable mold, of bluish green color, that had been accumulating for centuries on the bottom of the lake. Since its decay had taken place under water, practically all of its mineral content had been retained. It is of almost powdery fineness, a small quantity shaken with water requiring over 30 hours to settle out. In its lower strata it took the formation of a thick vegetable jelly. Tests with iron piping driven into the bottom showed the deposit to be nearly 200 feet thick.

Tracing the course of the glacial moraine, scientists have found it to be about 24 miles wide at its widest part, running inland into the rocky foothills of Mt. Ranier-Tacoma for a distance of about 45 miles. The sudden termination of the deposit in these foothills is explained by the fact that the 14,408-foot volcanic cone was at one time about 3000 feet higher; a gigantic explosion, which must have made the explosion of Krakatoa in Java Strait in modern times a puny affair, scattered the entire top and its masses of ice over a very wide area. Because of the heavy precipitation on the mountain and the higher altitude of the older cone, the ice-pack was forced clear to tidewater, carrying its burden of pulverized rock and sand with it. At the present time many small lakes are scattered over its surface, yet only in very recent times have scrub oak and the persistent Douglas Fir with its flat, fan-like root structure, gained a foothold on the loose sandy soil.

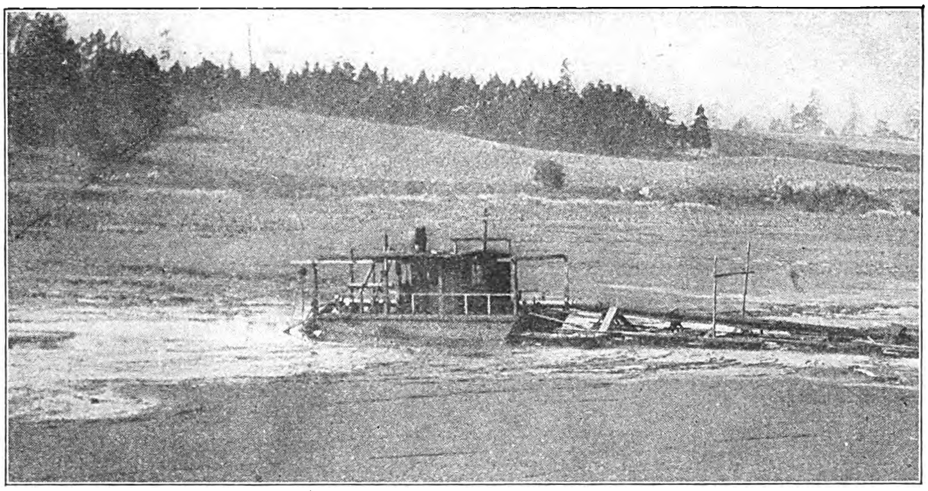
Traces of the one-time glacier have manifested themselves in freakish ways throughout the area. In the northern part of Thurston County there is an area of ground covered with peculiar mounds of gravel. On the soil of these mounds, for the presence of which no explanation can be made, only buttercups and coarse grass grow for a short while each spring, although on the heavy clay of Tacoma nearby, plant growth is luxuriant the year 'round.

After careful study, Dr. Taylor found that many of the lakes over this section had similar deposits of the soft mold, which accounted for water remaining on the sandy soil. It is commonly believed by people living on the shores of these lakes that any attempt to drain the lakes in order to remove snags and stumps will break this seal and ruin the property. Real-estate developers are always poetic about describing the virtues and picturesqueness of the snags and stumps, so the lakes are never drained for cleaning.

If small-scale use of this deposit as fertilizer and binder was successful, why not use it on a large scale and test its merits on a public farm? Thus would be proved for the small farmer the possibility of using land that is not worth over 25 dollars per acre for crops in its present state. Dr. Taylor also wondered whether the lake, which is about 30 acres in extent, was not fed by springs instead of merely being a drainage pocket for rainwater. Accordingly, plans were made for placing the irrigation pump on a barge near the center of the lake.

Early in 1927 the pump was started, delivering 300 gallons per minute, and by autumn the lake was dry. The object was to expose the mud until it was hard enough to shovel out onto trucks. When the bottom was exposed it was discovered that three springs with an inflow of about 150 gallons per minute kept the bottom stirred up and continually wet. Tests of the fresh mud rising to the surface showed that it was fine enough to be pumped through the entire irrigation system, even through sprinklers with quarter-inch nozzles!

With one stroke it was possible to eliminate expensive hauling of the heavy black dirt from the valleys below and to irrigate the land and spread the mud which both sealed the loose sandy formation and fertilized it at the same time—all in one operation. The swiftly revolving blades of the centrifugal pump, which was driven by a 12-horsepower motor, using current costing nine cents per hour, helped to mash the small lumps of the blue ooze. Soon the material was pouring over the fields through sprinklers and irrigation ditches at the rate of 150 gallons per minute. It had the consistency of thick pea soup. The water soon filtered into the sand, leaving the fresh humus to mix with the topsoil. Steady flow of the springs during the year made it possible to spread a four-inch deposit on the entire farm. Dr. Taylor points out that there is still no explanation for the existence of vegetable matter in the lake unless it was caused by the constant drifting of grass and leaves which dropped into the three-sided pocket.

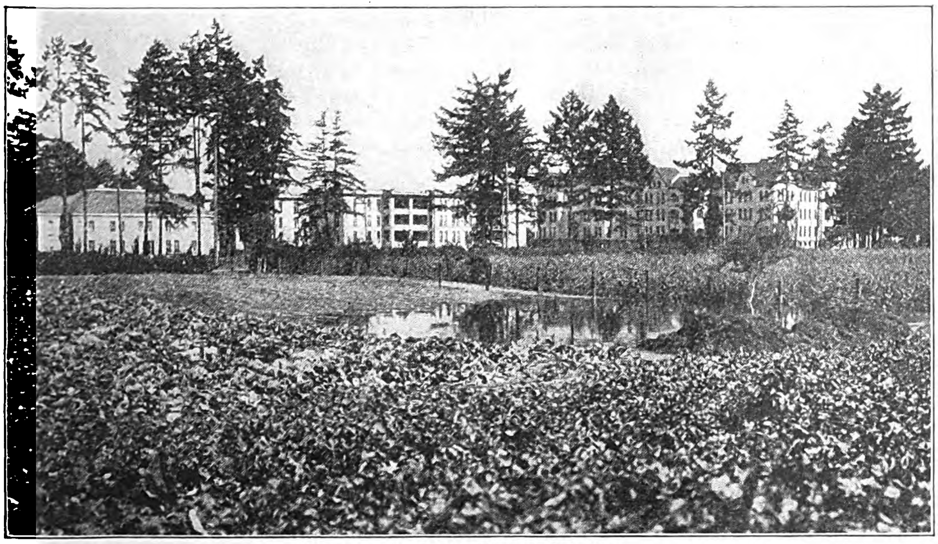


PUMPING THE FERTILIZING MUCK

When the lake was drained, it was found that the bed did not dry out because of several springs. This pumping station was installed to pump the humus-filled water over the land

To the astonishment of agriculturists at the Western Washington station in Puyallup, three crops of alfalfa were grown on a field during 1928. Puget Sound climate was supposed to be bad for this crop, with most of its growing centered in the volcanic ash soils of eastern Washington. Cabbage was grown where even fir trees previously had a hard struggle. Celery grew three feet high last year, on soil that formerly would not support plain grass. In 1927, 13 acres devoted to corn yielded 148 tons. In 1928, over 200 tons came from the same patch. Costs for fertilizer and soil hauling were cut to a quarter those of former years, and with increased yields. Rutabaga turnips for stock feeding reached 10 to 16 pounds in size.

The success of Dr. Taylor's experiment has attracted wide attention throughout the northwest and it is believed that further projects will be undertaken to utilize the properties of this vegetable mold that is so widely deposited in western mountain and hillside lakes. Costs are limited to pump, power, and labor for digging ditches or running pipelines. Countless thousands of level prairies that are adjacent to lake deposits such as this, are scattered over the west. Application of water alone to these areas would be without result, but the practicability of obtaining this vegetable humus from these natural storehouses and supplying it to the soil, would open up an entirely new field for application of the principles of reclamation on a restorative scale.



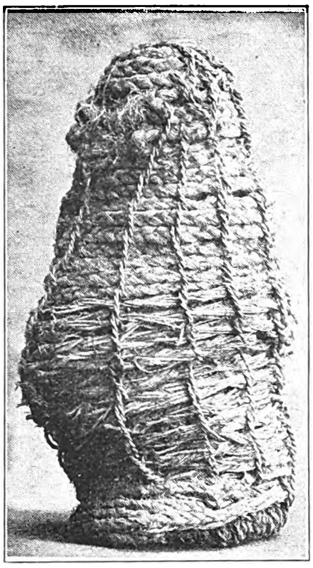
THE SPLENDID RESULTS

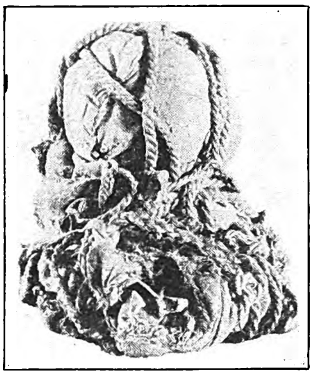
In the foreground is a fine growth of cabbage on sandy soil that, previously, was practically worthless. The firs were planted 40 years ago and won't grow higher due to sandy soil

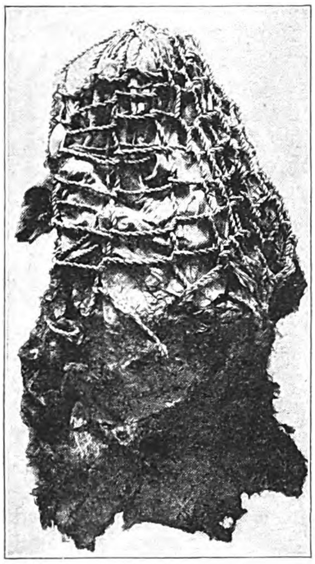
What Mummies Reveal

X-ray Studies of Peruvian Mummies Show Us the Injuries and Diseases From Which the Ancient Civilized Indians Suffered

By ROY L. MOODIE, Ph.D.*
One-time Anatomist, College of Medicine, University of Illinois





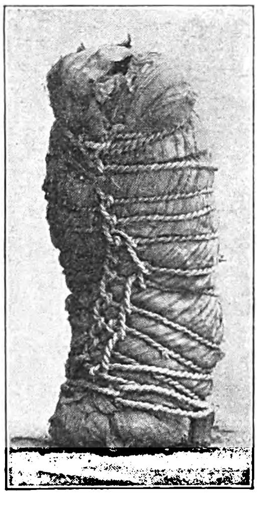


AMERICAN mummies have never received the attention accorded those from Egypt. They are neither so ancient nor so numerous as those found along the Nile, nor did mummification in the Western Hemisphere have such an important influence on the daily life of the people as it did in the land of the pyramids for thousands of years. During that period the elaborate embalming processes and the preparation and care of the tomb developed into a widespread industry which furnished employment for a considerable part of the population, including many of high professional training.

Mummies of one kind or another are known from isolated areas throughout that vast stretch of territory extending from Alaska to Patagonia, but are confined largely to the Pacific Coast. Nowhere in this area, however, did the preparation of human mummies attain the height it did in Egypt. There all of the sacred animals were also embalmed. This provides us with quite an insight into that country's vertebrate fauna. No animal mummies were prepared in the Americas.

THE nearest approach to the Egyptian mummification of the human dead was that which developed within the boundaries of pre-Columbian Peru, the empire of the royal Incas, where for hundreds of years great care was shown in the preparation of the dead. Recent studies of the ancient Peruvian mummies by the microscope, by the X ray, by the study of the dry bones of disrupted mummy-packs and by a search into their surroundings, have revealed a great deal of interesting information regarding the life of those times when the mummified bodies were the actors of life's drama.

It is said by early writers that great care was exercised in the preparation of the dead of the Inca household and that the mummies were brought out on feast days to share in the favor of their superior beings. Yet not one single royal mummy from ancient Peru is known today. This is in the greatest contrast to the royal mummies of Egypt. A large folio catalog is required to contain the descriptions of those preserved in the Cario Museum.



MUMMY PACKS

The packs served as coffins, there being no further protective covering. The one at the top, 33 inches long, is of plaited straw

Little is known about the preparation of mummies in pre-Columbian Peru. We are pretty sure that the body was never opened for this purpose, as it commonly was in Egypt, yet there were skillful surgeons in Peru. Embalming materials, such as resins, astringents, gums, and so on, were known in early Peru, but we are not sure whether they were used. Sun-drying was probably the most common method.

The greatest care was often exercised in the preparation of the mummy wrappings. Often, on the other hand, this was carelessly and heedlessly done. The sarcophagus and the coffin were unknown, nor were the tombs so elaborate as in Egypt. Many of the Peruvian mummies, after careful wrapping, were buried in the sands of the desert, or placed in fissures, in shallow recesses, or in deep caverns. Nowhere in Peru was a tomb chiselled from the rocks, although they did employ certain pyramid-like structures built of mud bricks.

THE wrappings, of beautifully woven and decorated cloth, of dressed skins, feather blankets, or of coarsely woven materials and even of native grasses, do not display the complicated arrangements and writings of Egypt, nor do these materials ever indicate foreign trade. But they do connote some degree of commerce between the coastal and mountainous regions of ancient Peruvian times. The colors of bird feathers such as those of the flamingo and of the macaws are perfectly retained after resting for a period of many centuries in the desert sands.

The mummy packs of Peru are unlike those of any other area. Often the huge bundle, gorgeously decorated and elaborately equipped, shows a false head, with features indicated by plaques of silver or other materials sewn on the face of the false head. One, two, or three bodies may be enclosed in the same bundle. Sometimes the X ray shows the mummy upside down in the pack. A pre-Columbian pack in Field Museum at Chicago contains father, mother, and child. Raw cotton, abundantly grown in prehistoric Peru, was used in quantities in the wrappings of the bodies. The greatest variety of appearances in the mummy-packs is found in different areas. A few of them are shown here.

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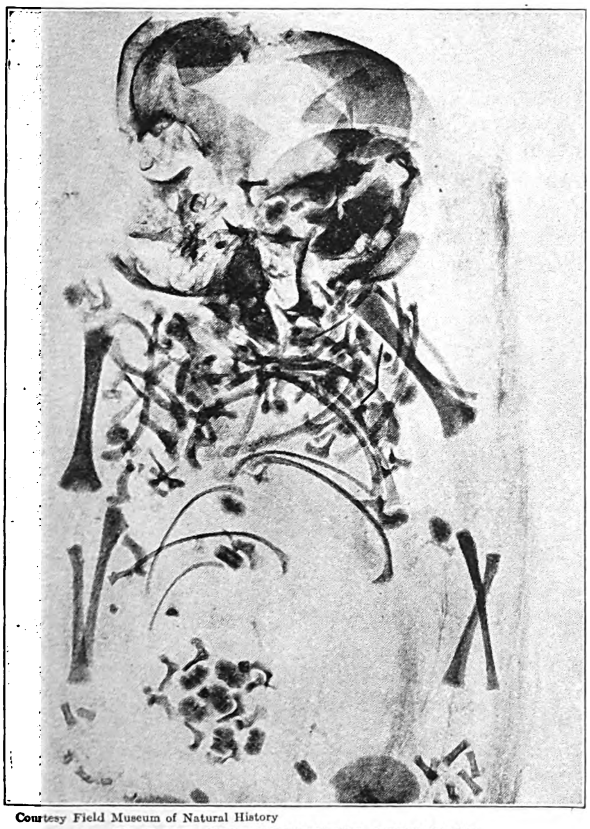
*See "Among Our Contributors," page 261.

The medical interest attached to the nature of these ancient mummies is very great. The X ray shows wide ranges of the diseases and injuries to the bones. The microscope supplements these findings by showing minute alterations in the walls of blood vessels, common to the hardening of the arteries. Diseases of the teeth are likewise revealed, and the evidence shows the ancient Peruvians to have been sufferers from many chronic ailments. A few of the mummies show trephinings of the head, a surgical procedure at which the pre-Columbian Peruvians were adept. It is a matter of surprise to learn how infrequently trephinings are found in the heads preserved in the mummy packs. This leads us to the query as to why trephining was so common in Peru.

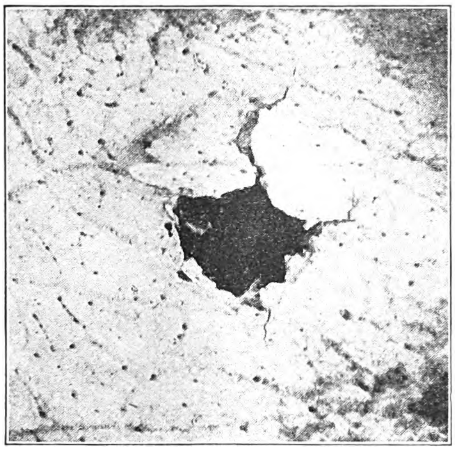
The relief of pain due to depressed fractures of the cranium, following sling-shot injuries, was doubtless the greatest single cause of trephining, though of course there were other causes. The sling shot was the one most important single weapon of war. The slings were beautifully woven of wool, and were decorated. Hence they served also as an ornament to be wrapped around the head when not in use. The distance and accuracy with which rounded pebbles could be thrown is amazing. Since such injuries as depressed fractures were received more often by soldiers, it is thought that trephinings were done as a military measure to conserve the man power of the state.


Courtesy Field Museum of Natural History

X RAY OF INFANT'S MUMMY

Usually in infant mummy packs the bones are greatly disarranged. The wrappings show in faint strands

The number of infant and youthful mummies is appalling. These often had received the briefest care, as shown in an accompanying figure. While our study of pre-Columbian pediatrics in Peru, as shown by the X ray, is still incomplete, yet it has gone sufficiently far to give us a fair cross-section of such maladies whose evidences would be visible in the skeleton, had they been present. Such a cross-section reveals an astonishing paucity of infantile troubles, showing a much greater degree of health than a similar cross-section of our own infant population would show. Rickets is surprisingly absent. Not a trace of it can be found. It is, of course, evident in these individuals that death was due to some digestive, febrile or other factor of neglect, having no effect on the skeleton.

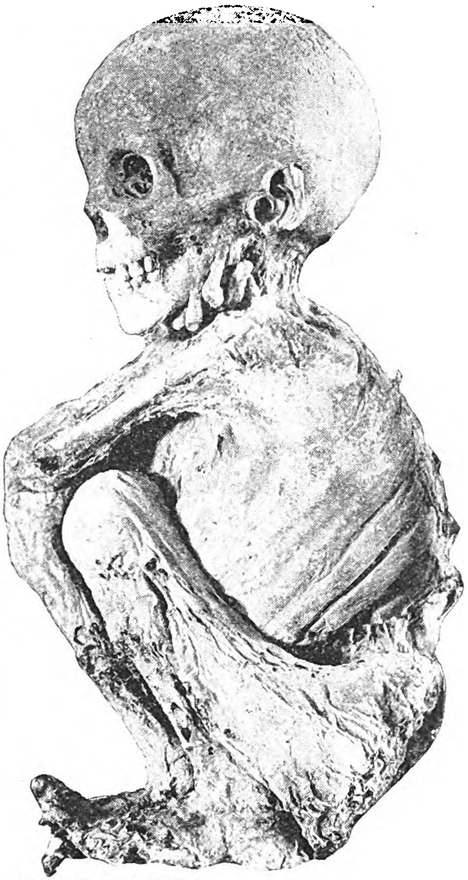

Courtesy San Diego Museum

INSTANT DEATH

Effect of impact of sling-shot pebble, seen from within skull of a child of eight

Vandalism has been the one most important factor in the loss of myriads of objects of the greatest archeological and anthropological interest, ruthlessly destroyed by treasure hunters throughout the ages. Egypt and Peru have shared alike in this. It is said that King Tut is the only royal personage of Egypt whose mummy had not been plundered. The Egyptian mummies had often been roughly broken up to secure objects of value. Similarly in Peru destruction has gone on, in spite of governmental mandates. We must read the story of the mummies from what is left of them.

Wrapped in the ancient mummy-packs are often found various ornaments, ears of maize, shells, dried food plants, packages of coca leaves, the native plant whose stimulating leaves commonly were chewed by the modern Indians. Associated with the burials are skeletons of the domesticated Inca dog and guinea pig. Thus we know what the food of these ancient people had been.


Courtesy San Diego Museum

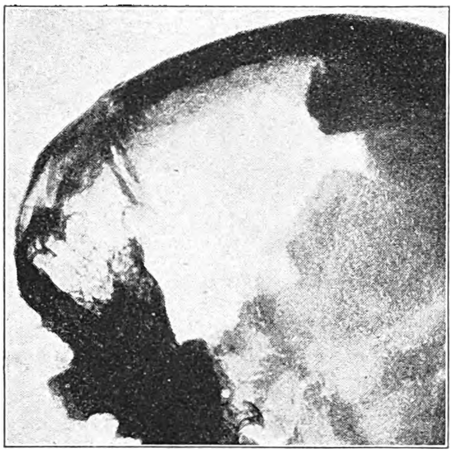
MUMMY OF AN INFANT

The tissues are well preserved and may be softened and examined microscopically

The nature of the ancient Peruvian mummies bespeaks a civilization which carried with it respect and care for the dead. Their woven and decorated winding cloths tell of a highly developed textile industry involving the agricultural care of the cotton and of wool-bearing animals, small camels which still serve the people of the Andes.

The religious motives underlying mummification in Peru are more obscure than in Egypt where the larger part of life was a preparation for the hereafter. We can but feel that we still have much to learn about those ancient folk whose mummies suggest unguessed thoughts and actions.

A STUDY of pre-Columbian pediatrics of Peru is now being carried on in Chicago at and by the Field Museum of Natural History where the large collection of prehistoric mummy packs of scores of infants and older children are being examined under the X ray. Some of the small mummies were simply dried and laid away without wrapping, as is shown in one of our illustrations. Unfortunately we are



Courtesy Field Museum of Natural History

HEAD UNDER X RAY

The skull shows the effects of a heavy smashing fatal blow from a metal mace

hampered in this study by the failure of the X ray to reveal all evidences of disease. This gap is to be filled, however, by examination of the bones themselves. These are to be found in profusion about the sites of prehistoric cemeteries in the coastal deserts of Peru and in caverns and rock shelters in the highlands.

It is, of course, evident that we are restricted in our search for evidences of diseases to those which make a definite change in the skeleton. A study of the soft parts by the microscope has yet to be undertaken. Water on the brain, called *hydrocephalus*, in its advanced stages causing a perceptible swelling of a characteristic type, has been detected in a few of the infant mummies in Field Museum.

The commonest disease of ancient Peruvian children was a nutritional disturbance whose effects (see illustrations) are known as *osteoporosis*. It is thought that this disease does not occur in America at the present time; or if it does it is rare. There are scant evidences of its occurrence among ancient Egyptian children, but it was extremely prevalent within the past century among the children of the island of Socotra in the Red Sea. Its bony manifestations occur in symmetrical patches at the backs of the eye sockets, on the bones of the skull, inside and outside, but are not known elsewhere in the body.

Under the paternal form of government instituted by the Incas in pre-Columbian Peru, children were well cared for but even at that time life in the higher Andes was hard. The perpetual cold, scarcity of fuel, absence of any attempt at personal cleanliness and, doubtless very often, parental neglect, are all antagonistic factors to which were due the high infant mortality. The children were savages, of course, and adepts with the sling, so we may account for such fatal injuries as shown in one of the illustrations as the results of childish squabbles.

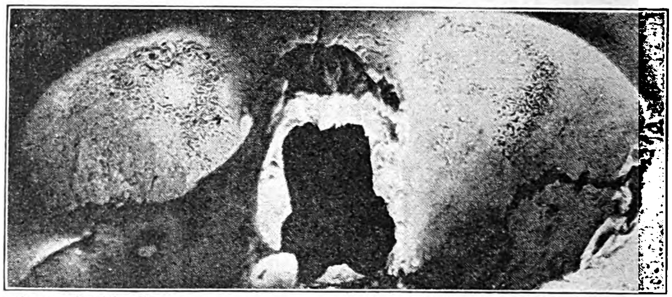
Although the surgical operation of trephining was extremely prevalent in pre-Columbian Peru, no child younger than 15 was ever operated on, among the many hundreds of trephined skulls which have been studied.

The teeth of the children in ancient Peru were usually sound and healthy. A few cases of cavity formation or dental caries have been seen in milk teeth. Shortly after the eruption of the permanent teeth, however, destructive processes were under way. Caries, pyorrhea, accompanied by huge deposits of tartar, abscesses, and other infections resulted in the loss of many of the teeth early in life and the loss of all of them later. Many an ancient Peruvian "gummed it" after he was 40 years of age. Only one perfect set of teeth from pre-Columbian Peru exists among a collection of 300 skulls in the San Diego Museum. Wisdom teeth seldom erupted and but four examples of impaction are known. No phase of dental surgery was understood or practiced in ancient Peru.

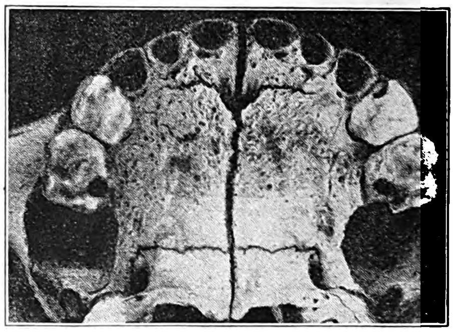
Only a beginning at pre-Columbian pediatrics has been made, but the progress already made is encouraging. A study of food substances in pre-Columbian Peru, now under way, will aid considerably in appreciating childhood life under the reign of the Incas and the pre-Incas of South America.

OSTEOPOROSIS

Osteoporosis or "bone porousness" was the commonest disease of childhood. The backs of the eye sockets are favorite places for this disease



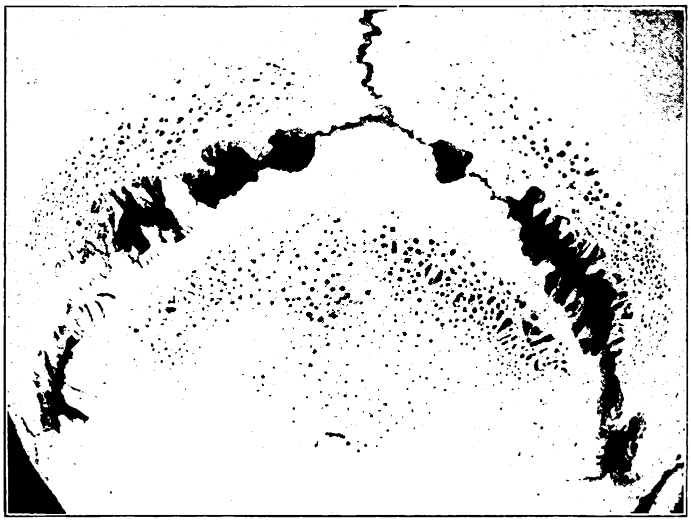
Courtesy San Diego Museum



Courtesy San Diego Museum

EXTINCT TOOTHACHES

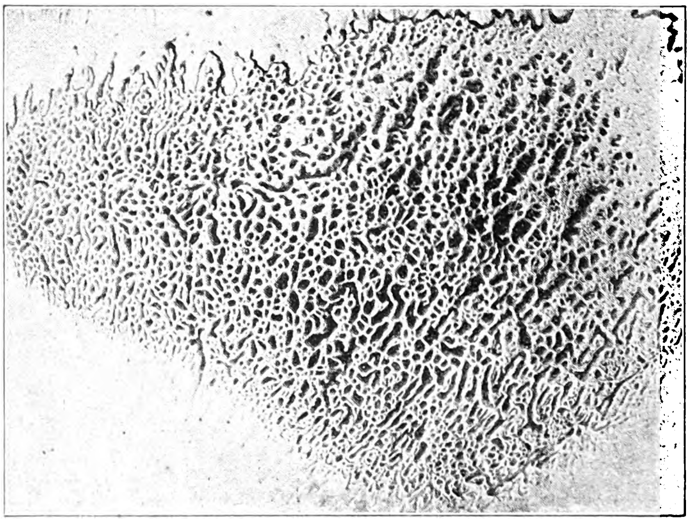
Milk teeth of children show cavities. Pyorrhea and abscesses were also common



Courtesy San Diego Museum

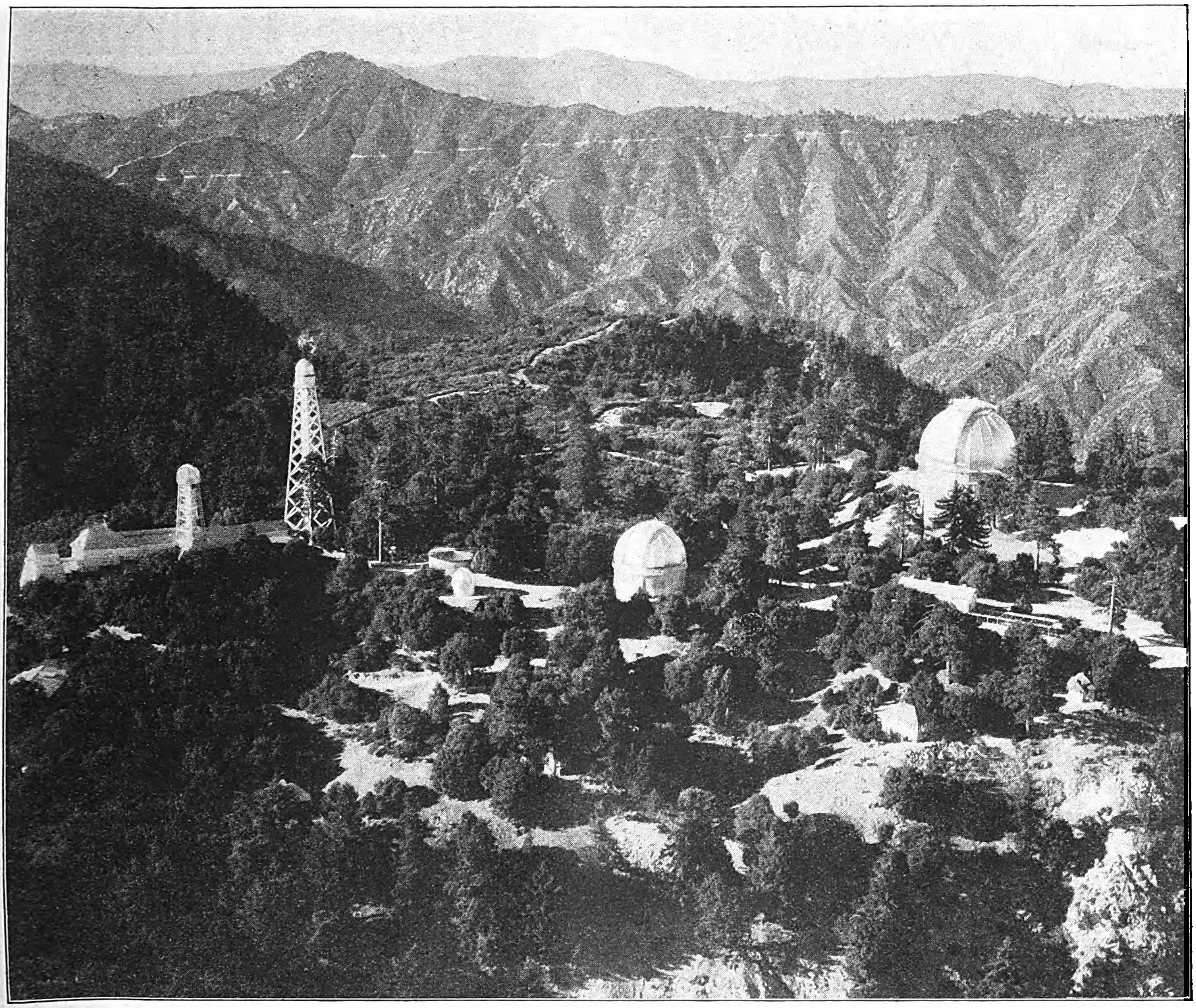
MORE BONE POROUSNESS

This is the top of a skull and shows the nutritional disease of osteoporosis along the wavy sutures or joint lines of the cranium



LACELIKE OPEN WORK—OSTEOPOROSIS

The disease results in patches of perforations. This child had reached the age of ten; the skin healed but the bone never closed



New Airplane View of Mount Wilson Observatory

FROM the vantage point of an airplane flying several hundred feet above the 5700-foot summit of Mount Wilson near Pasadena, California, one can obtain a clear impression of the famous Mount Wilson Observatory as a whole. The new photograph reproduced above was sent from Pasadena by one of the Corresponding Editors of this journal, Russell W. Porter, who is engaged in the cooperative project of the California Institute of Technology and Mount Wilson Observatory for building a 200-inch telescope and other equipment.

At the left is the long low structure of the Snow horizontal solar telescope. In front of its center is the 60-foot tower telescope, also for solar work, and near its end the higher powered 150-foot tower instrument for the same purpose. Nearer the reader and at the left edge of the picture the roof of a laboratory is partly visible through the trees. (The larger laboratory and the offices of the observatory are situated in the city of Pasadena). To the right is a reservoir and a comparatively small observatory dome which houses a six-inch refractor.

The two large domes are respectively those of the 60-inch and 100-inch reflecting telescopes. Between the large dome and the reader is the new Michelson-Pease 50-foot interferometer soon to be in operation. The entire housing for this refined instrument for measuring the diameter of the stars rolls off the instrument on a horizontal track.

"THE little cottage shown in the right foreground," to quote Mr. Porter's communication, "was built for the great astronomer Kapteyn, who occupied it for some time before his death. It is now used by the families of the observing staff and computers. Just out of the picture at the extreme left is the so-called Monastery where most of the astronomers live; also a hotel for visitors. The trees are pines, spruces, and live oaks; smaller growths are the manzanita and the yucca. Tame deer roam the observatory grounds unmolested. It is a hair-raising experience," Mr. Porter continues, "to come up the mountain by the narrow road in the big buses. If one car meets another the rule of the road requires that the one coming down must back up to a turnout.

"In the picture the distant mountains are typical of the San Gabriel Range. The long sloping line on the side of the mountain beyond Mount Wilson is a narrow road cut into the cliffs, and was designed primarily to permit the quick arrival of forest fire fighters. Somewhere near the distant horizon at the right, 30 miles away and 8000 feet up, an observer has 'dug in' for the winter. He is studying the 'air' and the 'seeing' at one possible future site for the great 200-inch reflecting telescope."

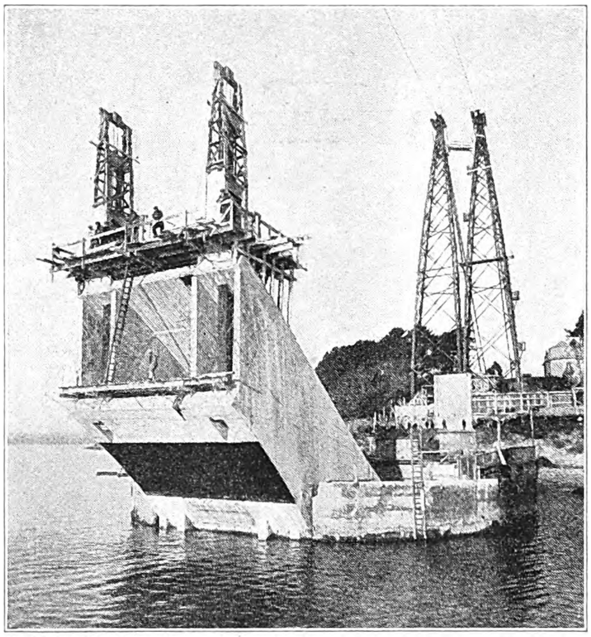
A New Departure in Bridge Building*

A Bridge of Unusual Design, Built by Unusual Methods, Is Nearing Completion Over the Elorn at Brest, France

By HERBERT E. STEINBERG, M.Inst.C.E.

QUITE a number of English engineers have already made pilgrimages to Brittany, with the object of inspecting the bridge over the Elorn River near Plougastel, which has been under construction for the last three years. Not only is it one of the largest reinforced concrete structures in the world, and designed for both railway and road traffic, but the methods of construction and the extraordinary number of ingenious devices used by the contractors are of absorbing interest.

The river at the point selected for the bridge is about 2000 feet wide, with sloping banks on each side, rising fairly steeply to a height of about 120 feet above the water level. The rise and fall of the tide is very considerable, adding to the difficulties of construction.



CELLULAR ABUTMENT

The two small towers on this section contain hydraulic jacks to lift centering. Large towers support cableway

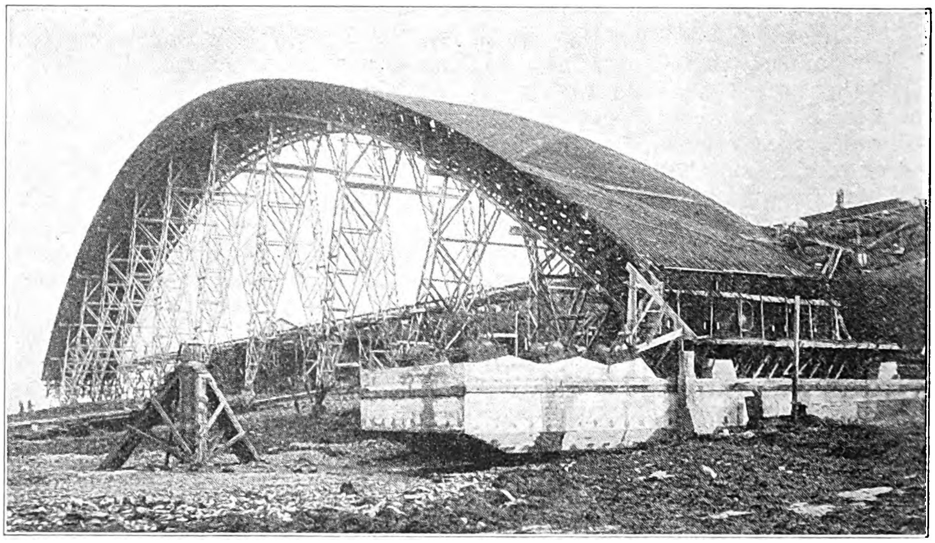
THE bridge was the subject of a competition in design, and the conditions indicated that it had to be capable of carrying a single line of standard railway, as well as a roadway 30 feet wide, for vehicular traffic. A number of designs were submitted, and the three more practical schemes were examined in detail by the commission appointed to adjudicate. Two schemes were in reinforced concrete, and both were cheaper than the third which was a steel scheme. As each of the reinforced schemes was sponsored by responsible engineers, the cheaper of the two was selected for comparison with the steel scheme and, after close investigation, this design was adopted.

It consists of relatively short approach viaducts and three arched spans over the water, each span being 590 feet in the clear. There are consequently two river piers. The arches themselves consist of hollow reinforced concrete vaults having four longitudinal walls and top and bottom slabs. These arches are surmounted by cross walls, supporting longitudinal girders which carry the double deck construction for the railway and road traffic.

Reinforced arched bridges of this type are not unknown, and have already been constructed in spans nearly equal to the bridge now being described, a notable example being the bridge recently opened on the main road between Annecy and Geneva. The methods of construction used for the Plougastel bridge are, however, entirely original as well as being extremely economical and practical.

Several bays of the approach viaducts on each side were constructed in the ordinary manner, with climbing shuttering and timber trusses acting as centering for the reinforced concrete girders. Simultaneously with these viaducts, the river piers were built up to high-water level by means of a reinforced concrete caisson or diving bell weighing about 900 tons, working under compressed air, and surmounted by air-locks, which permitted either concrete to be deposited or spoil to be removed with very little loss of air. The piers were continued above water level, and the springings of the arches were also built, so that they cantilevered out several feet from the center line of the pier. These projecting pieces of the arches were used subsequently to support the centering, and to enable them to do this, their strength as cantilevers was temporarily increased by tying the portions of each side of the pier together with bars having their extremities buried in the concrete. The requisite amount of tension was developed in these bars by jacking them upwards and packing them in the desired position.

IT was decided to use cableways spanning the full width of the river, in order to transport all material. The tenders for the cableway towers and necessary gear were, however, deemed unreasonably high, and M. Freyssinet, the designer of the bridge, therefore decided to design the necessary towers (which are 150 feet high) in timber. The timber, which is all in the form of joists and floor-board scantlings, is



BUILT ON LAND: THE CENTERING

The form which was to be the frame on which the concrete of the bridge was to be poured, was built on land. When finished, the supports were removed and the barges floated

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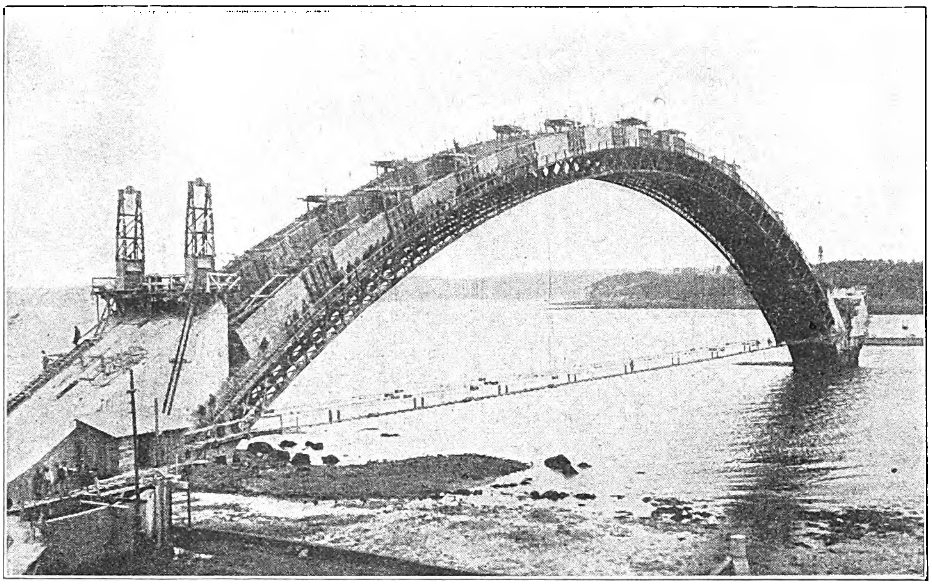
*Reprinted by permission, from *Engineering*, London connected entirely by nails $^{3}/_{16}$-inch in diameter and 10 inches long. The ends of the tower have hinged supports formed by burying the timbers in the concrete, through which a hollow mandril has been placed, which forms the axis of the hinge. The towers were constructed horizontally and lifted into position by the cable, which was subsequently to be used for carrying the load. Smaller towers of similar construction were erected at convenient points, as sheer legs, in order to commence the lifting of the main towers. The back stays to the towers consist of a number of ⅜-inch rods connected at top and bottom by means of concrete blocks, and anchored at their lower end to large blocks of concrete buried in the ground.

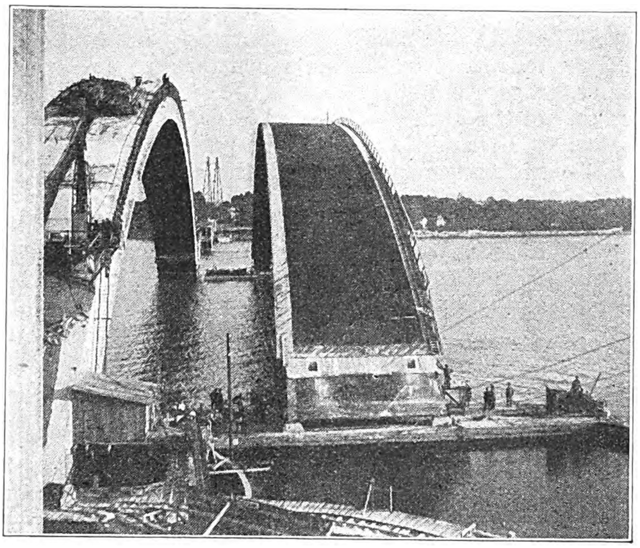


THE FIRST CONCRETE ARCH

The centering was floated into place between the abutments, lifted by means of the jacks in the small towers on the abutments, and fastened; then the concrete arch was poured

THE transporters are worked by electricity, the control cabins containing the motors moving backwards and forwards with the loads. The current reaches the motors through the overhead carrying cables, and returns through small hauling cables. Two similar transporters were built, and have worked without hitch for nearly three years, during which time they have handled many thousand tons of material.

The type and method of construction of the centering for the arches was the chief problem in connection with the bridge. It was finally decided to build a lattice arched centering in timber, which could be used successively for the three spans. To enable this to be done, two pontoons (each weighing 1000 tons) in reinforced concrete, were built, launched, and moved into position on the foreshore. Between them a number of timber towers were constructed, forming the ordinates to the parabolic curve of the centering, the towers near the middle being over 100 feet high. The lower ends of the arched centering, for a length of about 25 feet, were built in reinforced concrete, but the remainder was constructed in a manner similar to the towers for the transporters—that is to say, entirely in small section timber nailed together at the connections.

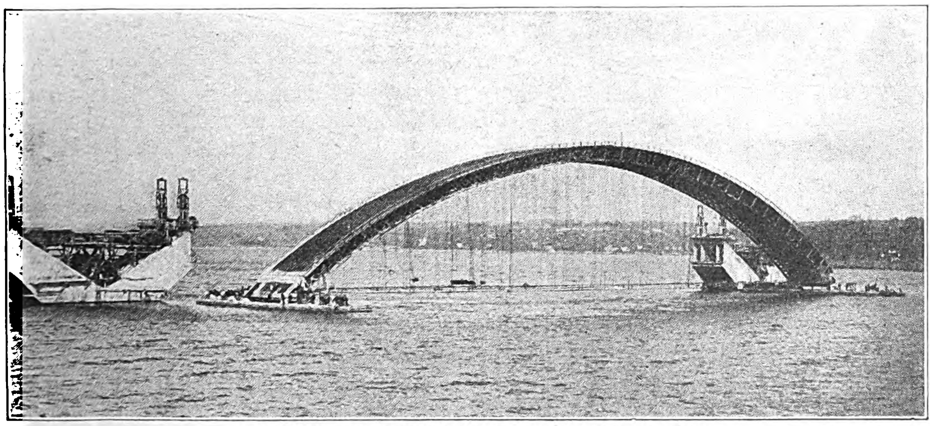


REMOVING THE CENTERING

After the concrete of the first arch was allowed to set, the centering was again lowered to the barges and floated away

Nearly 1000 cubic yards of timber were employed, and about 15 tons of nails. The curved top platform of the centering consists of 9-inch by 3-inch timbers placed on edge side by side, and nailed firmly together. These are surmounted by two layers of planking laid diagonally to act as wind bracing. The lower members consist of a series of ribs each made of four 9-inch by 3-inch joists nailed together and connected to the top boom by diagonal lattice work.

TO make possible the demolition of the temporary supporting towers, the ends of the arched centering were tied together by 80 wire ropes ¾-inch in diameter, and provision was made at each end for tightening or slackening these ropes by means of hydraulic jacks working horizontally. When the construction was finished, the temporary towers were demolished and the water pumped from the pontoons, which, in consequence, floated at the next tide and enabled the entire centering, having a span of nearly 600 feet and a height of 100 feet, to be floated out to its position between the piers of the first arch. This operation took only four hours; and the centering, which weighs 540 tons, was then jacked up and slung to the projecting portions of the arch already referred to. Slings were passed through the cantilevers and through the concrete ends of the centering.

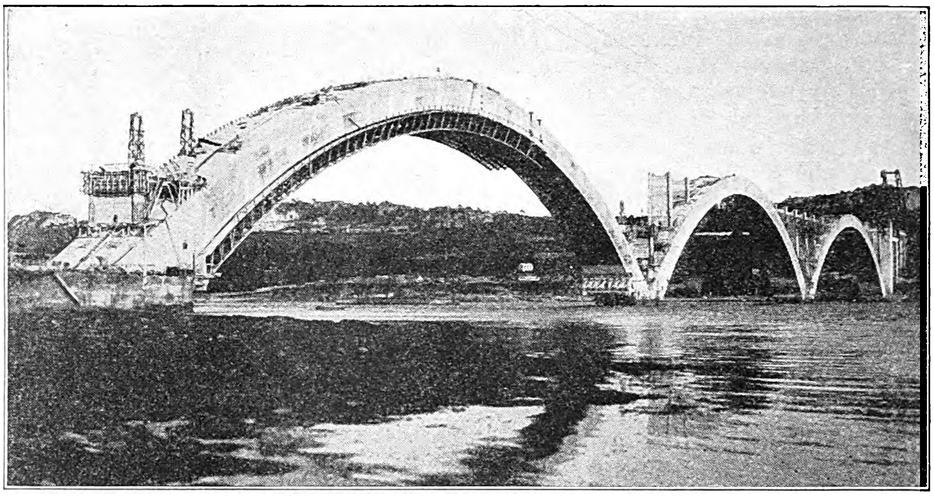


INTO PLACE FOR THE SECOND ARCH

The centering is here shown, on its two concrete barges, being floated into position for the second arch. The horizontal cables give it additional strength to support the concrete

In this condition the centering was, however, not strong enough to take the weight of the concrete, and provision was therefore made for converting it from a bow-string girder to a braced arch. This was done by taking the thrust through concrete blocks direct onto two projecting shelves left on the underside of the portions of the arch first constructed. This enabled the pontoons to be removed, and also permitted the tension cables to be slackened, the centering thus becoming a braced arch and capable of supporting the weight of the wet concrete.

The necessary stone for making the concrete was obtained by quarrying rock close to the site. Good sand was also obtainable locally, and the actual proportioning of the concrete was carefully controlled by test and experiment. A testing machine (in reinforced concrete) for crushing the tubes, was built on the site, and it was found that a small addition of stone dust increased the strength of the concrete. About 26,000 cubic yards of concrete were required.



THE ARCHES COMPLETED

The three arches having been completed, the centering is now useless. It may be seen, under the nearest arch, in process of demolition. In the background is the deck structure

When the concreting of the arch was finished, the cross cables to the centering were again tightened; the concrete thrust blocks were cut away, and the centering gently lowered by jacks onto the pontoons, which had again been placed in position under each end. The entire structure was then floated out, and into position for the construction of the next arch.

This operation was done three times, but as the final demolition, either on shore or afloat, of such an enormous timber structure presented great difficulties, it was decided to make provision in the last arch for supporting the centering by bolts left projecting on the underside. This enabled the wire cables and the pontoons to be permanently dispensed with, and also permitted the timber centering to be cut, *in situ*, into pieces of convenient length, lowered into the water and floated ashore for demolition.

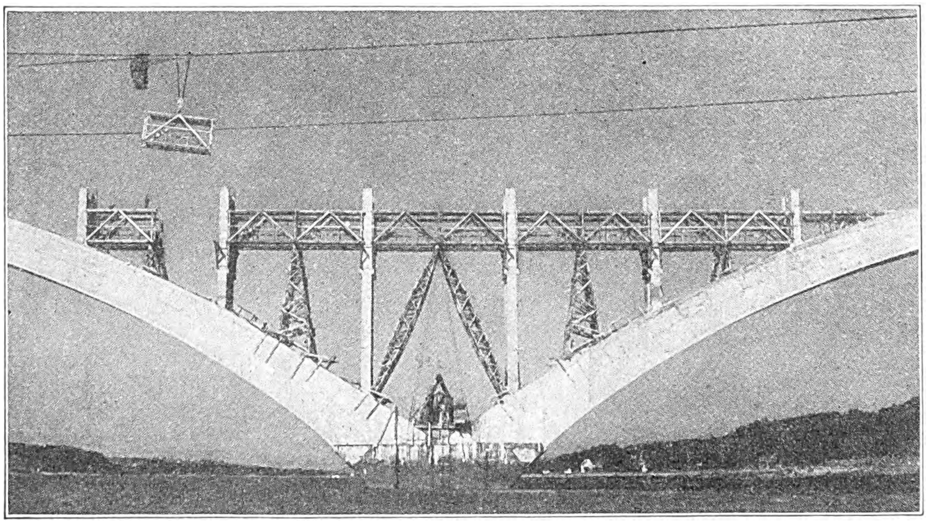
The greatest pains have been taken to eliminate stresses in the permanent work due to shrinkage and elastic settlement. The program for concreting the arch was carefully arranged towards this end, and not only was the concreting commenced and carried forward symmetrically from each side, in alternate lengths and gaps, but the portion of the bottom vault next to the springings was omitted—the thrust being temporarily taken by a series of pre-cast concrete struts. Similarly the portion of the four longitudinal walls next the springings was not done until the remainder of the arch was finished.

In addition to these precautions, niches were provided in the slabs and walls at the crown of each arch (where no reinforcement passed through) and a series of 28 hydraulic jacks, each with a capacity of 250 tons, were installed. These jacks were connected in series and operated by six pumps. They were expanded until the desired opening movement had been obtained, and the gaps were then grouted and the jacks removed ready for a similar operation in the next arch. Incidentally, the walls of the hollow vaults have been thickened slightly at the crown, in order to compensate for the loss of area due to the niches for the jacks.

At the present moment (October, 1929,) the three arches are complete and about two thirds of the timber centering have been removed. The remaining third is still slung from the underside of the arch. The sections of timber centering, after being floated ashore, are dismantled, a simple and practical form of nail-puller having been devised for quickly withdrawing the 10-inch nails.

The timber trusses forming the supports to the longitudinal beams carrying the railroad have been made ashore, and are now being carried out one by one and placed in position between the cross walls, and it is anticipated that another 12 months' work will complete the job. This process is illustrated at the bottom of this page. In the same view is shown the cableway conveyor, described elsewhere in this article, in operation.

The resulting structure will not only be a permanent example of the genius of M. Freyssinet, the designer of the bridge, but will also serve as an indication of the possibilities of reinforced concrete when both design and construction are in the hands of persons thoroughly conversant with this material. It is impossible in a short description to do justice, or even to mention the many original devices that have been developed and put to use during the construction of the work, but it is hoped that these notes, as the result of a recent visit, may be of interest. The contractors are Limousin and Company. The low anticipated cost of the bridge, coupled with the absence of maintenance charges, together with the artistic appearance of the final structure, should be of service in bringing home the paramount suitability of reinforced concrete for large bridge construction.



THE SUPERSTRUCTURE IS BEGUN

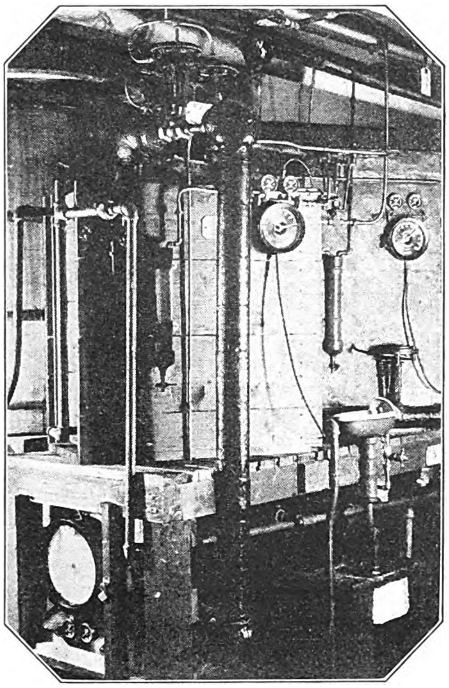
Timber trusses being placed in position for the longitudinal deck beams. Overhead a completed form may be seen being lowered from the conveyor cable. Note thin walls

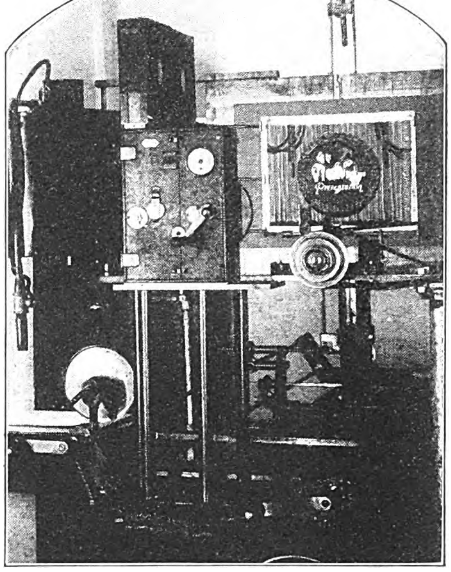
Movies Take On Color

By A. P. PECK

EVER since the invention of motion pictures, natural coloration in the films has been a goal toward which experimenters have worked with but little success until comparatively recently. All sorts of schemes have been tried, ranging from hand tinting of the individual frames to the simultaneous projection of two films, dyed in a separate color range.

The public, however, is critical of its entertainment, and crude efforts at natural color have been greeted with coolness and disfavor. Then the process of film coloration known as Technicolor was introduced, and as it was improved it found favor. Now comes Technicolor's only serious competitor, Photocolor, with a fully equipped plant for processing film and with a fully developed system for producing colored movies that faithfully reproduce on the screen the original subject.



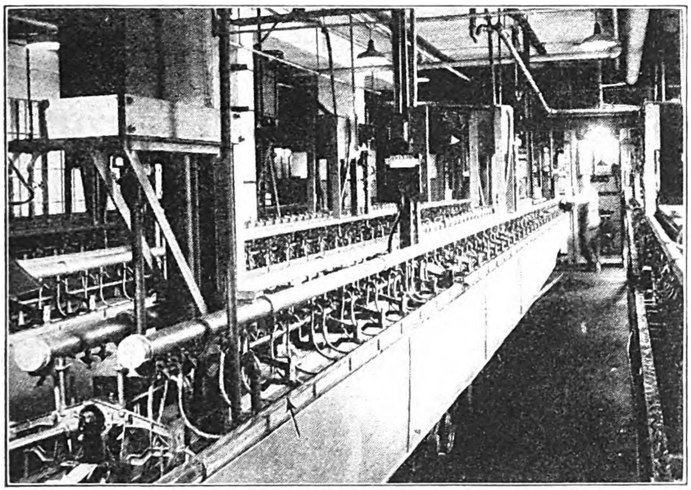


TITLING

In the foreground is the camera; in the background is the stand holding the copy

< TEMPERATURE CONTROL

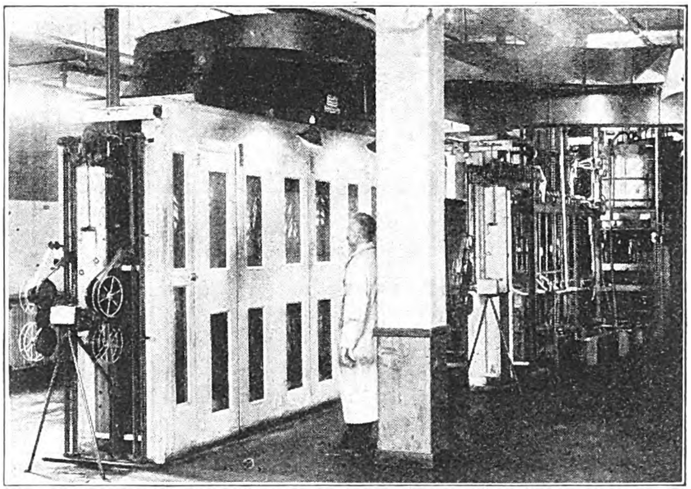
Absolute control of the temperature of the solutions is obtained by circulating water



GREEN-BLUE DYEING

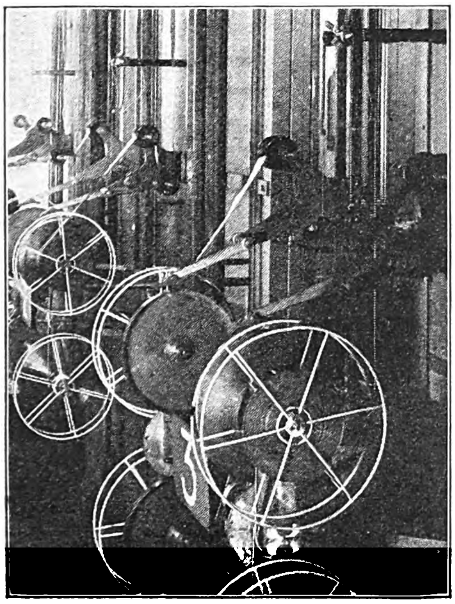
The film, indicated by the arrow, floats on a carefully regulated solution of dye, absorbing the color in the emulsion on one side

All photographs courtesy Photocolor Corporation



RED-YELLOW DYEING

After one emulsion is dyed, as at left, the film is run through the red-yellow bath, where the emulsion on the other side absorbs color



< TAKE-UP

After the dyeing operations, the film is dried and wound on these take-up reels

At a recent showing of a Photocolor production, the writer was favorably impressed with the degree of accuracy achieved in reproducing that bugbear of all color photography—flesh tints. Also, unusual in colored movies, pure blacks and clear whites furnished a pleasing contrast to the colors, all reproduced in the proper tones.

The Photocolor process has been under development for several years, during which time it has been refined to a point where a completely equipped plant is ready to start work on feature length productions. Essentially the system is as follows:

The camera is equipped with two lenses and operates the negative film at two and one half times normal speed. This is done because two frames of the film are exposed simultaneously, one through a filter for the red-yellow tones, and the other through a filter for the green-blue tones. There is a space between the frames that is eliminated in the printing. In the printing machine, which is accurate to within one ten-thousandth of an inch, alternate frames are printed on one side of a double-emulsion film, and the remaining negative frames on the other positive emulsion. Thus, the simultaneously exposed frames are registered and combined. When the positive is developed it is still in black and white. One side is dyed with a green-blue dye and the other with a red-yellow dye, the result being a close approximation of natural coloration when projected on a motion-picture screen.

MOTOR TRANSPORT SCHOOL

More than 1800 men in the motor transport school are registered for instruction. The course is very complete and experts furnished by manufacturers lecture. Principles and practice instruction run concurrently

Policemen Are Made, Not Born

In the Highly Organized New York Police College Every Branch of Law Enforcement Is Dealt With in Detail

By ALBERT A. HOPKINS

WHATEVER may be the causes of the organized crime of today—its bold robberies, dastardly disregard for human life, in brief, its apparent contempt for all the laws of society—the situation is critical. Our bulwark against the diabolical minority responsible for this state of affairs is the policeman, who often sacrifices his life so that "they shall not pass." From the humblest patrolman to the chief inspector, the ideas constantly borne in mind are the repressive influences as well as the actual detection of crime and apprehension of criminals. Every police officer is constantly on the alert, as he is part of the eyes and ears of the police department. But the policeman of today does not even remotely resemble the officer of the nineties. The great improvements which the 20th Century brought about are modern means of transport and communication, criminal identification, and police training.

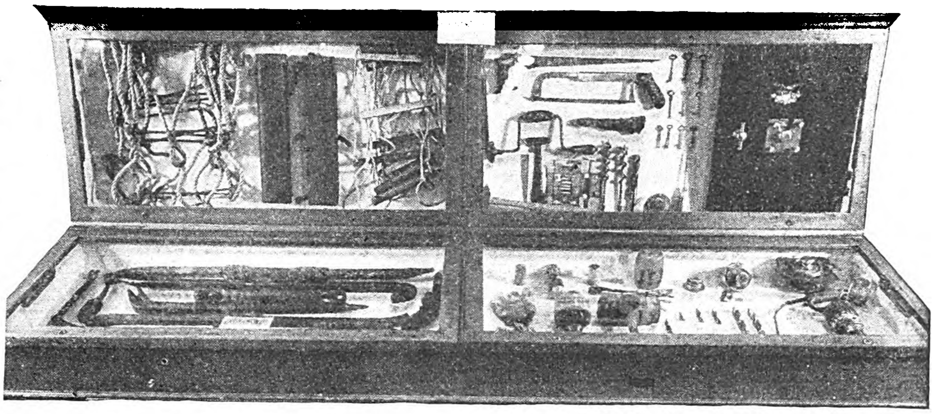
We shall, at this time, concern ourselves with the latter question only. Police schools are not new, for there are 16 of them in the United States. For a long time, however, the Police Academy of New York has had the most elaborate organization of any police school and has recently taken a forward step by the creation of a "Police College" under the Presidency of the Hon. Grover A. Whalen, New York's versatile and efficient Police Commissioner. There are 11 schools in this college, so we could also refer to it as a "Police University."

Police work is fascinating to the lay reader as is evidenced by the great popularity of detective stories which form a large slice of fictional literature.

THE great mistake which most writers make is the creation of a super-detective who co-operates with the police and supplies the brains to Scotland Yard, or any other police headquarters. As a matter of fact, co-operation of this nature would be highly dangerous and has no basis in fact, for on the force are men picked to unravel mysteries and detect crime 365 days a year—the underworld never sleeps and takes no Sundays or holidays off. It is for the training of officers and men of the uniformed force, as well as detectives and "rookies," that the Police College was established.

Crime control must be approached from a scientific viewpoint as well as the practical one. Strong-arm methods are all right in their place, but strong-brain methods are equally important. The police must "outsmart" the criminal or society must suffer. Crime has become so scientific that we must devise improved methods of approach to problems which formerly did not exist. We hear a great deal of Paris, Vienna, Scotland Yard, and other great centers of police investigation, but we have, right in our own land, some of the most successful methods of detection that the world has ever known.

Near Police Headquarters there was an unused candy factory which was admirably adapted for a police school or college. It was rented for a period of five years at an annual rental of 65,000 dollars and was entirely remodeled to house the various schools, record rooms, engineering offices, et cetera. The seating capacity of the schools is 2100. There is an Advisory Board of nine members made up of prominent educators, law-school professors, and one of the assistant district attorneys. When we get down to cases, who is more competent to teach a policeman than a policeman? Superior officers should be the ones to teach the lessons which they themselves have learned by experience which is often bitter and costly. We can cut corners with well planned instruction by those whose personal experiences, both successes and failures, fit them to become teachers of police theory and practice. Therefore 230 men, including a Chief Inspector and sergeants, have been assigned to the teaching force. Special lecturers include Justices of the Supreme Court, Judges of the Court of General Sessions, the United States Attorney, the dean of a law school, handwriting experts, prominent lawyers, surgeons, sanitarians, and criminologists. In fact, 11 pages of the program at the opening contained the names of exactly 500; certainly a large faculty, even though the majority wear blue uniforms and brass buttons.



A "BLACK MUSEUM"

Here are burglar's tools galore, rope ladders, jimmies, and all the evidence in the notorious Snyder-Gray case. The public is not invited to this Crime Museum, now or at any time

SUCH an array of talent would almost make writers of detective stories want to sit at their feet and learn at first hand some of the grim incidents that occur daily in their profession of combatting the arch enemies of society, particularly the gangster and the gunman. The faculty makes policemen out of raw recruits, and the "rookies" will in time come back for post-graduate instruction; for the patrolman's job is a job for young men. After a few years of hard-earned experience, all are able to compete for higher grades in the service and, if possessing ability, may rise to the position of inspector before retirement.

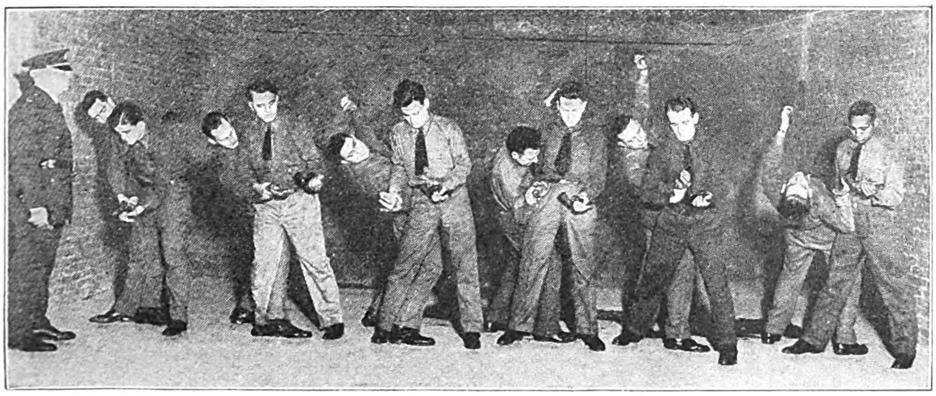
How can the Police College war against the gangster? It is a prime essential that a detective must have an excellent knowledge of the social foe with whom he is likely to deal. To this end, the most experienced men in the department acquaint the new detectives with gangster manners and customs. It would take years to gain the knowledge which these "hard-boiled" detectives impart in three months of intensive training.

THERE is nothing the gunman fears like the headquarters' camera, the lineup, and the fingerprint pad. A cardinal rule of the New York Police Department is that a gangster must be "frisked" on sight, as must his companions, male or female. The average gunman is not a two-fisted animal and without his gun he is lost; and if a gun is found on him the police know where he will be for the next five years. A gun is called a "rod" and a bomb a "pineapple" in New York gang-land. Gangs are constantly under the eyes of the police and are chivied hither and yon with relentless energy, so that sometimes the gangster goes to work from sheer exhaustion and becomes an unwilling member of the society which he has tried to undermine.

All crimes, however, are not committed by gangsters and the detective must be able to piece together the thin web of destiny from almost impossible beginnings: a piece of torn time-table, a half smoked cigarette, or a burned match stick may and has meant the "chair." On one of the floors of the Police College is a "black museum," like the one in Scotland Yard. The "public is not invited" but here will be found policemen and detectives eagerly scanning the exhibits which may mean a gold shield for them, if they answer the knock of opportunity. In one of the cases are over 100 exhibits showing how the "perfect crime" met its Waterloo. It was indeed thrilling to hear the man that pieced together the evidence in the Snyder-Gray case tell how a little scrap of a Pullman ticket led to the identification of Judd Gray, and spoiled a nearly successful alibi. Here are the burned match sticks which also helped to convict him. Here are the two bottles of poisoned whiskey carefully prepared for hubby by the loving Ruth. Here is a magazine with a colored cover and around it are figures showing that if she got the insurance she would have 78 dollars a week for life. Here is the torn Long Island timetable, the sash weight, the chloroform pad, the picture wire, and the necktie, all elements in this revolting crime for which two criminals were electrocuted.

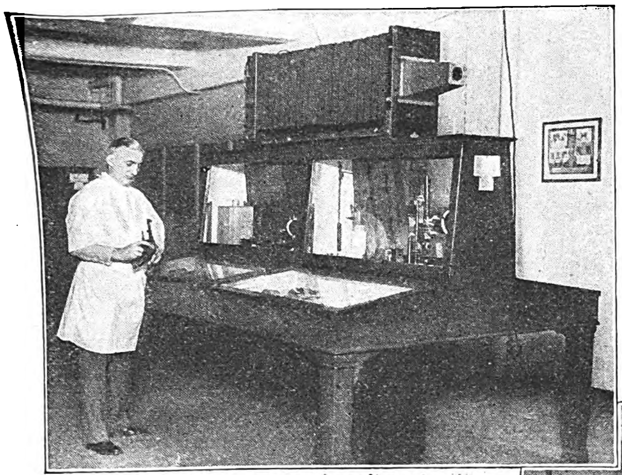
HERE are also collections of burglar's tools and jimmies of the 1929 model. It is a travesty on civilization that such ingenuity is spent on the production of such illegitimate tools for an illegitimate purpose when the place of their artificers is in the tool room of an automobile factory earning 15 dollars a day. The wages of sin are not very high; the average burglary nets $29.75—and a chance of a few years in prison.

The detective must have a very wide general knowledge if he is to rise in his profession. One of the principal objects of the college is to train newly appointed detectives to notice significant evidence when they see it. The familiar "*cherchez la femme*" is now changed to "find the bullet and the gun." Today when a criminal fires a shot, he seals his fate if the pistol is found. Fingerprints will identify the finger that pressed the trigger. The juryman hears the fire-



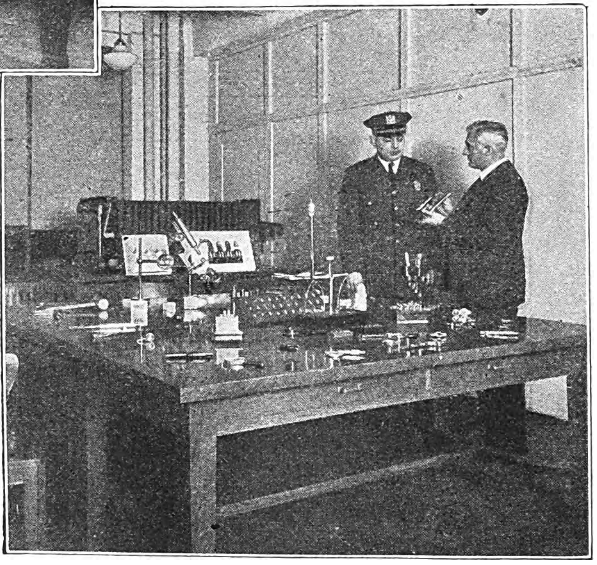
"ROOKIES"

The disarming of criminals is one of the subjects taught and it is not elective either. The "rookies" become splendid athletes and are soon able to cope with brutes of the underworld



SMALL ARMS EXPERTS

The ballistics laboratory solves many crimes. Here we have Detective Stanley Gorman, small arms expert, and Deputy-Inspector John J. O'Connell, Dean of the Police College, in conference over a mysterious homicide case



arms expert; he gazes into the interior of the barrel; he sees photographic enlargements; he sees and handles the evidence. He learns that no two revolver bores are the same, and begins to realize that the policemen who collect such evidence are being given a scientific training which is very valuable. Ballistics, as taught to student policemen, enables the policeman to solve crimes with a certainty never before attained. By means of it, not only is guilt more clearly proved, but innocence absolutely confirmed. It is accuser and protector in one.

WHILE the College is intended to make "finer and broader minded" policemen, you must first have your policeman. Therefore, a large part of the building is devoted to the "rookie" who is qualifying for the line of blue or "getting on the force" as it is usually called. The candidates may come from all over the country but a year's prior residence in New York, just to get acquainted, is necessary. The applicant must be under 29 and weight not less than 140 pounds. He must pass rigid mental and physical examinations, and is then finger-printed to see if he is a wolf in sheep's clothing. He takes a pledge of office, is given a shield, and is ready for his 90-day intensive training. He is the ward of the city; and he soon sees that being a "cop" is a good deal more than a mere job.

The course in physical training is particularly severe, for the policeman cannot always use kind words. Only the ablest survive, and a close approximation to the perfect type is the goal. The student policeman's day is divided between calisthenics, wrestling, jiu-jitsu, and academic instruction in subjects germane to his future work. Such studies are the fundamental purposes of a police department and the part it plays in society. He studies the penal statutes, the courts, and methods of preparing evidence for the district attorney. The things he learns are too many to specify. He must know that the responsibility is his to stop street brawls, without arrest if possible, restore a lost child, and to aid an injured person before the clang of the ambulance gong is heard. At the end of the qualifying period, if the man has made the grade, he receives his badge of office; is allowed to buy a revolver and to go upon the street armed with authority which he must use with discretion. Present and prospective criminals will shun the company of policemen who are the product of modern training methods.

The special schools make the policeman a specialist. The mounted police constitute the "second arm of the service" and the horsemanship school instructs both the man and the horse; the latter must become used to revolver shots. Explosives and small fires are started near him and he is gradually led up close to the fire and shown there is no danger in it for him. While New York City has only 400 mounted men they are a great aid to traffic control.

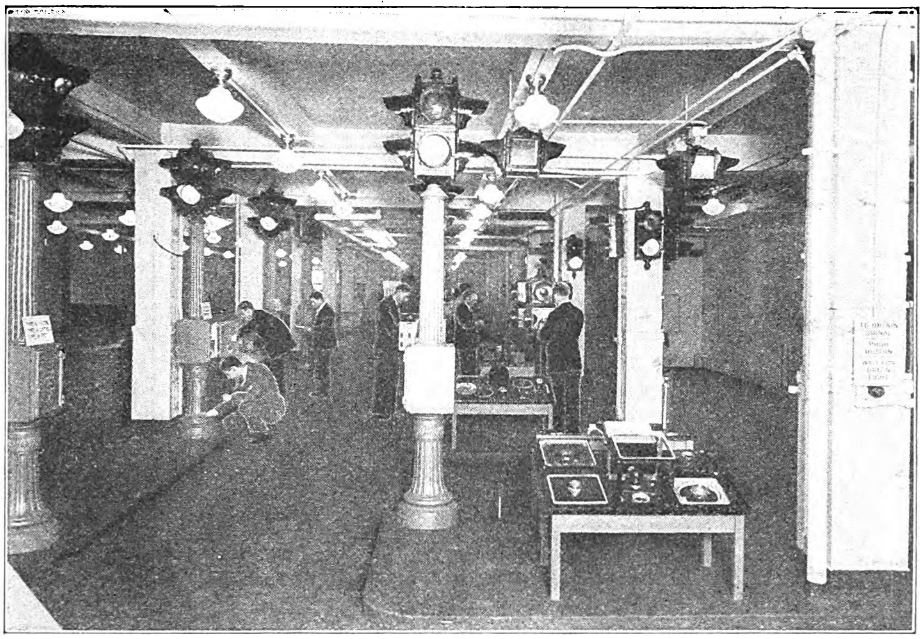
The motor transport school has 1800 men registered for instruction and many of the large automobile concerns send engineers and instructors to lecture. The traffic school is very important; for New York, of all cities, being "long and narrow" needs the best traffic specialists that can be produced by education, and even policemen far removed from their rookie days must take an intensive course.

THE motorcycle school gives instructions not only to new men but to the 300 in the motorcycle division. The job is a depressing one, for a motorcycle officer hears enough sad stories to bring a sphinx to tears. All kinds of alibis are offered: one knows the Commissioner, another the traffic judge, still another tenders a "fiver." Despite all these lies, blandishments, and attempted bribery, the officer must do his duty, as he is held rigidly to account.

Grouped under the general head of the Bureau of Crime Prevention are those agencies having to do with all welfare work. The Women's Bureau of the Police Department has a force

THE OFFICE FORCE

They may punch typewriters but they are all policemen, for police work is a man's job, except for the policewomen who have their own field looking after wayward girls, fortune tellers, and so forth. They also receive special instruction in the Police College of more than 125 trained women. Their sole work is to protect women and children and to prevent the latter from passing over the line of safe home life to that of existence as wayward street waifs. Their main activities are the supervision of dance halls, the detection of shoplifters, the curbing of girl adventurers who are looking for the proverbial pot of gold, getting work for girls and helping them increase their earning power, and the detection and arrest of fortune tellers, fake and voodoo doctors, and moving picture "mashers." The Police College has a comprehensive course for police women. Preventive work is especially stressed in this department.



"STOP-GO"

Policemen will be taught all about the traffic and lights on this floor. It looks like the electric show but nothing is for sale. The instruction is class work and demonstrations

THE aviation school was deemed necessary, as modern police work demands that science play its part in the prevention and detection of crime in the air as elsewhere, and that every modern invention be utilized to further the ends of justice.

From more than 1000 candidates among the younger officers, only 12 were selected for this branch of the service. These men receive intensive training, both the Curtiss and Roosevelt fields being used as training bases. The air course in the Police College is thorough and complete. The New York Police Department is the first to have a regular patrolling air force, operating in much the same manner as the policeman patrols the streets.

From the policeman, we get the detective. The course of instruction in the School for Detectives aims to give the student ability to apply legal principles to concrete situations; to understand and appreciate people, normal and abnormal; to examine with a high degree of skill every detail connected with a crime; to spare no pains in searching for the slightest clue; to preserve exhibits and to consult experts; to make effective use of traces left by criminals; and to master the technique of criminal investigation in various fields according to their relative importance. This is a big job but the Police College is equipped to turn out an honest-to-goodness detective who could do more in shorter time than Sherlock Holmes. Here is where the well equipped laboratory comes into the picture, involving chemistry, microscopy, and ballistics.

There is also in the Police College a school of law to teach the basic principles of criminal jurisprudence, a training school for teachers, a training school for officers, a specialized training school (police emergency service and clerical instruction), and a school for pistol instruction.

We have covered the College rather hastily but there are also housed in the building certain police activities which are very important. There is a model muster room of a police station house, an exhibition of apparatus for the control of traffic, an auditorium, the property clerk's office, the record room, the traffic engineering department, and the printing bureau. In the printing department, manned by policemen, the confidential circulars, with "Wanted" as a scare head are printed.

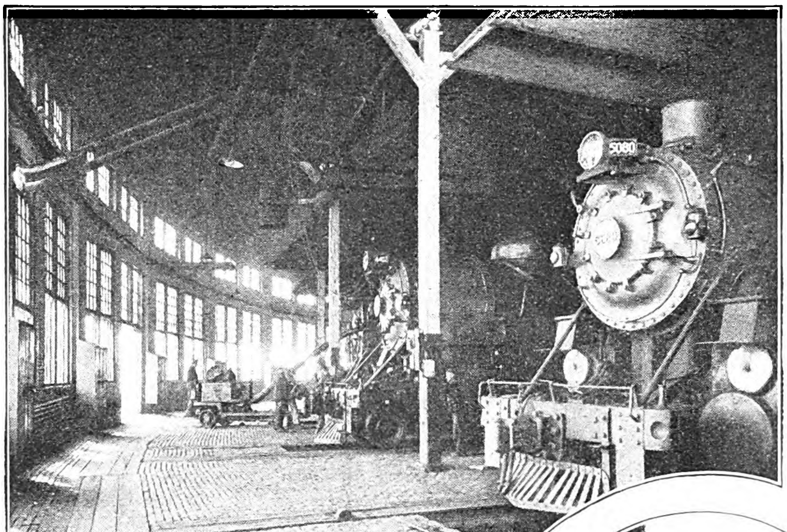
THE PROPERTY CLERK

In the envelopes under the calendar are enough narcotics to supply all the "hop-heads" in gangdom for a long time. Every kind of article comes to the property clerk's office

If a crook eludes the ring of detectives around New York City, he may ride on the very train which is carrying one or more of his pictures. In less than a week 250,000 police officers will know that he is wanted. The way of the transgressor is hard and is constantly being made harder.

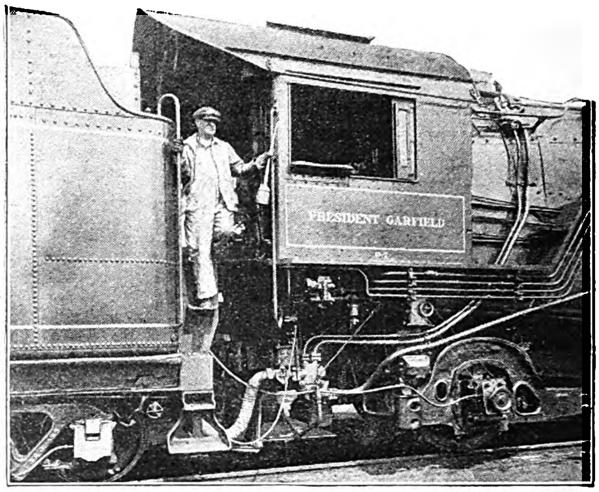
The busy property clerk controls nine warehouses and is the largest second-hand automobile dealer in the world. Here are also many shelves filled with revolvers in brown paper envelopes and enough narcotics to supply every "hop-head" in gang-land for a year. He also has charge of more than 300,000 dollars in jewelry and cash. The record room can trace any of the 20,000,000 arrests made since 1855. Recently they had to look up the history of a woman criminal whose first crime was committed 65 years ago at the age of 15. The elapsed time of the search was less than a quarter of an hour.

THE foregoing gives one a feeling that the Police College will do much to aid clear, hard thinking by intelligent police officers so that they may do more to create fear of the law in the minds of criminals than all the jails and punishment cells of the last century. We are indebted to Deputy-Inspector John J. O'Connell, Dean of the Police College, for many courtesies in connection with the preparation of this article.



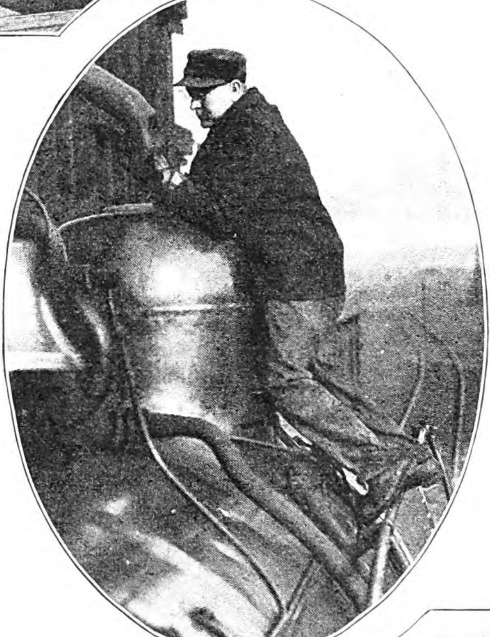
NO CORNERS HERE

Here the locomotive is sheltered, minor repairs made, and the firing-up process begins. The smoke passes out through a hood to the outer air. The semi-circular form of the round house was born of necessity, as the engine must be routed to tracks



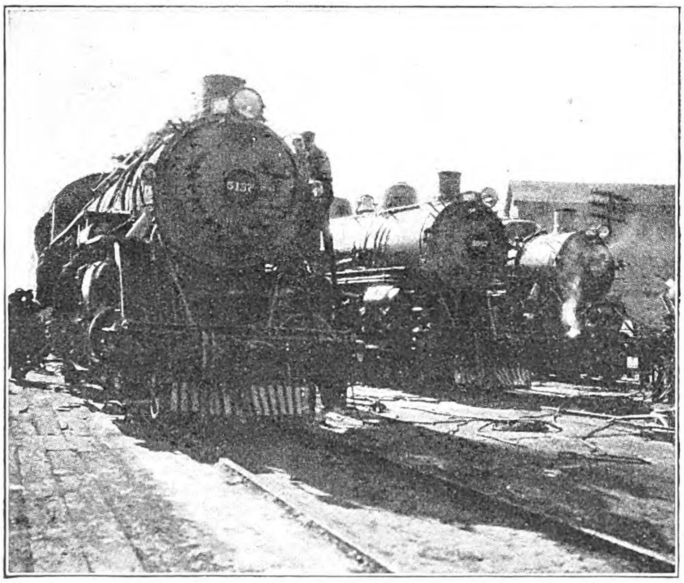
END OF THE RUN

The engineer has brought the giant locomotive to the yard and is about to descend and make out his report. Great care is used to keep the 80,000 dollar machine in order. The locomotive will now be inspected by six experts and the ashes will be dumped



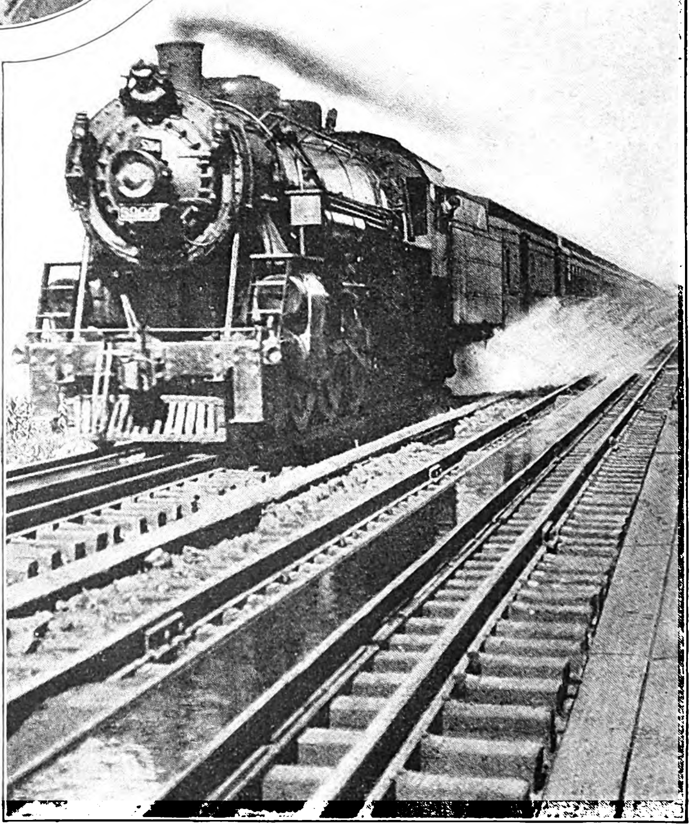
◄ "SAND"

Sand is almost as necessary as coal and water to assist in starting the immense load. The sand is thoroughly dried before it is put in the dome atop the boiler. The sand is blown on to the track as needed



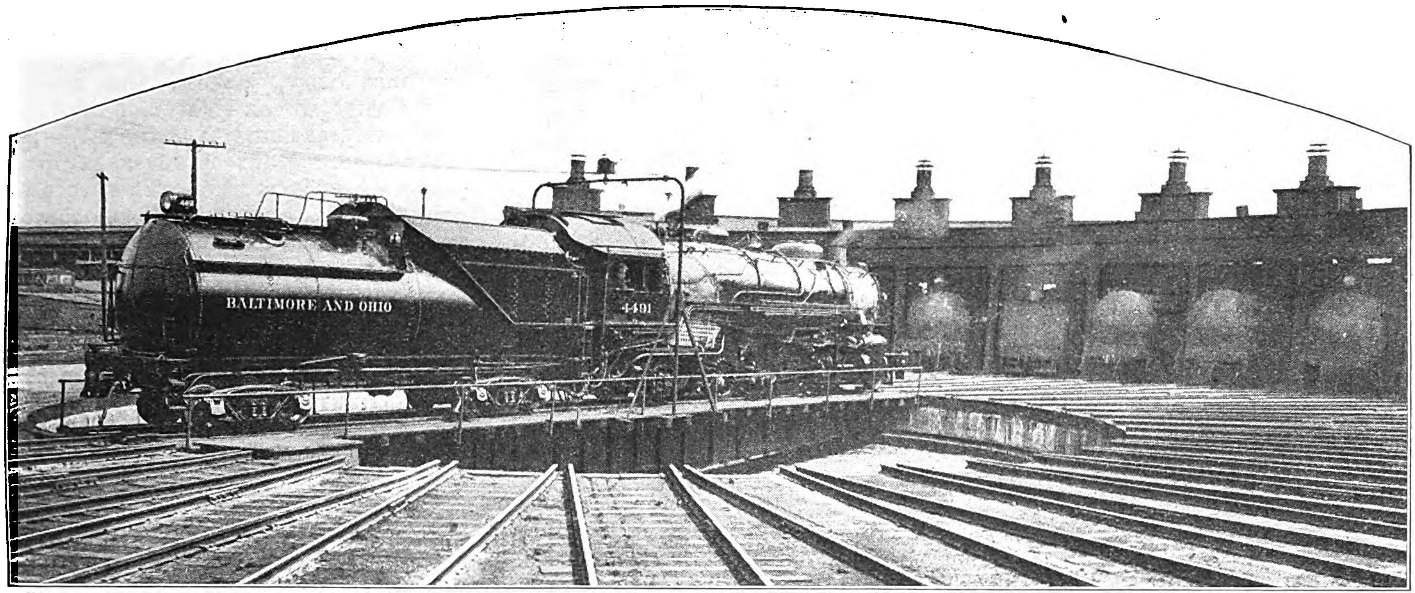
THE READY TRACK ▼

Here the locomotives stand with their crews awaiting the signal to start. They have been cleaned, fueled, watered, and sand put in the dome. They have steam up ready to do their part to help make dividends for the railway company



"WATER" ►

Taking up water en route saves much time. When the track tank is reached, a scoop is let down and the water surges into the water tank on the tender. Track tanks are often a quarter of a mile long and are kept filled



All photos courtesy Baltimore and Ohio Railroad Company

THE TURNTABLE

The electrically operated turntable serves to berth the locomotives in the round house and gives them access to the proper track so that they may be refueled, obtain water and sand, and finally go to terminal or freight yard to be coupled to their burden of cars

’Round a Round House

When Its Hard Day’s Work Is Finished, the “Iron Horse” Retires for a Bath and Complete Inspection

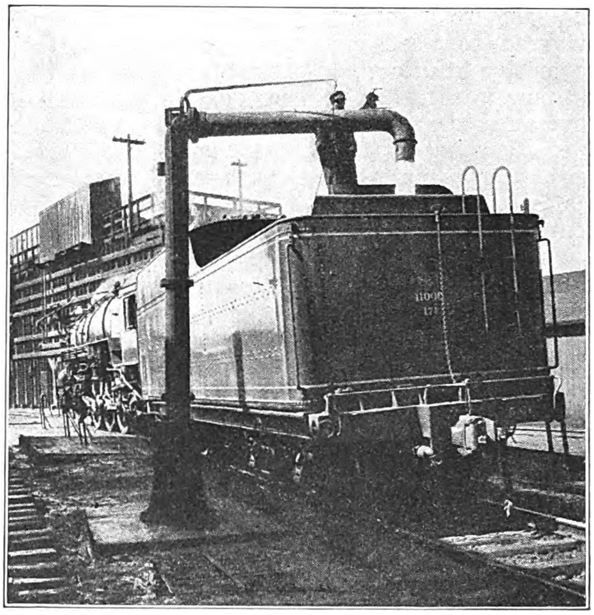
By FRANCIS X. MILHOLLAND
Assistant to the Senior Vice President, Baltimore and Ohio Railroad Company

ALTHOUGH we cannot truthfully say that a locomotive actually sleeps, it is true that a period of rest is beneficial. At the same time it allows a thorough cleaning and inspection of the machine before it again undertakes the responsibilities that accompany its long runs over the rails. Few of the inventions of man see harder service than the engines which haul our passenger trains on schedules that are seldom broken.

While locomotives are built nowadays on a progression system comparable to that of automobile mass production, still there is an individuality about them which is different from that of any other machine. Early in their careers they disclose variability as to steam distribution, acceleration, and tractive effort. All of these little quirks have to be straightened out, so that there may be uniformity in the locomotives as they stand fully fueled, with steam up, on the “ready track.”

THE service period of a locomotive begins in its berth in the round house. Probably all have seen round houses, but few have visited them, for rather obvious reasons. A round house should be visited only when “personally conducted” by someone who knows the ins and outs of railroading, for there are many pitfalls in the railroad yards. A round house is a grooming shelter, circular in shape, where locomotives can be berthed for examination and firing up, and where minor repairs can be made. The shape of the building is such that the locomotives may be readily assigned to any designated berth, shifted to it with the aid of a turntable. The same turntable routes the locomotives to the tracks which lead to their daily tasks.

An elongated hood or “smoke jack” is located over each stall of the round house. This, in conjunction with electric motor-driven draft generators, permits the smoke and gases to be eliminated, so as to render the round house less murky than it would be otherwise.

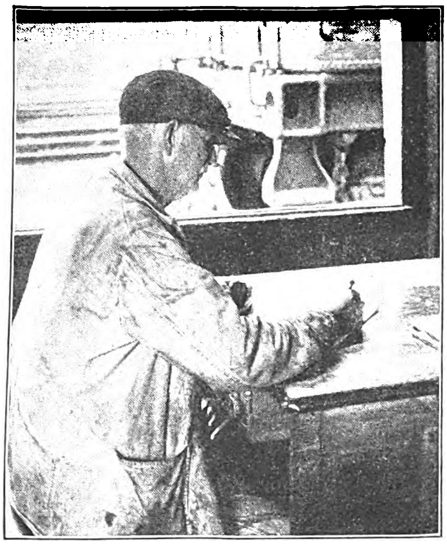


“WATER”

10,000 gallons are poured into the tank. From Washington to New York about 25,000 gallons are used

The locomotives are fired-up with the aid of oil under air pressure. When the steam pressure is high enough to permit operation the engine is run out by the “hostler” on to the turntable, which is rotated so that the engine can be run, either to the ready track, if already supplied with fuel, or to the “coal tipple,” where 8 to 12 tons of coal are run by gravity into the coal space of the tender. The coaling is accomplished with the aid of chutes and the amount of coal delivered is charged up against the locomotive and the run. While normally the locomotive backs beside the coal bridge to receive the fuel, means are provided at most terminals for coaling on any one of the mutiple tracks.

The water is supplied to the tank in the tender with the aid of a movable



"REPORTS"

The engineer makes out a report complete in all details at the end of every run

spout. This tank supplies water to the boiler under the direction of the fireman. The tanks hold from 10,000 to 18,000 gallons and a run from New York to Washington would require about 25,000 gallons of water and 11 tons of coal for the engines of the "President" class.

All is now in readiness for the crew, the sand boxes having been filled at time of taking coal. Sand is indispensable and is usually supplied at or adjacent to the coal-handling station. The sand, to be of any use, must be delivered to the sand dome of the locomotive in dry condition so that it will flow freely when needed. Special stove and steam sand driers are available. Varying with weather conditions, approximately two bushels of sand would be required for the trip mentioned. Sand is quite an item. A trunk line may readily pay 50,000 dollars a year for sand. The sand is used for starting, in order to give the driving wheels better adhesion to the rail. The sand is blown on the track with the aid of a compressed air jet controlled by the engineer in the cab.

The crew arrives and the engineer and fireman sign the book in the master mechanic's office. They look over their 80,000 dollar beauty to see if everything is "O.K." The dispatcher's orders must now be obeyed and the engine slowly moves to the head of the assigned train and the coupling is completed. The engineer and the conductor compare their watches. The leaving time approaches. The tower man gets a signal from the dispatcher's office. A lever clicks, a disk or semaphore changes position. The conductor signals the engineer, who sands the tracks, opens the cylinder cocks, and pulls the lever which controls the throttle valve concealed in the dome of the locomotive. The stately machine is in motion over the steel rails and we sit back in our comfortable seats while the begoggled and begloved crew on the pulsating locomotive watch for anything that looks like danger.

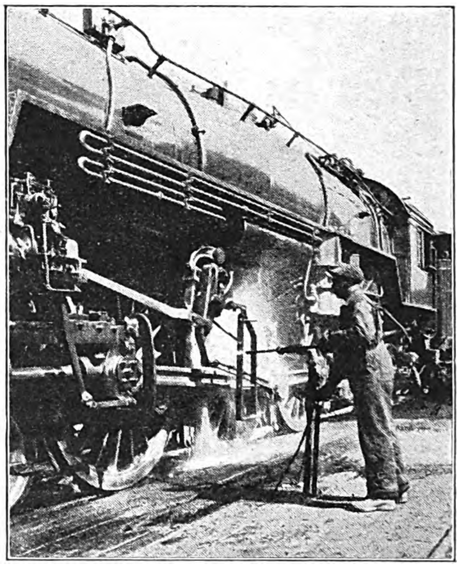
IN olden days the riding qualities of a locomotive were comparable to those of an artillery caisson. Today, however, this condition has been improved with such spring resiliency and uniformly distributed action of same that the riding comfort of the modern locomotive is almost equivalent to that of a Pullman car.

There is plenty for the crew to do until the end of the run is reached. Then the locomotive backs the empty train out into the yard. Here the engineer stops at the hostlers' quarters, delivers the locomotive to the shop forces, and gives an account of his stewardship in a written report.

What now becomes of the locomotive? An idle locomotive costs money, but a dirty locomotive is a liability and not an asset. In the early days the engineer and fireman did the cleaning, but as business increased and engines became larger, a group known as "wipers" was engaged to go over the machinery, jackets, and tanks, and finally six or eight men had to spend several hours to "wipe" a large locomotive. Now, however, a new plan has been introduced. This process, using what is known as the "locomotive wash rack," rapidly removes the accumulation of oil, dirt, and dust by means of a mixed stream of air, oil, and water, played at high pressure upon the parts to be cleaned.

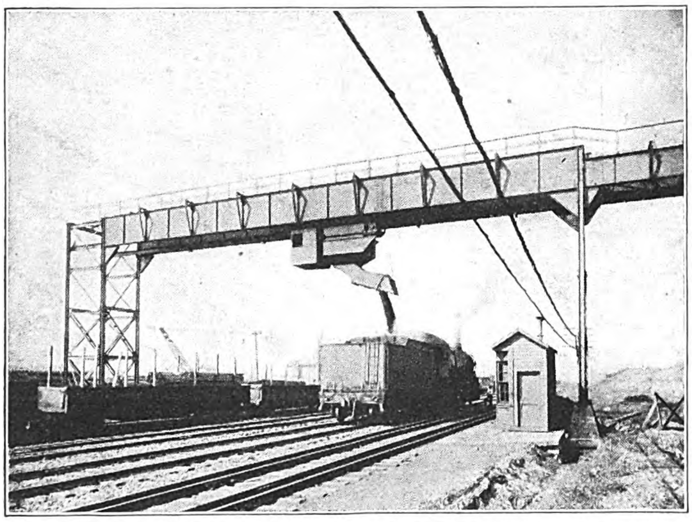
When the engine comes in from the run, the ashes are dumped at the cinder pit of the inbound tracks. It is then run on to the "locomotive wash rack." (See photograph below.)

Six men now inspect the locomotive and it is then ready to go to the round house for another preparatory period. At the scheduled or called time, it (we almost said "she," for that is the more affectionate term used by the railroad man), will be tuned up and fired, ready for the next long run.



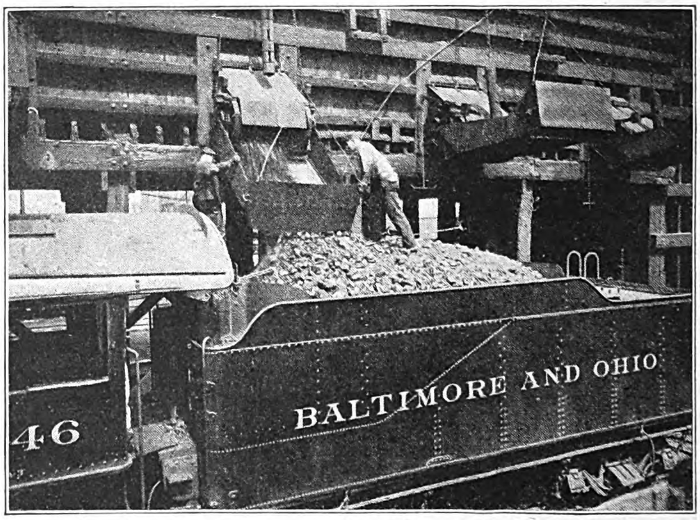
"WASHING"

Hot water, oil, and compressed air clean the engine, replacing a dozen "wipers"



"TRACK FUELING"

Here we have a tender being fueled on an intermediate track. This system tends to save much time in switching locomotives



FUEL BRIDGE

Coal is weighed out and dumped into the coal bin in the tender. The fireman controls the coal consumption by careful firing

Take Your Camera Into the Air

Whether on Your First Flight or on a Long Air Journey, You Can Make Snapshots With an Ordinary Camera

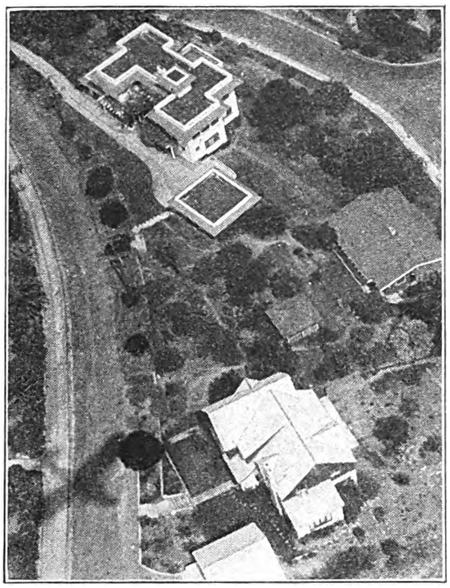
By ROBERT E. GOODE*

AERIAL flights have ceased to be a novelty. With increasing popularity and its attendant publicity, people now take to the air with the assurance of a safe return. With no time being devoted to the working up of an excellent case of nervousness, passengers are finding time to look around while up in a plane.

They are seeing sights from the air. The new angles of familiar objects appeal to them. Perhaps their photograph album at home has a dozen pictures of a show place—good snapshots, too, but none that can equal this "new" view. If on the ground, out would come the trusty camera to record the scene. Why not use the camera while in the air?

Many of us own a camera of some sort. All of us have, at some time or another, taken a snapshot that we secretly thought was just about as good as any professional photograph we had ever seen. That automatically qualifies each and every one of us as an amateur photographer. But in spite of our general knowledge of cameras, most of us are inclined to think of aerial photography as an extremely professional calling. This is not so.

AGAIN, we are likely to believe that special equipment is necessary to obtain beautiful aerial photographs such as are shown in the Sunday rotogravure sections. Neither is this so. The person who takes only a short sightseeing flight should carry his camera along and the person who commutes back and forth in one of the huge airliners should certainly take advantage of his many opportunities to obtain good snapshots.



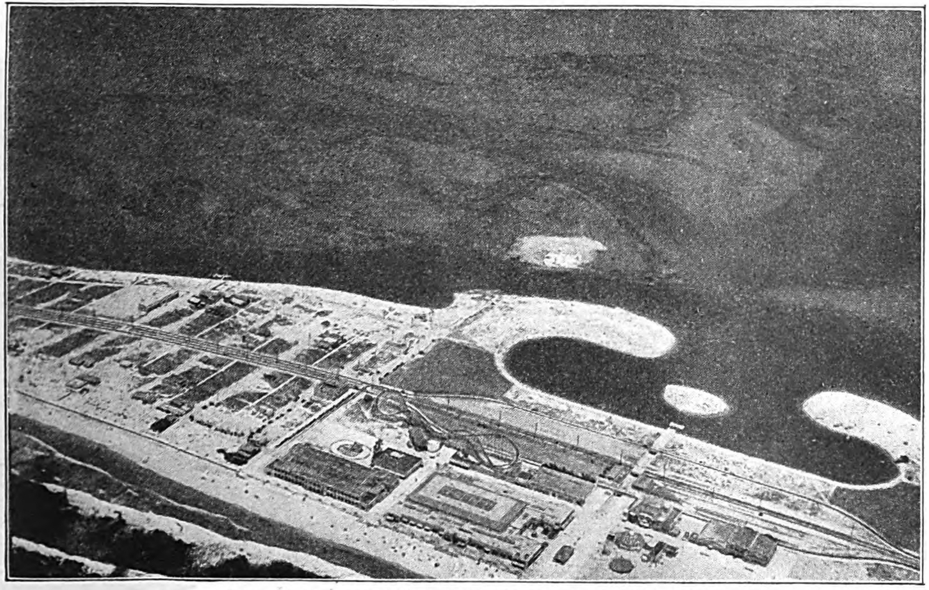
YOUR OWN BACKYARD

As the plane in which you are flying casts its shadow over your home, make a snap

The old familiar box camera will take pictures from the air as well as on the ground. The Graflex works as well at altitudes as at sea level. It, of course, takes a photograph proportionately better than the family box camera. Familiarity with rapid rectilinear or so-called double lenses of f.8 or U. S. 4 diaphragm opening is a great advantage.

Various kinds of ordinary cameras were used by the author in gathering illustrations for this article and a large number of other splendid ones. So you see, any type will operate in the air successfully. Good pictures can be obtained with ordinary roll film and film packs. Clouds and ground haze, however, often complicate the case. A general knowledge of color-sensitive films is helpful. The use of color filters is simple and useful.

A scarcely perceptible haze may ruin an otherwise good picture. Haze possesses a bluish tint that photographs as white. A snapshot taken under these conditions will appear to have been taken through a gauze screen. Fortunately, haze is the only color problem that the amateur need worry about. The resulting cloudy effect can be eliminated by using an orthochromatic or panchromatic film. A yellow color filter should be used in conjunction with these films. Commercial orthochromatic film in either rolls or cut-film form is recommended. Most aerial pictures made by professionals are on this type of film.



BY AMATEURS' METHODS, BUT GOOD

Mission Beach, San Diego, California, photographed on panchromatic film, using a "minus blue" filter. Note how the filter has made the shoals show up in the water off the beach

PRACTICALLY all of the novice aerial photographers will take their pictures from a large cabin airliner. This is best since a howling wind is not present to interfere with the operations. Moreover, there is more room in which to move about.

It is perfectly feasible, however, to take photographs from an open cockpit type of plane, and in some cases, it may be better. For example, in photographing another plane in the air, the upward and downward angles may give better results. Such shots would be very difficult in a cabin plane. The sketches in Plate I illustrate the angles through which photography is possible in an open cockpit plane.

The folding camera must be protected from the slip stream, otherwise the bellows will blow inward and cut off a portion of the resulting photograph. Moreover, the turbulent air will cause vibrations and resultant blurring. It might even blow the bellows off the camera. The camera may be shielded behind the windshield or behind the body. The pilot is

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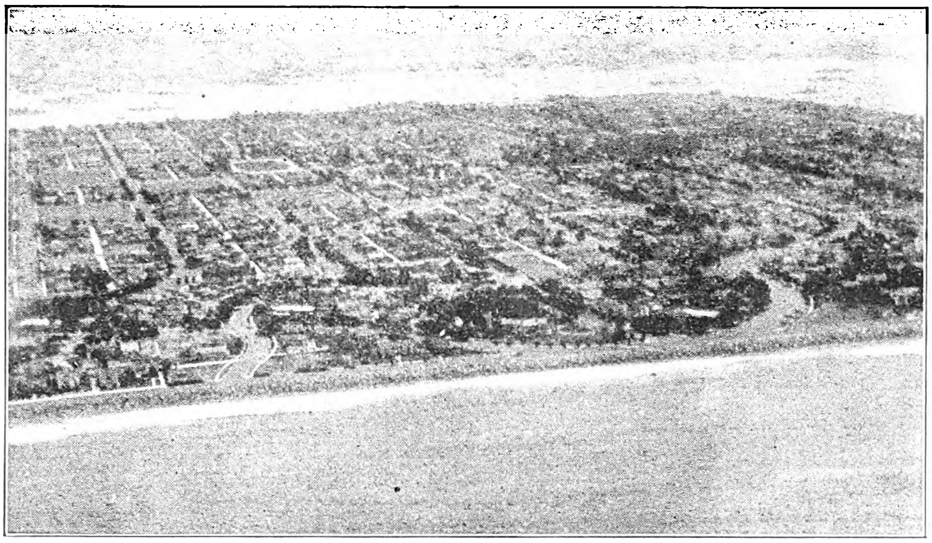
*See "Among Our Contributors," page 261



YOU CAN DO AS WELL

This splendid view of a section of Coronado, California, was made with ordinary roll film and no filter was used. With your own camera you can make many such pictures for your album

always willing to throttle down his engine to idling speed if you make your wants known. This will reduce the passing windstream, and will also decrease the vibration of the plane.

By all means always hold the camera with your hands. In this way, the body will absorb most of the natural vibrations of the plane. If you rest your camera on the fuselage of the plane while "shooting," the photograph will be blurred and unsatisfactory. To eliminate blurred pictures further, combine a very short exposure with as small a stop as possible. The exposure should not be longer than 1/100 of a second duration in open cockpit planes.

Plate II shows the positions in which a folding camera should be held for best results. If used as in Figure 2, the viewfinder will show the view in an inverted position as in Plate III.

The box camera, of course, is not adjustable. It is necessary merely to aim it and make your exposure. Remarkable results have been obtained with this type of camera.

THE best altitude for photographs is from 1200 to 3000 feet. If under 1200 feet, the relative motion between the plane and the ground is too apparent and close objects will be blurred. If over 3000 feet, the distance is excessive except for cameras made especially for that purpose.

Operation of the Graflex type is, in general, the same as for a folding camera. In this case, however, the focusing hood will give trouble because of its tendency to blow off. It is advisable to focus your camera while you are on the ground. Mark a scale on the focusing rack to be used while in the air. This will eliminate the necessity of using the hood while in a plane.

Another method of avoiding difficulty with the hood is to re-inforce it with plywood or some light, strong material. Or, you may even replace it with a similar box of plywood or sheet metal. The advantage of these methods is that you can have a perfect focus because the ground glass can be seen at all times.

Focusing is unnecessary when using aerial cameras. Their operation is simple in every way. A direct-view sight is provided in order that sighting can be done from the level of the eye. Some of these cameras require the operator to re-wind the shutters and then to change the film. In others, this operation is combined. No lens stops are provided with aerial cameras but they can be easily made from black paper or from tin, painted black. These pieces are inserted between the elements *of the lens.*

No matter what the type of camera used in the open cockpit plane, take no chances on losing it. Make fast a strong cord on the camera and tie it securely to your body, or to the plane. If it should be blown from your hands, you can at least retrieve it.

The length of exposure is governed by a great number of variables. Among these are altitude, strength of light, conditions of atmosphere, and kinds of filter used.

A "between the lens" type of shutter is used on the ordinary camera. These shutters usually are graduated in 1/100th, 1/50th, and 1/25th of a second—speeds that are adequate for most aerial photography. High shutter speeds are desirable to obtain good results consistently for they help to eliminate blurring caused by vibration and to stop motion at low altitudes.

WHEN vibration and wind can be avoided, as in a cabin plane, 1/25th of a second may be used when at an altitude above 1000 feet. Cameras of the more expensive type have shutter speeds up to 1/1000th of a second. Some foreign types are capable of even shorter exposures.

Eposures may be computed with an exposure meter. In your calculations bear in mind that all views from the air are of distant objects. The most accurate method known is to use a "Justophot Exposure Meter." This is a vision meter which is easily operated by sighting at the object which is to be photographed. The correct exposure is then read directly off a scale.

When photographing through a haze, color filters can be used to advantage. This is also true when a background such as fields appears excessively green or yellow. The use of filters will accentuate detail in these colors.

Light yellow filters do little other than penetrate haze, although they correct slightly for the various densities

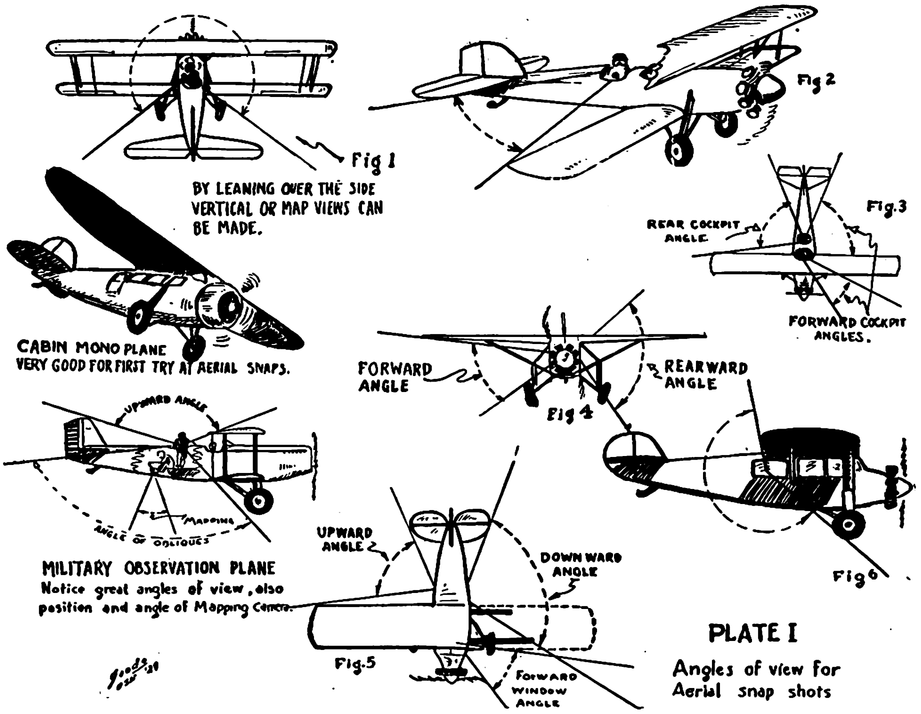


Fig 1
BY LEANING OVER THE SIDE VERTICAL OR MAP VIEWS CAN BE MADE.
Fig 2
Fig.3
REAR COCKPIT ANGLE
FORWARD COCKPIT ANGLES.
CABIN MONO PLANE
VERY GOOD FOR FIRST TRY AT AERIAL SNAPS.
FORWARD ANGLE
REARWARD ANGLE
Fig 4
UPWARD ANGLE
MAPPING
ANGLE OF OBLIQUES
MILITARY OBSERVATION PLANE
Notice great angles of view, also position and angle of Mapping Camera.
UPWARD ANGLE
DOWNWARD ANGLE
Fig.5
FORWARD WINDOW ANGLE
Fig 6

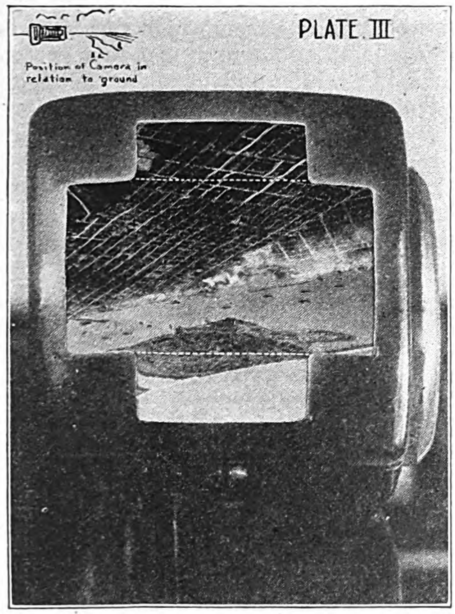
PLATE I

Angles of view for Aerial snap shots

of color. Dark yellow filters fully correct for the apparent density of color. Extremely dark yellow and orange filters are used to emphasize some detail of the landscape. For example, a beach will appear very light while the water will appear quite dark. Often roads are made to stand out clearly from the surrounding country by this manner of over-correcting. Haze can be eliminated by combining these filters with a panchromatic film and a fast lens.

OVER-EMPHASIS is also gained by the use of a red filter. In the resulting photograph, red appears lighter than yellow. Blue shows up as black. Slight variations of green are very noticeable. This property of a red filter was used to advantage during the World War. The green paint and artificial trees of camouflaged objects showed up clearly against the natural foliage. Browns were easily detected when the fresh foliage had dried up. Camouflage fooled the eyes but not the cameras. This partially explains why so much importance was attached to aerial photography during the war. The use of a Wratten K1 filter requires approximately five times longer exposure than when using roll film without a filter.

It is advisable for the beginner to use the gelatin film form of filters for economy's sake. They can be cut to any necessary size to fit between the lenses of the camera. Care must be taken in order to prevent moisture being transferred to the filter by the hands. It is best to cut the filter to size and form before removing the wrapper. This prevents unnecessary handling. Remove the wrapper as the filter is inserted between the lenses. Scratches on your filters should be prevented by handling them carefully by the edge.



LOOKING INTO THE FINDER

Scene will show upside down in finder when camera is held as in Figure 2, Plate II

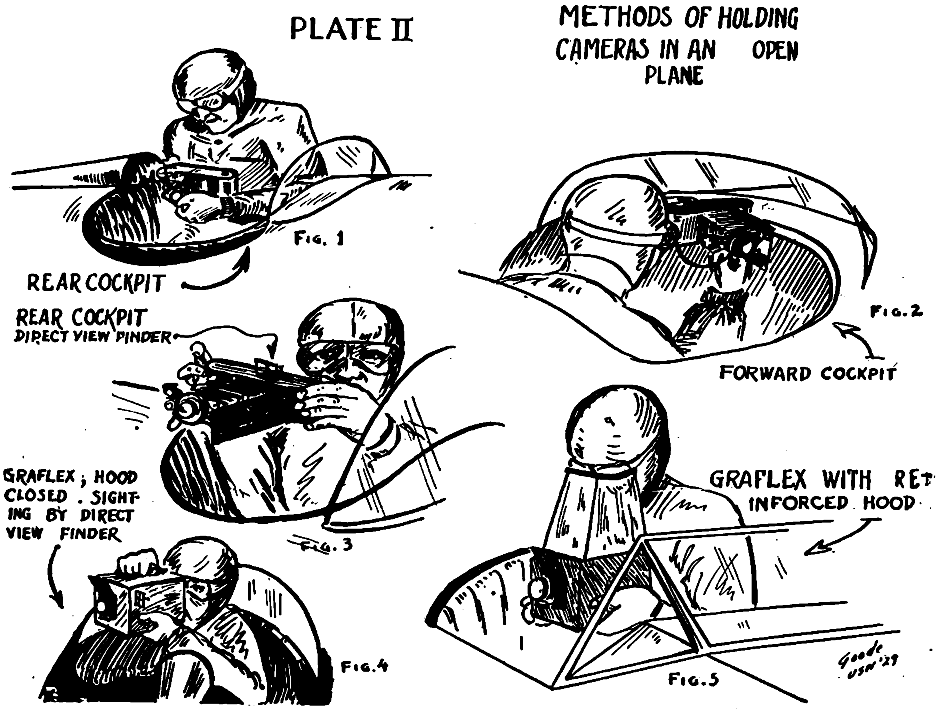


PLATE II
METHODS OF HOLDING CAMERAS IN AN OPEN PLANE
Fig. 1
REAR COCKPIT
Fig. 2
FORWARD COCKPIT
REAR COCKPIT
DIRECT VIEW FINDER
GRAFLEX; HOOD CLOSED. SIGHTING BY DIRECT VIEW FINDER
Fig. 3
GRAFLEX WITH RE-INFORCED HOOD
Fig. 4
Fig. 5
Goode USN '29

Cameras That May Be Used, and Methods of Holding

Orthochromatic film in cut-film form is more sensitive to yellow and green rays than the ordinary roll film. Consequently, when using a filter with this film the increased exposure need not be so great. Generally, the orthochromatic roll film is not so sensitive as the cut film or plate. An exception to this is the Wellington Anti-Screen film. This has a filter manufactured into the film and thus obviates the necessity of any additional filter except under unusually hazy conditions.

PANCHROMATIC films are most sensitive to all colors. They are readily obtainable in either cut-film or plate form. Rolls are provided for the largest aerial cameras. This type of film gives especially clear results if brown predominates the landscape. Because of its sensitiveness to all colors this film is most easily adaptable for over-emphasizing by the use of filters.

Great care must be taken in developing. The red safelights ordinarily used by photo finishers in their developing rooms are as destructive to panchromatic film as daylight. Total darkness is desirable, though a Wratten, series three, green safe-light may be used. If the amateur does not develop his own work, he should patronize a well-recognized commercial studio. Explain carefully just what kind of film you have.

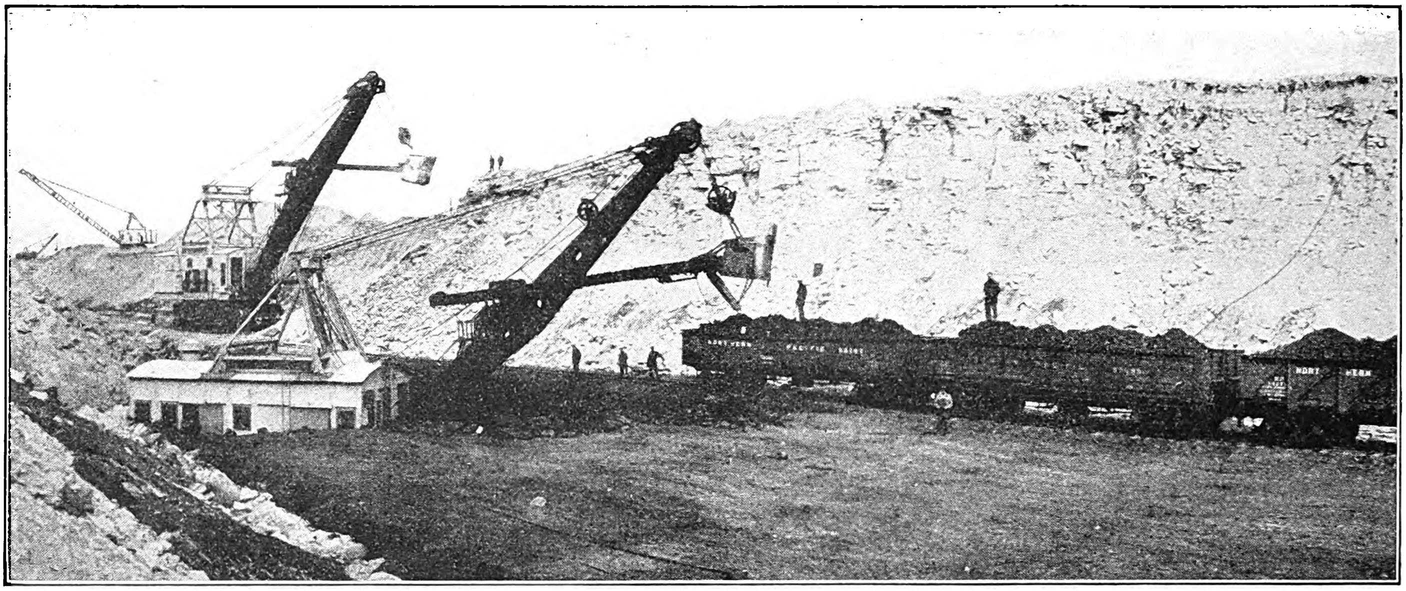
The small motion picture camera which has become so popular is capable of taking excellent pictures from the air. Good results can be obtained with ordinary film and the f.22 stop. Proportionately better results will be had with a panchromatic film and a K1 or K2 Wratten filter. The filter demands a longer exposure, of course. With the K1 filter, use f.16 stop while an f.12.5 stop may be used with the K2.

The motion picture cameras are handled similarly to the still cameras. Avoid vibration and wind blasts. A lens of focal length longer than 2 inches or 50 millimeters will lead to blurring of the resulting picture.

The first attempt at aerial photography may be discouraging. A little practice, however, will give results that are well worth the time and effort spent. More and more people are using aerial transportation. A great many of these passengers carry their cameras tucked away in their luggage. Why not use them en route? Parts of this discussion may seem too complicated to people who have always used their cameras simply to make unstudied pictures—snapshots on the spur of the moment. If you belong to this class, ignore the discussion of filters for the time being, make your snaps according to your usual methods, and you will be pleasantly surprised with the results. As time passes, you will gain by experience and may wish to improve your pictures by the use of filters. In any case remember that:

Working rules for amateur aerial photography may be concisely summed up as follows: 1.—Use as short an exposure as possible; 2.—Exposures in the air are approximately one third of those on the ground; 3.—Hold the camera in your hands and out of the wind to avoid blurring.

¶ *"When you buy your plane" is the subject of a comprehensive discussion coming in May. This article will tell you the things you ought to know if you are in the market for a plane for private flying. Read it and be prepared.*



STRIPPING OPERATIONS AT THE WORLD'S GREATEST OPEN-PIT COAL MINE

Scooping up eight tons of coal, the new electric loader dumps it in the waiting freight cars. The stripper follows, widening the cut and dumping the overburden in the channel behind the loading shovel. In the distance is shown a drag-line excavator with a 150-foot boom

Mining Coal With Mammoth Shovels

Open-Pit Mining Operations at Colstrip, Montana, Using New Operating Equipment of Unsurpassed Size and Efficiency

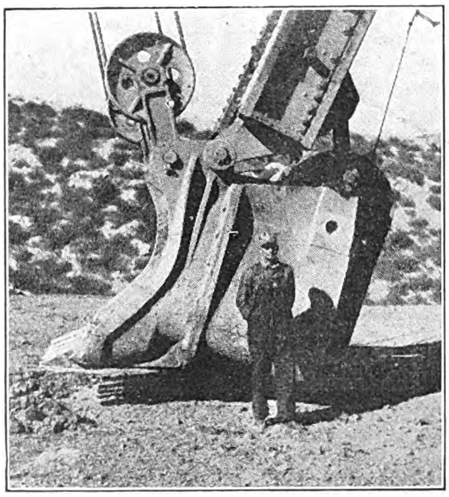
By HENRY W. HOUGH

ON-THE-SURFACE mining long has been recognized as the ideal method of extracting various minerals from the earth. Two noteworthy examples of such operations are the bench workings of the copper mines at Bingham, Utah, and the famous open-pit iron mines of the Messaba range in northern Minnesota.

Of the numerous coal "stripping" operations, perhaps the most interesting are those conducted by Foley Brothers, Inc., on the Northern Pacific Railway Company properties at Colstrip, Montana. At this mine, new operating equipment of the most advanced type recently has been installed. Colstrip is situated about 80 miles northeast of Billings in eastern Montana—part of the Great Plains.

MAN'S domination of the earth is appreciated when one witnesses the gargantuan work of a new electrically-driven machine, operated by one man, which bites a hole in the ground large enough to serve as the cellar for a house, and deposits the 15 tons of excavated earth a full city block away, perhaps at a height equivalent to that of a 10-story building. Within one minute the operation is completed, and the shovel is back for another 15-ton bite.

This machine, which recently has been placed in operation at Colstrip, is a newly designed Bucyrus-Erie stripping shovel. It weighs 1100 tons, has a 120-foot boom with 90-foot dipper sticks, and a dipper which handles from 10 to 15 cubic yards of material at each load. A special train of 60 cars was required to transport the parts for this equipment from the Bucyrus-Erie factory in Wisconsin to the mine in Montana. This shovel is noteworthy not only for its size and operating speed, but because it has what is probably the longest operating range of any shovel in the world, according to Mr. E. T. Foley, president of the contracting firm which has charge of the Colstrip operations.



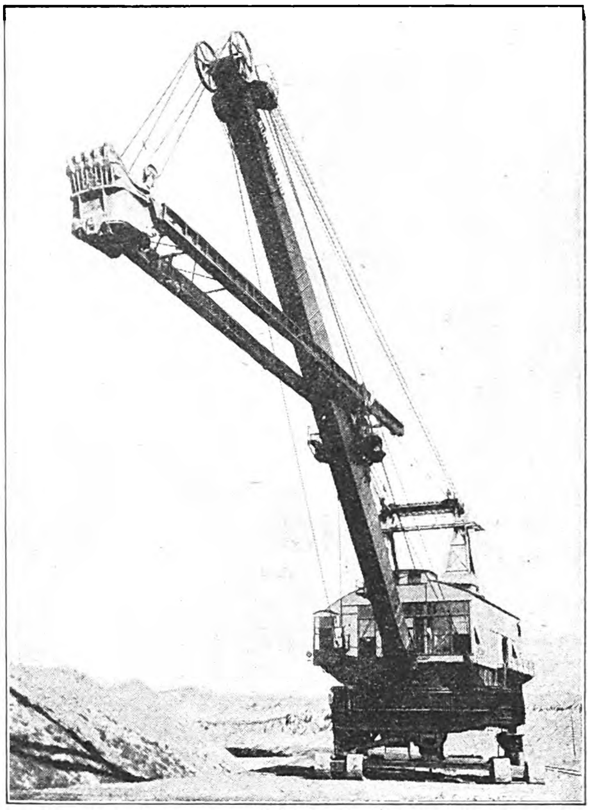
THE NEW STRIPPER'S DIPPER

Each time this new shovel bites into the earth, it removes 15 cubic yards of dirt

The stripping machinery was assembled in a new pit which will be two miles long and about 900 feet wide. This pit, which will be slightly longer than that in which operations were begun in 1923, contains more than 11,000,000 tons of coal. The deposit or vein of coal is from 22 to 28 feet in depth, which is several times the thickness of most veins which can be exploited economically.

A WORTHY team-mate of the stripping shovel described above is the new Bucyrus-Erie coal loading shovel, another recent installation. This machine lifts out more than eight tons of coal in one operation, raises its load to an unusual height, and dumps the coal directly into gondola cars standing on temporary railway tracks skirting the pit. This operation, as timed by a stop-watch, requires only 45 seconds. In a 10-hour shift this machine will dig and load 5000 tons of coal.

The combined capacity of this loader and a slightly smaller one which has been in use at Colstrip for some time, is 20,000 tons in 24 hours. This much coal would fill 400 average freight cars, or about 300 of the new 70-ton cars recently purchased by the Northern Pacific. The new shovel is probably by far the largest coal load-



READY TO MOVE A MOUNTAIN

This electric stripping shovel can dump its load at the height of a 10-story building, 300 feet away

ing shovel in the world, according to Mr. Foley. It is operated by an electric motor-generator set, as are all of the other large machines at Colstrip. The Montana Power Company supplies the electricity from its interconnected hydro-electric plants located in various parts of the state.

Other major items of the operating equipment now in use include a Marion drag-line excavator with a 150-foot boom and a six-cubic-yard bucket, a Marion stripping shovel with a rated capacity of eight cubic yards, two General Electric 72-ton storage battery locomotives, and a new General Electric-Ingersoll Rand Diesel-electric locomotive. All of this equipment is used in the pits, with the exception of the drag line, which is used in the initial work of removing the overburden. All of these enormous shovels, including the drag line, move from one scene of operations to another under their own power, crawling on huge caterpillar-type wheels.

BLACK blasting powder is used to loosen the overburden, a layer of sandy earth about 40 feet in depth. This common explosive, probably the oldest known to man, has been used for thousands of miles of railway and highway construction, and is considered "an old stand-by" in the mining industry. Liquid oxygen is becoming popular as an explosive for shooting overburden, but has not been used at Colstrip, to the writer's knowledge. After the layer of earth has been loosened, the drag-line excavator removes the dirt, piling it some distance away in a mountainous dump paralleling the pit or channel. About one and one half cubic yards of overburden are removed for each ton of coal, an uncommonly economical proportion.

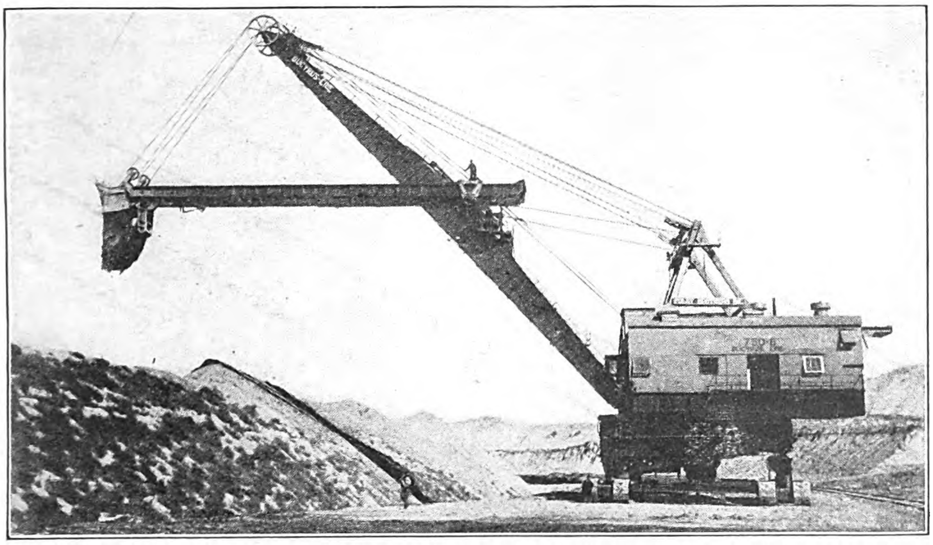
Railroad tracks are laid on top of the layer of coal, at one side of the cut. The coal to be removed is loosened blasting, and the loader in the pit scoops it up, raises it to the required height, and dumps the coal in the cars. Following the coal loader comes the stripper, widening the cut. As the overburden is removed, the stripper drops the dirt into the channel behind the loader. The dirt deposited in the cut takes up much more room than the coal did, so as the process continues, the landscape assumes the appearance of a series of miniature mountain chains placed side by side. From an esthetic point of view, the appearance of the landscape is not enhanced by stripping operations, but the workings present an interesting picture, particularly from an airplane.

Government geologists inform us that the Colstrip operations are being carried on in the Rosebud coal bed of the Tongue River member of the Fort Union formation. The Forsyth coal field, on which the Colstrip property is located, contains approximately 20,000,000,000 tons of coal and extends beneath a region about 800 square miles in area. This field is a section of the great coal bed underlying an enormous region in Montana, Wyoming, and the Dakotas. A strip mine in Wyoming, in another section of this remarkable deposit, is operating in a coal bed 79 feet thick.

THE coal mined in the Forsyth field is sub-bituminous, with heating value about 80 percent of coal produced in the deep mines at Red Lodge, Bearcreek, Bridger, Roundup, Sheridan, Sand Coulee, and other mining centers of the region. Representative analyses show the coal from the Rosebud bed (Colstrip) to contain from 9090 to 13,230 British thermal units. It is shiny black on a freshly exposed surface, but has a marked tendency to slack upon short exposure to weather, a weakness rather common to coals of the region.

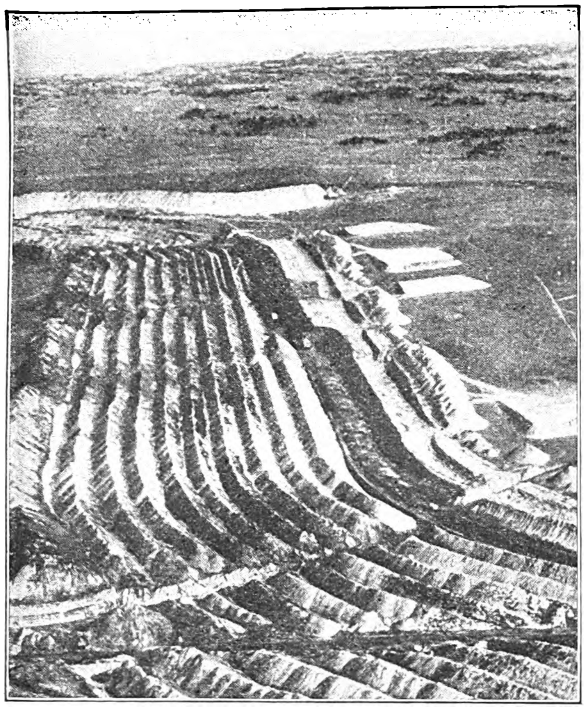
Coal always has played an important role in the development of frontier regions. This was particularly true in the northwest. When the surveyors were gathering data required by the Northern Pacific for constructing the first of the northern transcontinental railroads, their reports showed that the new road was to traverse one of the greatest coal bearing regions ever known. Pioneer settlers made it a practice to obtain their winter's supply of coal from the thick beds of the region simply by blasting it off the face of one of the numerous out-crops. The only easier method was to set fire to the out-crop, which was not an uncommon practice. However, such methods had their limitations.

NOT many years after the railroad opened up the country for settlement and development, dozens of coal mining towns had sprung into existence. At first they were kept busy supplying fuel to meet the railroad's needs, but later the industry expanded to meet the industrial and domestic requirements of the rapidly developing region. As the miners dug deeper and deeper and production became increasingly expensive, strange, disquieting



THE NEW STRIPPING SHOVEL IN OPERATION

Unusual size, exceptional operating speed, and unsurpassed operating range distinguish this one-man electric shovel. Note the relative size of the man on the dipper handle



THE COLSTRIP WORKINGS FROM THE AIR

Viewed from an airplane, the workings at Colstrip resemble a series of mountain ridges side by side

rumors began to reach the mining towns. It was said that a new mining property of fabulous character was to be developed by the Nothern Pacific, which had acquired from the government most of the valuable coal lands of the region.

According to these rumors, a great coal vein 25 to 30 feet thick had been located near Forsyth and was to be developed; the coal was so near the surface that it could be dug out by "steam shovels" and loaded directly into freight cars! To most of the miners it sounded like a myth. But industry demands ever-increasing efficiency. It is not enough to equal the production achieved last year by a given number of workers at the same cost. It is required that fewer men working under more favorable conditions shall produce more goods at less cost. Such an inexorable demand can be met in only one way — by creating and utilizing new and improved power-driven machinery to exploit the enormous deposits of low-grade coal. The myth become a reality—daybreak at Colstrip meant twilight at the deep mines.

ROSEBUD County, in which the Colstrip mine is located, now leads the rest of Montana in coal production. Fewer men were employed in the coal mines of the state last year, but the records show increased production and an increased output per man, at a reduced cost per ton.

Two or three men operating the new electrically-driven coal loading shovel described above can dig and load more coal in a shift than can dozens of workers in the average deep mine. Each worker in the pit averages 50 tons of coal a day, or about 10 times the normal unit production of coal mines. Not more than 75 men will be needed at the Colstrip mine to produce the 11,000,000 tons recently contracted for by the Northern Pacific. This amount of coal will be sufficient to meet the company's requirements for this class of fuel for the next eight years, according to present estimates.

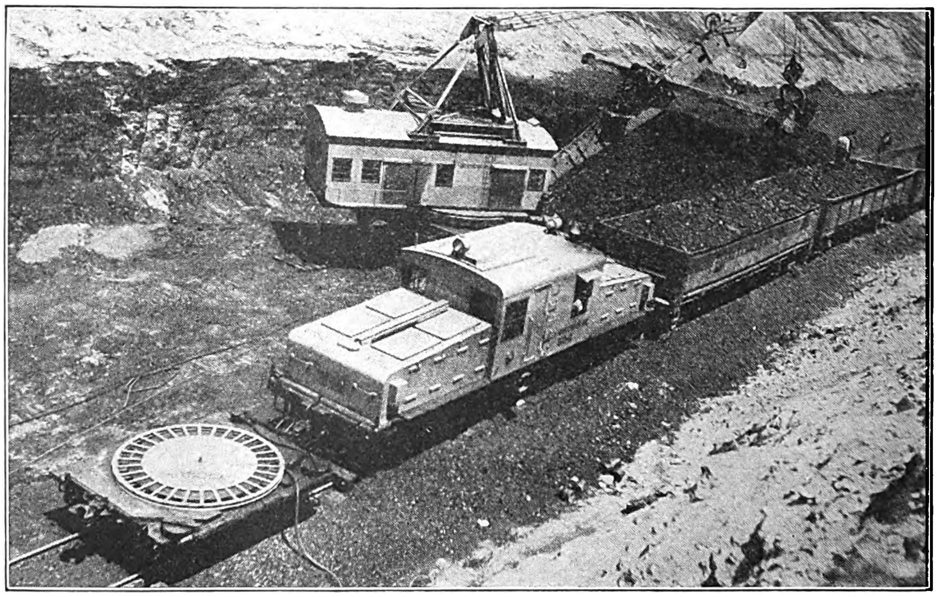
Far-reaching economy has accrued to the railway company through the opening of the Colstrip mine, under its contract with Foley Brothers. Shortly after the government returned the railways to their owners, an economical method was developed for obtaining coal from the Colstrip mine. Then, vigorously commanding its engineering talent, the railway company devised a thoroughly practical method of burning the lower grade coal in its steam locomotives. This proved to be a mechanical problem, involving reconstruction of the locomotive fire boxes.

Today this semi-bituminous coal is being used on all Northern Pacific freight and passenger locomotives operating between Spokane, Washington, and Jamestown, North Dakota. Operating department officials declare that the cheap fuel from the Colstrip mine largely was responsible for decreasing the Northern Pacific's coal bill from 10,233,708 dollars in 1923 to 6,113,721 dollars in 1929.

Revolutionary changes have been made in the type and size of the locomotives, with many resultant economies. Locomotives have been made to haul trains longer distances, and the power of each engine has been increased greatly. In 1922 the company owned 1441 engines with an average power or tractive effort of 38,143 pounds. Between 1922 and 1929 many uncommonly large locomotives were purchased, making it possible to displace and dismantle a large number of the smaller engines. Within this period, the number of locomotives owned by the company was reduced from 1441 to 1099. The average power of each engine was increased to 41,244 pounds.

AS a direct result of using Colstrip coal, the company recently purchased the largest steam locomotive in the world. Its enormous proportions are due to an advanced mechanical design permitting the use of lower grade coal. This locomotive is 125 feet in length, and is of the Mallet type, used in mountainous districts. An order for 11 more of these large Mallets has been placed, and when they are received 28 more engines of ordinary size will be displaced and dismantled. The average power (tractive effort) of the locomotives owned by the Northern Pacific then will be 42,870 pounds.

For many centuries miners have been digging tortuous tunnels deep into the earth in the quest for coal and ore. The development of open pit mining on a large scale is a relatively new phase, but already it has become of great importance in the mining industry. During the average year, the open-pit mines of this country produce approximately 19 million tons of coal, 24 million tons of copper ore, 32 million tons of iron ore, nearly three million tons of pebble phosphate, and about 150,000 tons of bauxite (aluminum ore).



LOADING NINE COAL CARS IN AN HOUR, WITH ONE SHOVEL

Digging into a coal vein which averages 25 feet in thickness, this new shovel can dig and load 5000 tons of coal in a 10-hour shift. Note the electric locomotive hauling the coal cars

Unbreakable Movie Film

Steel-Sheathed Film Reduces Replacement Costs; Has Great Educational Value

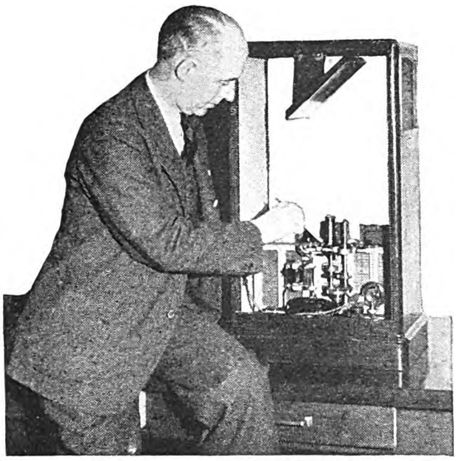
FROM the earliest development of motion pictures to the present day, the most costly, annoying, and wasteful defects in projection methods have been the breaking and scratching of film. The cost of renewal prints aggregates millions of dollars each year.

In the rapidly developing use of 16-millimeter or "narrow width" film, which is only six one-thousandths of an inch thick, film breakage is even a greater problem. Millions of dollars have been lost in attempts to develop 16-millimeter projectors with break-proof film for advertising, educational, and "nickel-in-the-slot" motion picture purposes. Projectors for these fields must operate hour after hour and day after day, thus requiring the film to run through the mechanism thousands of times.

The accompanying photographs illustrate the Dramagraph, a recent invention of Van Dyke Hill, of the Dramagraph Motion Picture Corporation, New York City. The outstanding feature of this projector is the steel-clad, break-proof film used therein, and the method of projecting these strips in a connected sequence to give an unbroken picture on the screen.

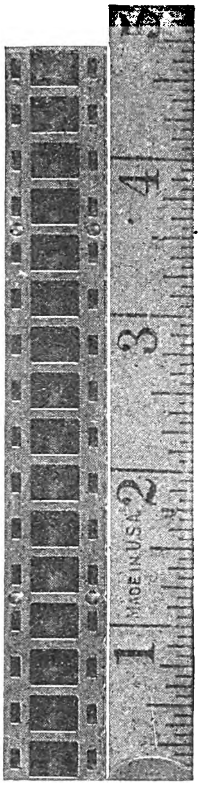
The film, cut in 4¾-inch lengths, is sealed between two pieces of thin steel through which an aperture for each frame has been punched and along the edges of which are a number of holes that are equivalent to the sprocket holes in the film. Each film section is equal in length to 16 pictures or approximately 1 second of projection; hence a hundred feet of 16-millimeter film can be loaded into 250 sections.

The sections are stacked horizontally in recesses in the main casting of the projector. Over one recess, or magazine, is an electro-magnet which draws the top section into a breach located at one end of a horizontal track. Claws operating from an intermittently moving shuttle engage the holes along the edge of the frames and progressively move the sections across the bridge to the take-up magazine. Located mid-way of the bridge is the light aperture through which the beam of light emanating from a 100-watt lamp is directed vertically through the film and lens. This beam is deflected along a horizontal axis onto a translucent screen by a superimposed mirror.



THE PROJECTOR APPARATUS

The light beam is projected upward and is turned through an angle by the mirror



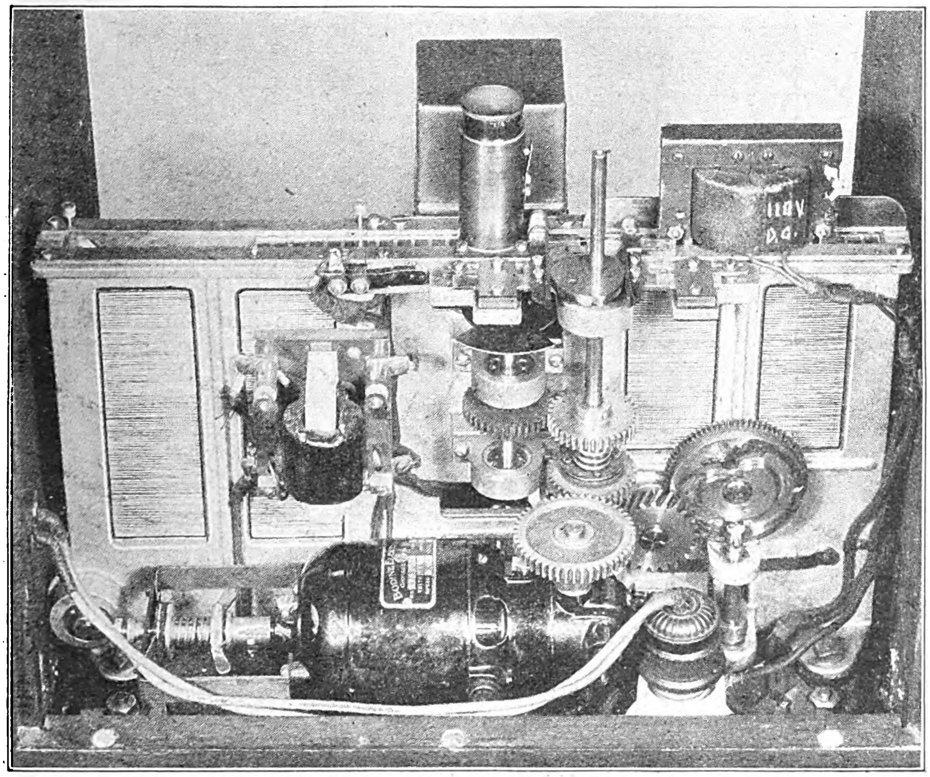
UNBREAKABLE

A sixteen - frame section of 16-millimeter film in its steel protector, compared to an inch rule, at the right

AFTER the film sections have passed beyond the aperture, they drop by gravity into the take-up magazine, at the bottom of which is a horizontal conveyor chain equipped with claws which slide the bottom sections off and convey each synchronously to a lifting mechanism at the bottom of the feed magazine. This lifting mechanism elevates each individual frame to a point above a group of spreading pawls which support the stack of frames in the feed magazine.

The frames thus travel upwardly, across the bridge, down through the take-up magazine and return horizontally to the bottom of the feed magazine, the movements being perfectly synchronized. Test runs exceeding 15,000 passages through the system have shown no wear whatever upon the film.

Plans have been made to introduce this type of projector in museums of natural history, libraries, art museums, medical and technical schools, and similar institutions in a form whereby students or visitors can operate motion pictures at will by the mere pressing of a button. The invention will also be used with 35-millimeter film for projecting 10-foot wide motion picture advertising posters in natural colors through translucent screens.



THE INTERIOR MECHANISM

The 4¾-inch sections stacked in the magazine at the right, are drawn upward by a magnet, to the left through the light beam under the lenses in center, and into magazine at the left

Substituting for Sunlight

Has a New Era of Artificial Lighting Arrived? Illumination That Approximates Sunlight Is Foreshadowed

By M. LUCKIESH

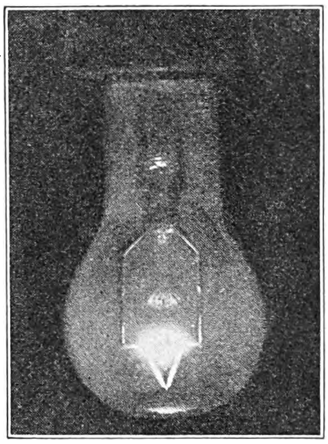
Corresponding Editor, SCIENTIFIC AMERICAN. *Director, Lighting Research Laboratory, Incandescent Lamp Dept. of the General Electric Company, Nela Park, Cleveland*

FOR many centuries man has recognized instinctively, or through vague experience, that sunlight is directly or indirectly involved in life processes. During recent years scientific research has firmly established many interesting facts. Ultra-violet radiation was discovered over a century ago, but only during recent years has its influence upon health been established. Much scientific research is needed to fill the many gaps in our knowledge of curative and health-maintaining value of solar radiation. However, we have sufficient scientific knowledge of the beneficial effects of sunlight which, combined with a justifiable recognition of the general importance of sunlight as an ever-present environmental factor, leads us to look forward to the possibility of a new era of lighting with simulated sunlight.

SUCH a point of view, while admitting the desirability of much more scientific knowledge than is available at present, avoids the necessity of making detailed claims for simulated sunlight produced artificially. If an artificial source of radiation emits energy throughout the spectral range of solar radiation (to λ2900) and is found to be an effective substitute for sunlight in those phases of health maintenance and of curative effects which have been established for sunlight, we who light the world are justified in preparing for the opening of a new era of lighting. During the past few years we have been passing through the rudimentary stage of lighting for health as well as vision.

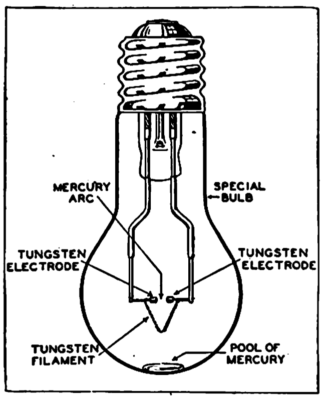
Professional practitioners of radiation therapy, manufacturers of devices which supply ultra-violet radiation, and users of "home treatment" apparatus have not generally recognized the past decade as an evolutionary stage. However, it has been just that. Light for vision is emitted by all the practicable sources of ultra-violet radiation. Up to the present time, the use of the light for vision has been ignored and the effects of ultra-violet radiation have been emphasized, while outdoors throughout the ages man has used sunlight for vision and the health benefits have been ignored or at most have been secondary in his consciousness. With certain beneficial effects established it is logical that we are now ready to consider lighting for health, as a possible adjunct or result of artificial sunlight, incidental in our consciousness as we proceed with our everyday activities.

Anyone who has read, or pursued any other visual task, while exposed to the radiation from one of the many sources available, unconsciously ushered in (for himself) this new era of lighting for health as well as vision. For this act to spread throughout our world of human activities it is necessary that the illuminant contain insufficient radiation of such wavelengths as are harmful to the eyes. Naturally solar radiation, excepting in extreme cases such as reflection from snow, produces beneficial results without the production of conjunctivitis[1] or other known injury. Artificial sources of health maintaining radiation, in order to be used widely for this extended purpose, must meet certain requirements already firmly established in lighting practice. Convenience, safety, simplicity, flexibility are important factors in lighting. The quality or color value of the light must be acceptable.



THE NEW TYPE S-1 LAMP

It is simple and compact, 6¼ inches in length. Its white light, regarded as illumination, is strikingly like natural sunlight



We have available some of the old sources such as carbon arcs, the mercury arc, tungsten filament lamps, and new sources such as the tungsten-mercury Type S-1 lamp and, of course, further new developments. We have sunlight to utilize with special ultra-violet transmitting glass, but artificial light has long ago become an essential to our indoor world. Nearly everyone spends sufficient time under artificial light, and its cost has long ago come within the range of the cost of daylight, so that we may look upon it very generally as an adequate dispenser of the health-maintaining radiation which apparently is chiefly confined to the region between λ2800 and λ3100.[2]

THE sources of light and suitable ultra-violet radiation can readily be screened or so installed in fixtures that the rays that are harmful to the eyes are absorbed by proper transmitting or reflecting media. Already we have a great supply of such data pertaining to the spectral transmission and reflection of common media. But those heretofore interested in lighting must alter their point of view, for materials which conserve light do not necessarily conserve the valuable ultra-violet radiation.

Among the metals, chromium and aluminum reflect quite well throughout the visible and important ultra-violet regions. Oxidized aluminum is particularly efficient throughout this range. Among the white pigments which are approximately equally efficient reflectors of light for vision there is a great diversity in their ability to reflect ultra-violet radiation for health. For example, zinc oxide reflects very little ultra-violet radiation, its absorption being almost complete for radiations shorter than λ3900—the limits of the visible spectrum. Although titanium pigment, lithopone, and tin oxide efficiently reflect radiation of shorter wavelengths, none of them reflects appreciable energy in the vital region between λ2800 and λ3100. White lead reflects fairly well in this region.

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[1] Conjunctivitis is inflammation of the outer membrane of the eye.—*The Editor.*

[2] The Greek letter λ is a conventional symbol to indicate the wavelength of radiation in Angstrom Units, one Angstrom Unit being a ten billionth of a meter. Radiation of wavelengths in the region between λ2800 and λ3100 Angstrom Units, mentioned by the author, would be in the ultra-violet.—*The Editor.*

The vehicles in which pigments are used in paints and enamels are likewise important. A common mistake is the use of vitrified white enamel reflectors for ultra-violet sources. The "glass" carrier of the pigment absorbs the desired ultra-violet energy. In fact, a black paint is practically as efficient for reflecting this energy as the common porcelain enamels, and graphite is better than several common white pigments.

Transparent glass can be made to transmit as far into the ultra-violet region as desired. Quartz transmits efficiently much farther than desired for the purpose under discussion. Translucent quartz can be produced at reasonable cost to be practicable in fixtures for this new era. Between quartz and common glass there are many possibilities. Apparently, purity of materials commonly used in glass is all that is necessary to extend the transmission to λ2800. However, iron oxide as an impurity is the greatest nuisance. It must be reduced to 0.01 percent if high transmission is to be obtained, even as far as λ2970, which is the region of greatest effectiveness in the cure of rickets and in the production of erythema or reddened skin.

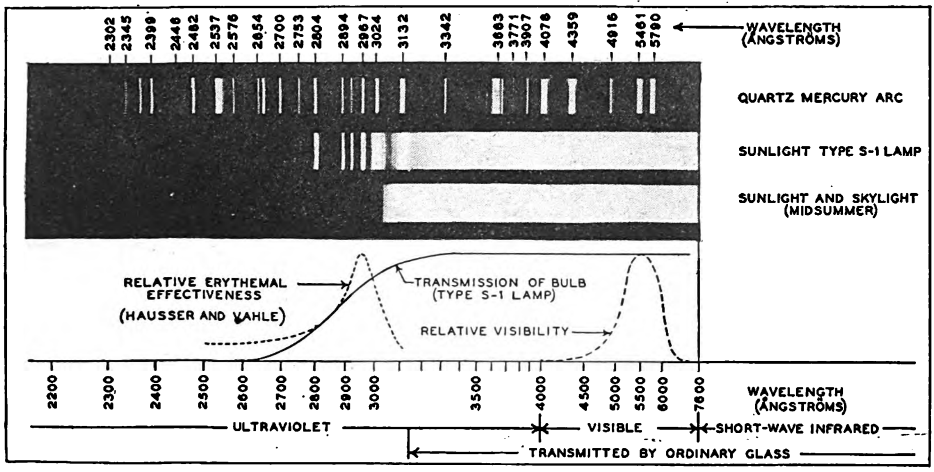
THE production of erythema is important as a step between energy measurements and physiological action. It is also important because it is a visible and sometimes painful result of exposure to ultra-violet radiation. We have found that measurements of energy at λ2968 or λ3024, emitted by the mercury arc, are directly correlative with erythemal effectiveness. In other words, the production of erythema is directly proportional to the quantity of energy in either of these wavelengths. There are indications that this holds approximately for other sources.

Exposure consists of the quantity of energy per unit area and the duration of the application. Exposure to a quartz mercury arc at a distance of 30 inches for a period of five to ten minutes is sufficient to prevent and cure rickets if applied only once or twice a week. Obviously this is entirely too potent to be used in lighting where persons are exposed hours daily, unless the intensity of illumination is greatly reduced. Of course, with such an illuminant goggles would have to be worn in order to protect the eyes. This emphasizes one of the qualifications of an illuminant suitable for this extended lighting purpose. A suitable glass for filtering out too potent radiations can be used with the mercury arc, and such glass is being experimented with. Likewise, any source can be made safe for the eyes.

In our study of the tungsten-mercury arc (Type S-1 lamp) we found that the reciprocity law held for erythemal effectiveness over a range of 25 to 400 foot-candles. In other words, an exposure of 10 minutes' duration at 400 foot-candles produced the same degree of erythema as an exposure of 160 minutes at 25 foot-candles.

This brings up the question as to the necessity of producing erythema in order to obtain health benefits. Much evidence points to no such need. In fact, our common experience with sunlight is usually without erythemal result, still we feel that it does us good. Consideration of this question is also connected with that of the minimal quantity necessary to obtain health benefit. Prof. R. Adams Dutcher reported to me several years ago the results obtained with an ordinary 50-watt tungsten-filament lamp on rats which were fed upon a restricted diet. This small lamp was operated in their cage from six to eight hours per day. In three weeks their bone-ash was more than twice that of the control group which was kept in darkness.[3]

This experiment seemed worth repeating, so we made some 500-watt tungsten-filament lamps in special bulbs. Doctor George H. Maughan at Cornell University found that under 20 foot-candles of this illuminant for eight hours per day appreciable improvement was made by chickens which initially had severe rickets. Doctor H. J. Gerstenberger of the Babies' and Childrens' Hospital in Cleveland co-operated with me by using the radiation from this tungsten-filament lamp upon guinea pigs fed upon a restricted diet.[4] For several weeks rickets was warded off.



SPECTRAL CHARACTERISTICS OF THE SUNLIGHT TYPE S-1 LAMP

The diagram will repay detailed study for it reveals very many significant facts

In this brief account space does not permit going afield or into detail. However, I have given glimpses of dependable data at both ends of the scale—extremely mild and extremely potent ultra-violet radiation. I have obtained sufficient data during recent years with this extended purpose of lighting in mind to feel encouraged to venture into a new era of lighting. I am certain that results can be obtained by means of a properly safeguarded illuminant at the foot-candles required in modern lighting. Many questions still arise. For example, is a substitute for sunlight when used in lighting for health as well as vision a substitute for vitamins? In the case of rickets it has been proved to be an adequate substitute for vitamin D. Whether or not it is a complete substitute need not concern us unduly because people must eat.

IN considering health maintenance along with lighting for vision we are confronted with the same questions as arise in the use of "health equipment" in the home. Much more research has been directed toward the cure of disease than toward the maintenance of health. At first glance it may appear to be impossible to prove whether a group of persons in normal health is aided in maintaining that state of health by exposure to ultra-violet radiation. However, research can establish a good deal along the line of prevention. It has been proved that rickets is prevented by 15 minutes' daily exposure of the body to adequate sunlight. There is some evidence that colds are less prevalent in a group of persons treated with ultra-violet radiation than in a group not treated. Medical men advise sunlight for health maintenance. Certainly interiors should be freed of some of the germs when illuminated by sources emitting ultra-violet radiation between λ2800 and λ3600 which has been proved to be germicidal.

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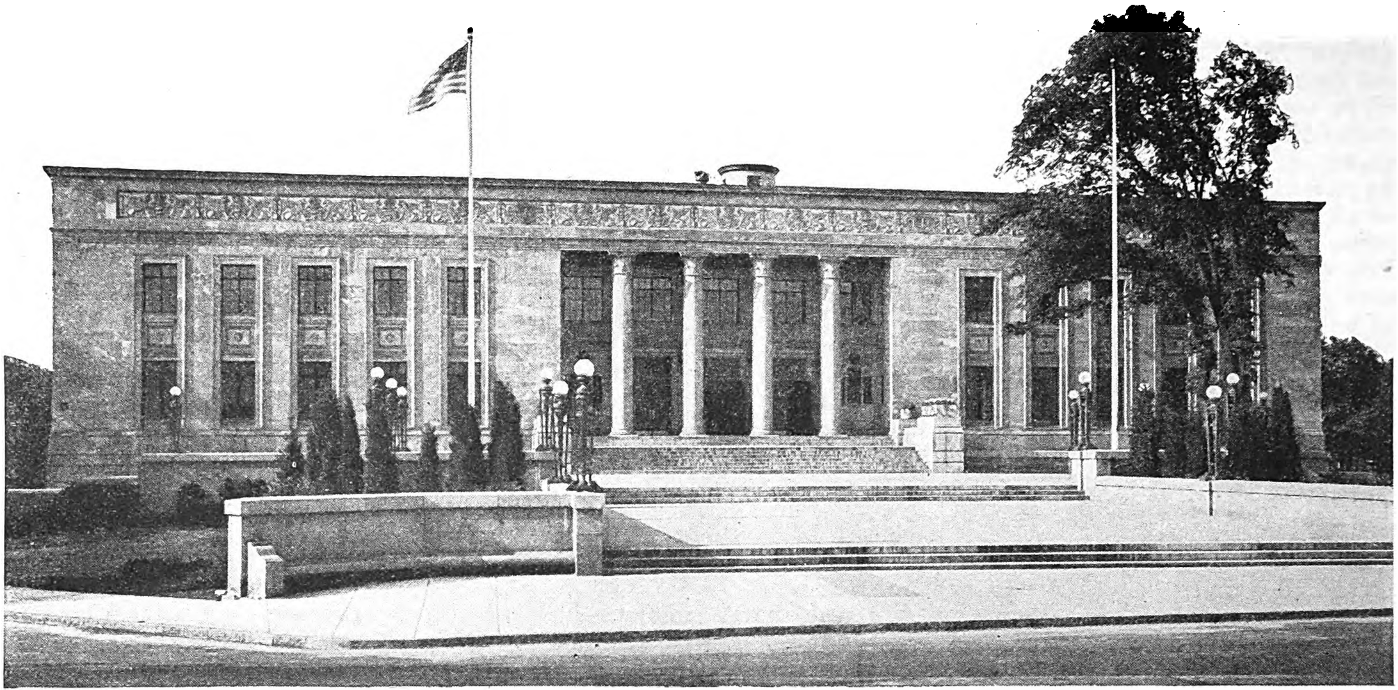
[3] Rickets is a bone-deficiency disease often caused by lack of enough ultra-violet of proper wavelength to cause the bone-forming elements of the diet to be deposited in the bones. In experiments on rats the amount of bone-ash found after the animal has been killed at the end of the experiment bears a relation to the amount of ultra-violet of appropriate wavelength that it has had.—*The Editor*.

[4] In making experiments of this kind on animals it is usual, in order to exclude as far as possible outside factors which might confuse the results determined at the end, to restrict the diet to food elements which do not themselves tend to prevent the occurrence of rickets.—*The Editor*.



All photographs courtesy Buffalo Museum of Science

THE BUFFALO MUSEUM OF SCIENCE

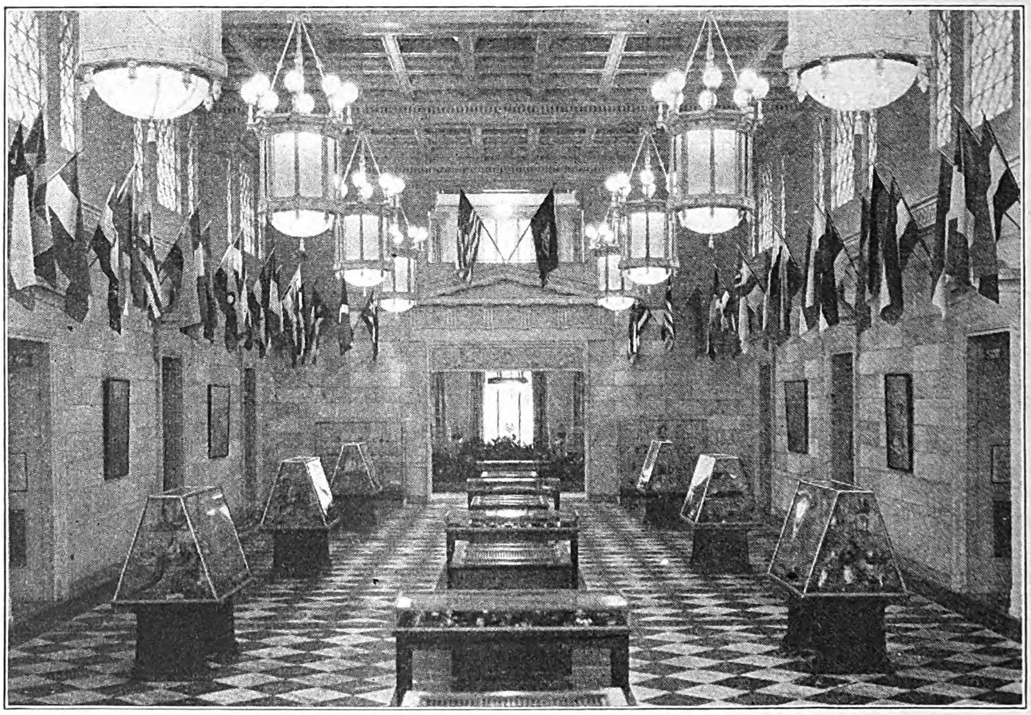
A modern adaptation of classical architecture gives the severe lines appropriate for a science museum. The approach is 100 feet wide. Most of the exhibition halls are illuminated with artificial light only, and many of the animal groups are in miniature form, conserving space

A Friendly Museum

Doing Away With the Disease Called "Museum Fatigue" by Skillful Planning and Lighting

IN the dedication address at the formal opening of The Buffalo Museum of Science, the President, Mr. Chauncey J. Hamlin, aptly described the function of a museum which is often lost to view. He said: "The value of a museum to its community must be measured in terms of service to the citizens of that community. In order to render the largest measure of service possible the museum must be dynamic and not static; it must be not a storage warehouse of dead objects but a hive of spontaneous activity, ever storing up the honey of pleasant memories of having brought a larger share of happiness and joy through opening up fuller and wider horizons of knowledge to a constantly growing circle of friends."

It was with this end in view that the Buffalo Museum of Science was built. The Buffalo Society of Natural Sciences dates from 1858, so there is a real historical background. There are many features of the museum which are unique. It is neither too large or too small. It is not "highbrow," yet it is not at any time unscientific. A pleasure is in store for all who visit Buffalo. The activities of the staff are really remarkable and the organization is a model one. An investment of 2,000,000 dollars has been wisely made. Other cities have science museums either in whole or in part, but this museum has great points of difference which we will endeavor to explain. The museum is located in Humboldt



THE CENTRAL HALL

The artificially lighted exhibition halls open from the great central hall and display the whole circle of the sciences. The exhibits are all so beautifully balanced that the visitor does not tire easily

Park and while the location might have been made more central, the effort expended in getting there will be well repaid.

The building of Indiana limestone appears to be two stories in height set on a high base. Actually it contains a high ground floor story with three floors above it, although the upper floor does not show in the exterior.

The architects were requested to do everything possible to avoid that dread disease known as "museum fatigue." The architects decided that the malady was caused mainly by three things: First, hard floors; second, eye fatigue caused by the necessity of constantly shifting the foci of the eyes from the usual high ceilings in museums down to a nearby exhibit, this often being accentuated by the daylight from the clerestory windows or skylights; third, reflections from the exhibit cases.

To avoid hard floors, rubber and linoleum surfaces were used. To remedy the second cause of fatigue, the ten exhibit rooms were built with rather low ceilings and are softly illuminated by direct artificial lighting. A special exhibit case and plan of lighting were designed to meet the third difficulty.

The usual exhibit case is illuminated by lighting the room brightly and borrowing that light for the exhibit cases. The reason that the lights cannot be placed directly within the cases is because many exhibits are of wax, and they would be destroyed by the heat from the lamps, and it is necessary that all exhibit cases be air- and dust-tight. Fortunately, in the Buffalo Museum, it was decided to use many photographic transparencies to compose an illustrated guidebook to each room. This allowed the exhibit cases to be designed with the electric lights so arranged that they illuminate the transparencies directly but are separated from the exhibit.

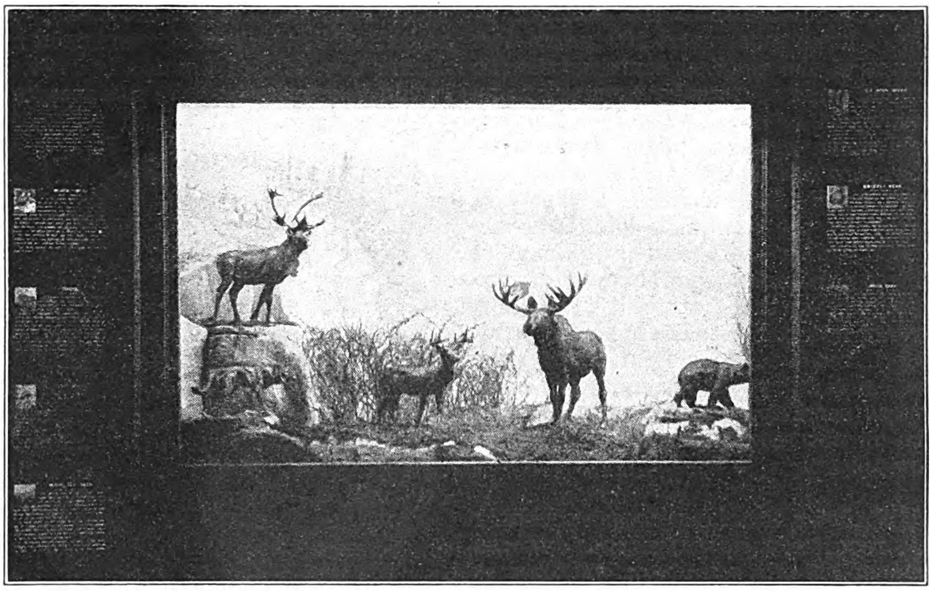
Off the central hall are a series of rooms devoted to physics, astronomy, geology, biology, invertebrates, vertebrates, evolution, heredity and environment, human geography and climate, and primitive races. In the rear is a large hall of plant life. On the second floor are the offices and library; an aquarium room is over the hall of plant life. The third floor contains the laboratories and preparation rooms which are splendidly equipped. On the ground floor is the auditorium, a cafeteria, offices, and a children's museum with a separate entrance.

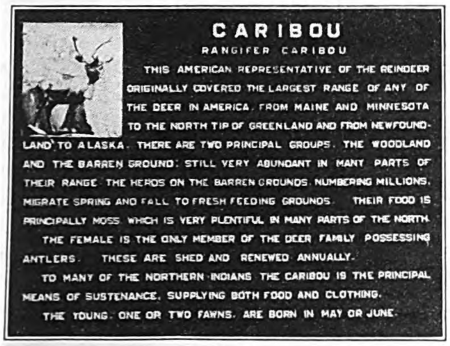
MAKING ARTIFICIAL FOLIAGE

The extensive laboratories and preparation rooms are on the upper floor

ILLUMINATED LABELS ∀ ➢

The group shown at the right is in miniature and illuminated labels at the side serve to interpret the group. The labels [below] incorporate text and a picture of the animal itself





CARIBOU

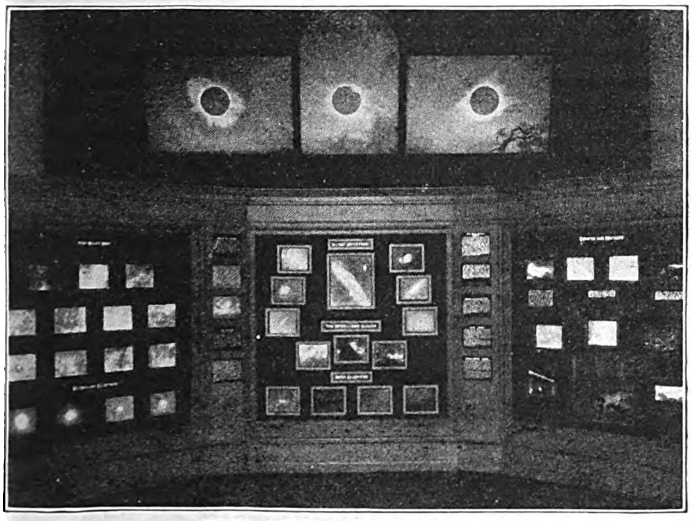
RANGIFER CARIBOU

THIS AMERICAN REPRESENTATIVE OF THE REINDEER ORIGINALLY COVERED THE LARGEST RANGE OF ANY OF THE DEER IN AMERICA. FROM MAINE AND MINNESOTA TO THE NORTH TIP OF GREENLAND AND FROM NEWFOUNDLAND TO ALASKA. THERE ARE TWO PRINCIPAL GROUPS. THE WOODLAND AND THE BARREN GROUND: STILL VERY ABUNDANT IN MANY PARTS OF THEIR RANGE. THE HERDS ON THE BARREN GROUNDS. NUMBERING MILLIONS, MIGRATE SPRING AND FALL TO FRESH FEEDING GROUNDS. THEIR FOOD IS PRINCIPALLY MOSS. WHICH IS VERY PLENTIFUL IN MANY PARTS OF THE NORTH.

THE FEMALE IS THE ONLY MEMBER OF THE DEER FAMILY POSSESSING ANTLERS. THESE ARE SHED AND RENEWED ANNUALLY.

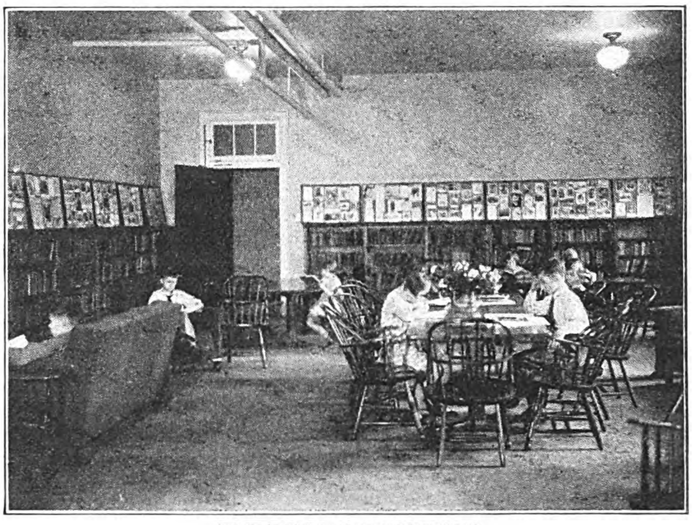
TO MANY OF THE NORTHERN INDIANS THE CARIBOU IS THE PRINCIPAL MEANS OF SUSTENANCE, SUPPLYING BOTH FOOD AND CLOTHING.

THE YOUNG. ONE OR TWO FAWNS, ARE BORN IN MAY OR JUNE.



THE ASTRONOMY ROOM

The photographs are all illuminated as are all the labels, producing an excellent effect. Such exhibits have great educational value



BUDDING SCIENTISTS

The children have their own museum, their own library, and even their own private entrance to them. They enjoy their privileges

Some Famous Centenarians

There Is No Recipe for Longevity, Which Is Mainly Hereditary. However, a Milk Diet Seems to Favor Long Life

By JAMES A. TOBEY
Doctor of Public Health

NINE persons who had reached the age of 100 or over died in Ohio in 1928, according to an item in a recent issue of the *Journal of the American Medical Association.* Of these nine centenarians, five of whom were women, one was stated to have been 114, according to her original birth certificate. The average age of the nine was said to have been 103 years and six months.

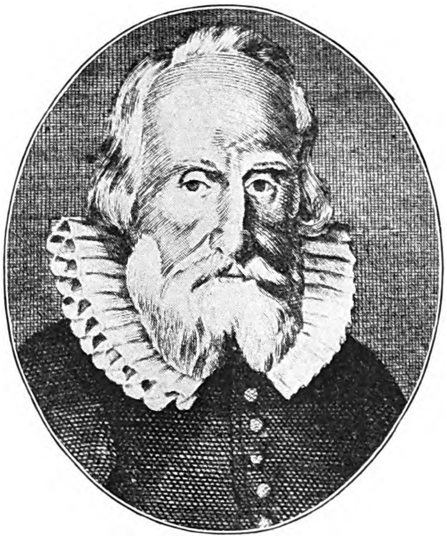
Many individuals are asserted to have lived more than 100 years, but most of the reputed centenarians are found on rigid investigations not to be centenarians at all. The age of a very old person seems to be one of the matters most susceptible to deviation from the truth, for memories are usually hazy in the extremely old, and the relatives, friends, and neighbors of these patriarchs seem always ready to exaggerate their antiquity. A few years ago a Kentuckian named John Shell received considerable notoriety as being 131 years of age, but a somewhat searching inquiry revealed him to be not more than 100, if he were even that.

IN 1904 a Russian newspaper calmly reported the death at the advanced age of 180 of a woman named Therese Abalva. Another Russian newspaper in 1926 was more modest, for it allotted only 138 years to Ivan Tretya, a peasant of Rostov. A Hungarian farmer, Peter Zortay or Torton, exceeded them all for he was supposed to have been 185 when he died in 1724; as was also St. Mongah, whose death occurred in 1781. Some months ago Henri Barbusse, the French author, recounted his visit in Georgia in Transcaucasia to Nikolai Andreyevitch Shapkovsky, who was reputed to be between 142 and 147.

The cautious reader will regard these allegations with as much skepticism as interest.

One of the most famous of the very aged persons of history was Old Parr, who was said to have been born in England in 1483 and to have died there in 1635. He was working blissfully as a tarm laborer at the tender age of 152 when an interested nobleman, the Earl of Arundel, whisked him off to London and put him on exhibition. The fast life of the metropolis proved too much for him and he promptly succumbed. Thereupon, one John Taylor, known as the "Water Poet," got out a book called "The Olde, Olde, Very Olde Man," in which he extolled this long life in prose and verse, or what passed for verse. Thomas Parr was said to have married at 120, and after the suitable interval to have become the father of a child. When he died in 1635, the celebrated William Harvey, discoverer of the circulation of the blood, performed an autopsy on him and found his general condition good, though the brain cells were somewhat worn. A reprint of Taylor's book was issued by James Caulfield of London in 1794.

Old Parr's unusual age was accepted until 1873 when Mr. W. J. Thoms, deputy librarian of the House of Lords, who was so unkind as to make a real investigation of the case, concluded that about 50 years had been improperly tacked on to the actual life of Parr. The gentleman was a real centenarian, but little more than that.



NOT MORE THAN 100

Old Parr claimed to have been 152 years old, but unkind investigators proved he was mistaken by 50 years, more or less

Mr. Thoms also exposed two other notorious long-lifers. A certain Countess of Desmond was credited with 140 years, but the doubting librarian showed that the ages of two separate countesses of the same name had been added together; instead of one person living to 140 years, two ladies had each lived about 70. Thoms examined, in all, 22 cases of alleged longevity and found that none of the records sustained the contentions of centenarianism.

A writer familiar with Mr. Thom's iconoclasm on this subject, a Mr. John B. Bailey, wrote a book in 1888 which he called "Modern Methuselahs," and in it he cited a number of instances of well-known centenarians and nonogenarians.

He began with St. Anthony, who was said to have lived to 105, but most of his other examples, such as the Emperor Cantacuzenus of the 14th Century, Pletho, Cornaro, Titian, de Fontenelle, and Amory, were only 99 or 100. The author, however, did list a dozen cases which he believed to have been actually 100 years old or more. This writer waxed philosophical in his final chapter and, while admitting that these human century plants reached their great ages in spite of a diverse variety of habits, offered a recipe for longevity. His three essentials for "long-lasting" were: good heredity, good digestion, and bodily and mental activity. He quoted these words of Sir Benjamin Brodie, "Men have been known to die, literally speaking, of disease induced by intellectual vacuity."

ONE of the best surveys of centenarians was made in 1899 by T. R. Young, former president of the British Institute of Actuaries. At that time he could find only 22 indisputable instances of such aged persons, but in a second edition published in 1905, he added eight more. The longest authentic life he could discover was one of nearly 111 years. Mr. Young discusses all of the previous works on longevity, of which there had been a considerable number, such as the works of Flourens in 1855, of Pinney in 1856, and of Humphry in 1889, as well as that of Bailey alluded to above. Contrast the conservatism of Young with the exuberance of one James Easton, who in 1799 got out a book listing 1712 persons who had lived 100 years or more between 66 A.D. and 1799 A.D. Old Parr and the Countess of Desmond were both on his list.

In a rather weighty tome on the prolongation of life, Professor Eli Metchnikoff, the famous bacteriologist, hazarded the opinion some 20 years ago that human life ought to average at least 120 years. In his book he describes various persons who were supposed to have attained great ages. Among them were Marie Priou, who died in 1838 at the alleged age of 158, after subsisting for most of her life on cheese and goat's milk; and there was also Nicole Marco, who lived to be 110 on a diet of bread and milk.

The Metchnikoff formula for long life was to drink soured milk containing the Bulgarian bacillus, though he also recognized the value of hygiene and sanitation. Today it is known that it is not the B. Bulgaricus, but the acidophilus bacillus, in soured milk which exerts a favorable influence on the digestive tract and hence contributes to longevity. Metchnikoff's theories were based on observations on the vigor and longevity of various Balkan peoples who lived on such fare. It is claimed that Bulgaria has more than 3000 centenarians even today, while other Balkan countries such as Rumania and Turkey are likewise so favored.

A WOMAN, Maria Ustav, who died in Carcalia in Rumania in 1927, was asserted to have been 135, while Milo Frantsitch of Yugoslavia, who also died in 1927, was reputed to be 126. Zaro Ago of Constantinople was living there in 1928 at the alleged age of 145. These people are undeniably old; you can believe the actual ages given for them or not, as you think best. Personally, I have my doubts.

The alacrity with which newspaper writers seize upon convenient facts regarding supposed centenarians and exploit them in the press is well illustrated by the news story about old Nah-Nee-Num-Skuk, which appeared in the papers a year or so ago. This ancient red man was definitely asserted to have been born in 1809 and thus to have been 118 years old in 1928, but not one scintilla of real evidence of his age was offered, unless the fact that he had had six wives could be so considered. More than a mere statement of extreme old age is needed to be convincing. There is, unfortunately, no way to diagnose exact age from appearances or physical condition. Authentic birth records offer about the only reliable proof.

In the Massachusetts town of Shutesbury is a monument to one Ephraim Pratt, who is stated to have died there in 1804 in his 117th year. According to the inscription, "He swung a scythe 101 consecutive years and mounted a horse without assistance at the age of 110." An investigation of this case by Mr. Leon F. Whitney revealed that old Ephraim had indeed been a centenarian, but that he did not live more than 100 years. Mr. Pratt's longevity was attributed to his diet, which was said to have consisted chiefly of bread and milk.

The question arises as to whether diet may not actually have an effect on the length of human life. That it may do so is indicated rather definitely by some extensive experiments conducted in the laboratory of Professor Henry C. Sherman at Columbia University in New York. For more than ten years extensive nutritional investigations have been carried out there on white rats. In a study of 400 of these animals, it was found that by doubling the amount of powdered milk in the diet, a gain of exactly 10 percent resulted in the span of life for both the males and females.

In human experience (for studies on laboratory animals may properly be compared to it) this would indicate that at least six years could be added to human life by means of proper and optimal nutrition. Pure milk, the most nearly perfect of the foods of man, was successful in lengthening life in this instance, and it is interesting to note that most of the famous true centenarians are reported to have subsisted largely on diets in which dairy products have been prominent.

NAH-NEE-NUM-SKUK, 120?

Born in 1809—according to the newspapers—this old Pottawatomie still was living at a Kansas reservation in 1928

Nutrition is, of course, only one of many factors which may influence longevity. The most important element in the ability to live long unquestionably is heredity. If all or most of our immediate ancestors attained to ripe old ages, generally well past the proverbial three score years and ten, it is likely that we shall also do so, provided we can escape the ravages of disease, avoid accidental death, and refrain from being hung for our sins.

Given two persons who, like Professor Sherman's rats, had exactly the same heredity and the same environmental conditions throughout life, the one who partook of an optimum diet during his entire existence would probably live longer than the one who had only an adequate diet. Such severe conditions are, however, practically never encountered, though there are instances of identical twins who have been separated in infancy and brought up under different environmental conditions, with the result that one has displayed an adult physique superior to that of his twin brother.

Most of the recipes for longevity are no more scientific than that given in a book printed in 1722 which revealed the secret of "rejuvenescency" of one Arnoldus de Villa. It consisted mainly of eating stewed vipers. Similarly, many of the warnings against practices which are stated to be sure to shorten life have little if any scientific foundation. Some of the current food faddists, for example, are vigorous in condemning white bread and attributing all of the ills of mankind to its use. The scientist realizes, however, that a diet with bread and milk as the basis comes as near to fulfilling average physiological needs as can any combination of known foods.

THE real centenarians are reported to have subsisted on all kinds of fare and have indulged in all sorts of hygienic practices. Some of them have eaten white bread, and some brown; some have smoked continuously and violently, and some never; some have partaken of the cup that cheers, and some have been total abstainers; some have trodden the primrose path, and some have been celibates; some have been cheerful, and some morose. Every centenarian usually attributes his longevity to his own peculiar mode of life, regardless of its correlation or lack of it with the accepted rules of hygiene.

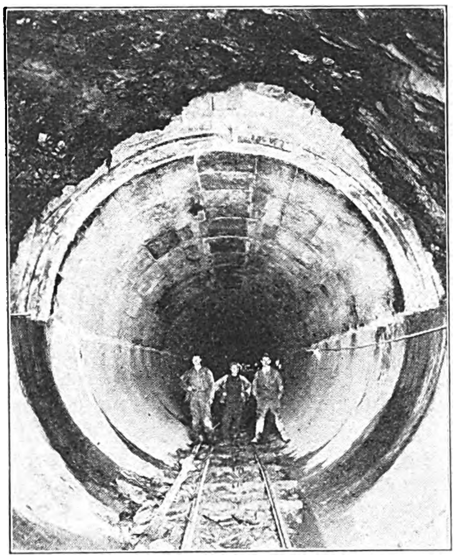
The fact that some centenarians have reached great ages without special regard to hygiene is not, of course, an argument in favor of such a regimen. Luck may have been with them, and fate may have played its mysterious part. The average span of life has increased greatly in the last half century, though practically all of the increment has been in the ages below 50, particularly in the periods of early life. This increase has been due to many conditions, of which improved sanitation, better nutrition, more favorable economic circumstances, and biological influences are among the leading factors.

Although a regimen of life might be outlined for an individual case which ought theoretically to assist in prolonging that particular life, positive assurance could not be given of its success, because there are so many complicating factors. There is, in fact, no definite recipe for longevity, and the fountain of youth is still unknown, though science is nearer to the explanation than it ever has been and it may conceivably uncover the secret sooner or later. The average duration of life will unquestionably continue to increase and the mortality rate to decrease, until the biological limit has been reached. When that will be, no conservative scientist can foretell.

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Sinking a "Mine" Under New York City


A tunnel of the New York City water supply system. The tunnel being built will be even larger

FAR below the streets of New York City, working day and night while the city's millions toil, seek pleasure, and sleep overhead, an army of workmen are now engaged in the gigantic enterprise of constructing a new tunnel through which will flow the additional millions of gallons of water daily needed to quench the thirst of the metropolis. Sixteen electric mine hoists and 62 mine locomotives are used in this project, for the work follows the same general lines as that necessary in mining.

The new tunnel, officially known as City Tunnel C Number 2, is being constructed by Patrick McGovern, Inc., for the Board of Water Supply. The mine hoists and locomotives which, with other electric equipment, were built by the General Electric Company, form the major part of the electric motor-driven machinery.

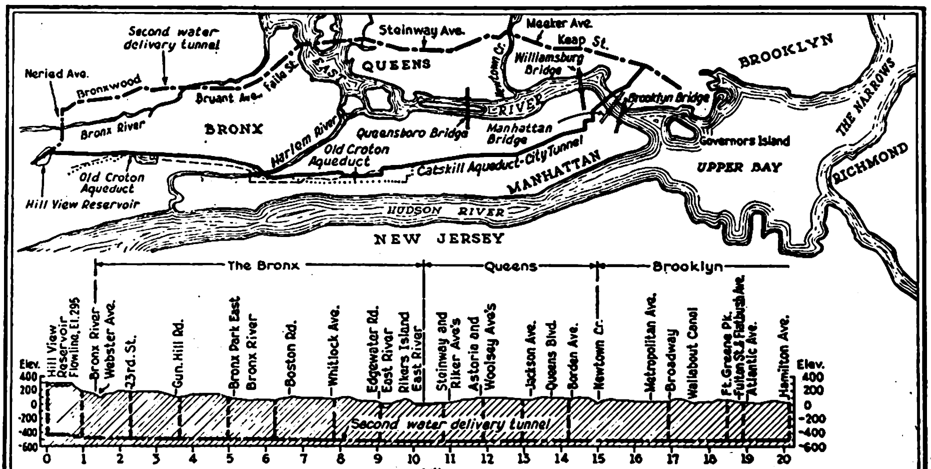
New York City now uses 875 million gallons of water per day, 30 percent of which comes from the Croton reservoir system, and 70 percent of which is supplied by Catskill water. The present distribution system has long been recognized as inadequate for future needs, and even at the present time is not large enough to maintain suitable pressure in the Boroughs of Brooklyn and Queens.

The new tunnel will run from the Hill View Reservoir, east through the Bronx, then south under the East River through Queens to Brooklyn, ending at Hamilton Avenue opposite Governor's Island. It will be 20.2 miles long, will be 17 feet in diameter when finished and will be at a depth of about 500 feet below sea level. Its construction will involve the sinking of 16 shafts from 14 to 32 feet in diameter, the depths of the different shafts varying from 500 to 850 feet, according to the land elevation. After the tunnel is completed, these shafts—with the exception of that at Hill View, to be used as an intake—will be used as risers to valve chambers from which the street mains will be supplied. The tunnel and shafts aggregating 22 miles linear measurement will be excavated to 19 feet diameter which will involve the blasting and removal of almost four million cubic yards of hard rock. Lining the tunnel to 17 feet diameter and incidental construction work will require the placing of 664,000 cubic yards of concrete. This work, together with other minor items, is to be completed in 70 months.

Electricity plays a vital part in the undertaking. Air for drills and shovels is furnished by 400-horsepower synchronous motor-driven compressors. As the muck is removed it is hauled through the tunnels to the hoists by storage-battery mine locomotives.

The mine hoists in the main shafts are each equipped with two cages in balance, one coming up as the other goes down. These cages are rectangular in shape, while the shaft is cylindrical, the space remaining being used for water pipes, air pipes, electric cables, et cetera.

Sixty-two seven-ton storage-battery mine locomotives will be used for haulage in the tunnel. These machines correspond in type to those used in the construction of the Cascade, Moffet, Hetch-Hetchy, Shandakin, and Cold Brook-Wachusett tunnels. Each locomotive is driven by two 12-horsepower motors, power for which is furnished by a storage battery consisting of 42 Exide cells. When the storage batteries are discharged, the locomotives are hoisted to the surface for recharging the batteries.


Second water delivery tunnel
Neried Ave.
Bronxwood
Bruant Ave.
Fails St.
Steinway Ave.
Meeker Ave.
Keap St.
QUEENS
Newtown Cr.
Williamsburg Bridge
BROOKLYN
THE NARROWS
EAST RIVER
Brooklyn Bridge
Bronx River
BRONX
Harlem River
Queensboro Bridge
Manhattan Bridge
Governors Island
Old Croton Aqueduct
Catskill Aqueduct-City Tunnel
UPPER BAY
RICHMOND
MANHATTAN
Old Croton Aqueduct
Hill View Reservoir
HUDSON RIVER
NEW JERSEY
The Bronx
Queens
Brooklyn
Hill View Reservoir Flowline, El. 295
Bronx River
Webster Ave.
23rd. St.
Gun Hill Rd.
Bronx Park East
Bronx River
Boston Rd.
Whitlock Ave.
Edgewater Rd.
East River
Rikers Island
East River
Steinway and Riker Ave's
Astoria and Woolsey Ave's
Jackson Ave.
Queens Blvd.
Borden Ave.
Newtown Cr.
Metropolitan Ave.
Broadway
Wallabout Canal
Ft. Greene Pk.
Fulton St. & Flatbush Ave.
Atlantic Ave.
Hamilton Ave.
Elev.
400
200
0
-200
-400
-600
Second water delivery tunnel
0
1
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3
4
5
6
7
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20
Miles
Plan and sectional diagram of the new water tunnel, showing, in the plan, the layout of the old tunnel. Note depth under familiar sections of the city

"Spider Threads" of Glass

SPIDER threads of spun glass, which rival in fineness those produced by the living insect, may easily be made by man and are of use for telescope cross wires in the instruments of the engineer, where they prove superior to the natural article. Natural spider thread will swell and lengthen as it absorbs moisture and, in damp weather, telescope cross wires of this material will buckle and sag, at least causing annoyance, or perhaps rendering the instrument useless for the time being. The replacement of these wires is at all times a delicate job and is particularly difficult in the field.

Glass fibers are not affected by dampness or by ordinary variations in temperature, are smooth, straight, and stiff, and do not need to be placed under tension in mounting. They may be drawn as fine as spider web without particular difficulty, with a very simple apparatus and a moderate amount of skill. They are remarkably strong and will stand a great deal of abuse. Being round and having a polished surface, they act as cylindrical reflectors; and light impinging upon them in the telescope is reflected away from the observer's eye, causing the wires to appear as dense black lines out to the edge, whereas spider thread, on the contrary, becomes translucent. It is, in consequence, easier to point the telescope so equipped upon the objective under adverse conditions of visibility.

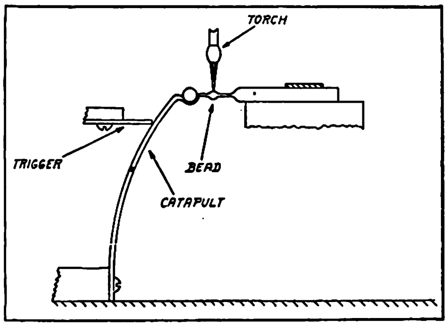
Fibers used in telescopes of ordinary magnifying power, such as 30 diameters, will be from one to four ten-thousandths of an inch in diameter, depending upon the use of the instrument. Fibers as small as these can hardly be seen with the naked eye. They can easily be felt, however, and such a fiber of glass can be wound about the finger like common thread.

A convenient form of apparatus for drawing these fine fibers, and one which is easy to construct, is a catapult such as is shown in the diagram. This may be made of wood with an arm of some springy material such as hickory or ash. The end of the arm should have a hand-like cup for holding a small segment of glass rod. In operation this arm is held back by a trigger and a small section of glass rod, approximately one inch in length, is placed in it, one end of the rod having been drawn out to a small tip. A similar piece of rod which has also been drawn to a small tip and which has a small round bead of glass at the end of the tip, is clamped to the base of the catapult and the two pieces of glass are then joined with a small blow-torch. As soon as this welding has been completed and the glass is cooled, a fine needlepoint of flame is directed upon the bead and as soon as this is a bright red color, the flame is withdrawn and the catapult sprung with the trigger. This act, because of the small quantity of glass involved, must be performed almost instantly and the withdrawal of the flame must slightly precede the springing of the trigger.

The small piece of rod in the catapult arm will be thrown a distance of several feet, drawing out the heated bead of glass behind it into a fine thread, the fineness of which will depend upon the size of the bead, the degree to which it has been heated, and the strength of the catapult arm. It is preferable to have the glass thrown over a dark cloth to assist in seeing the fiber, as it is almost invisible. With a little practice, very fine fibers may be made with this simple apparatus.

Bones Grown in Test Tubes

A MOST amazing case of living tissue being grown outside the animal body is the growth of embryo gristle or cartilage into bone. This remarkable transformation has been accomplished by Miss Honor B. Fell, working at the Strangeways Research Laboratory, Cambridge, England.



"Spider threads of glass" can be made with this simple apparatus

When the proper conditions of nourishment and temperature are maintained, isolated cells from animal embryos have been seen to grow and develop in the test tube just as if they were still in the animal body. Miss Fell, using a technique similar to one devised by the late Mr. Strangeways, has thus cultivated tiny pieces of gristle from six-day-old embryos of fowl. During cultivation, they increased to more than three times their original length and developed along practically normal lines.

Besides growing, these test tube cultivations have actually manufactured a substance called phosphatase, an enzyme, which is of immense interest to biochemists, Miss Fell and R. Robinson of the Lister Institute, London, have reported. When the tiny pieces of gristle were taken from the embryo, they contained no phosphatase at all.—*Science Service.*

The "Hush Hush" Locomotive, An Unusual Design

THE London and North Eastern Railway Company, England, have just completed a new locomotive of unique design for use on their East Coast Route express passenger services, and a number of trials have been run.

In outward appearance this new engine is an entire departure from previous practice in locomotive design in England and many of the constructional details are novel. The boiler has been constructed to the extreme limits of the railway gauge and there is no room for a stack to project above the boiler. The stack has, therefore, been sunk within casing plates which are arranged to throw the smoke upwards and clear of the engineer's view from his position on the footplate.

Considerable experimenting was undertaken and the outstanding design was arrived at by tests which were made with a model of the locomotive in a wind tunnel with air currents of speeds up to 50 miles per hour. The results indicate a bold departure from the conventional appearance.

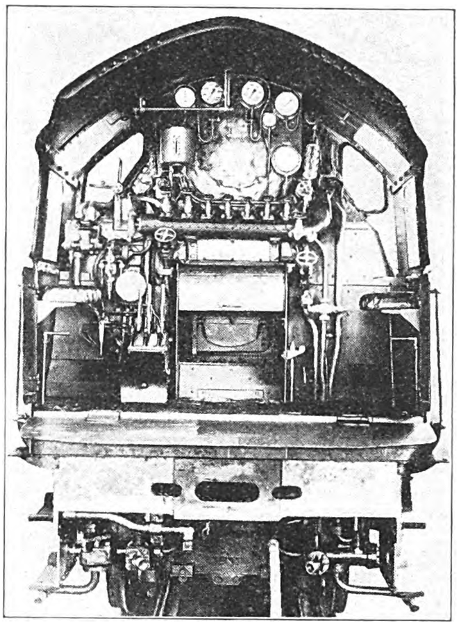
The locomotive possesses the unusually high boiler presure of 450 pounds per square inch, this being the highest pressure which has ever been used for a British railway locomotive. (The pressure hitherto used has been between 200 and 250 pounds.) This high pressure, which results in fuel economy, has necessitated the use of a boiler of the Yarrow water-tube type which has never before been applied to a locomotive.

The new engine possesses a 4-6-4 wheel arrangement known as the "Baltic" type, this being the first tender locomotive with this wheel arrangement to be constructed and operated in England. The six coupled driving wheels are six feet, eight inches in diameter.

One of the most striking features is that the whole of the air supplied to the firegrate is pre-heated, the supply being taken from the front of the smokebox, passing down a space between the boiler and the casings.

The engine is a four-cylinder compound. The two high-pressure cylinders, which are made of cast steel, (a new feature) are 12 inches in diameter and 26 inches stroke driving on to the leading coupled wheels. The two low-pressure cylinders are situated outside the frames and drive the intermediate pair of coupled wheels. Each of them has a diameter of 20 inches and a stroke of 26 inches.

The new engine has been constructed according to the designs and inventions of Mr. H. N. Gresley, C.B.E., Chief Mechanical Engineer of the London and North Eastern Railway Company. The engine was constructed at the railway company's works at Darlington, the high-pressure water-tube boiler being supplied by Yarrow and Company of Glasgow, well known makers of marine water-tube boilers.



The cab of the L.N.E.R. locomotive shown below. The engineer sits at the controls at the left

No name has yet been given to this "hush hush" engine which after trials will be tested in actual service between London, King's Cross, and Edinburgh, Waverley.

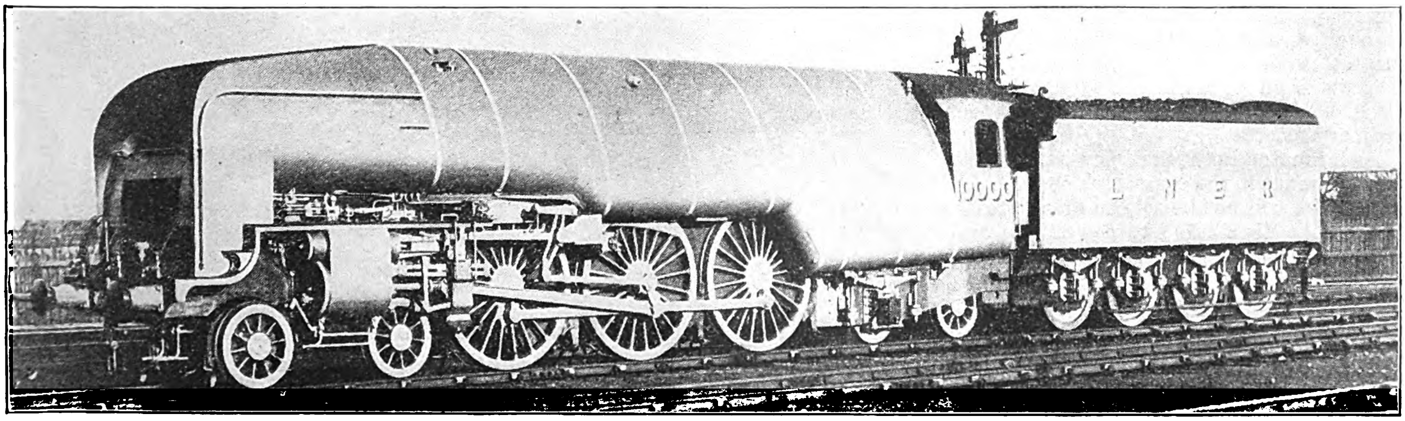
The engine is the longest and heaviest passenger locomotive in Great Britain, weighing, with its tender of the well known "Flying Scotsman" corridor type, nearly 170 tons.

Paper-Weight, Unbreakable Phonograph Records

"IS the 'Hit of the Week' out yet?"

"Yes, Madam," the newsdealer answers, and adds "It is a wonderful melody, too! I took one home last night and tried it out on my phonograph. Here you are. Fifteen cents please."

This conversation, mystifying to most



Principles of boiler construction new to British railway practice are embodied in this English locomotive people, may be a common occurrence in the near future when new phonograph records made of Durium which was recently invented by Dr. Hal T. Beans, Professor of Chemistry at Columbia University, are placed on the market.

Dr. Beans bends one of the phonograph records and pounds it with a hammer to show its durability

This invention consists of a new product, a resinoid substance which is a liquid in its original form but when subjected to heat becomes an insoluble, infusible solid, which combines hardness and flexibility to a remarkable degree. A thin film of this substance, which has been named Durium, is so hard that it can scarcely be broken with an ordinary hammer and is almost as flexible as a piece of paper. Associated with Dr. Beans in the development of Durium have been Dr. Louis Hammett and Dr. Geo. H. Walden, Jr., also of the Chemistry Department of Columbia University.

In making phonograph and sound-picture records by present methods, the plastic material of which they are formed is pressed in a heated mold so that a master die leaves its impression in the substance when it hardens. This is a slow process, however, because the metal molds must be cooled by artificial means before the molded record can be removed. The making of Durium records is simply a stamping process which may be practically as fast as ordinary mechanical printing.

The Durium phonograph record consists of a coating of only six or eight thousandths of an inch of Durium upon a heavy fiber paper. This paper is impregnated with Durium, passed through a drying room, cut into workable sections, passed rapidly through a stamping machine, and finally printed with titles in another machine. The die from which it is stamped is precisely the same as those used in making ordinary records.

As intimated in the first paragraph, these records, made in the company's own recording studio, will not be sold in music stores, but will be distributed to newsstands and sold therefrom for 15 cents each. Three celebrated figures in the world of music, Eddie Cantor, Florenz Ziegfeld, and Vincent Lopez have agreed to form a music jury to select the most popular song hit each week for recording.

The writer visited the Durium plant where he listened with amazement to the perfect tones of a Durium phonograph record which had already been test-played more than 200 times. The significance of this will be realized when it is known that the factory requirements for good tone reproduction of ordinary phonograph records is only 100 times. The writer also saw a Durium record hammered and scratched with great force with no apparent effect upon its tone quality.

Durium is being used at present for making "Hit of the Week" records and sound-picture records, but it is idle to speculate what its future uses in industry may be. Due to its heat-resistant quality it is effective for making matrices into which melted metal is cast, and since it can be applied with a spray, or with a brush, it may later be used as a paint where a fire-resistant waterproof surface is desirable—for example on the non-metallic parts of airplanes.

Preparing a "Square Meal" for the "Graf Zeppelin" in Brazil

AFTER the *Graf Zeppelin's* historic swing around the world in the almost unbelievable period of less than five days' flying time, it would seem that her forthcoming flight to Brazil and thence to the United States leaves little to stir the imagination. But such is not the case. A new difficulty, which for a time threatened to frustrate all the carefully conceived plans for this ambitious undertaking, set American engineers and chemists to scratching their heads in search of a solution.

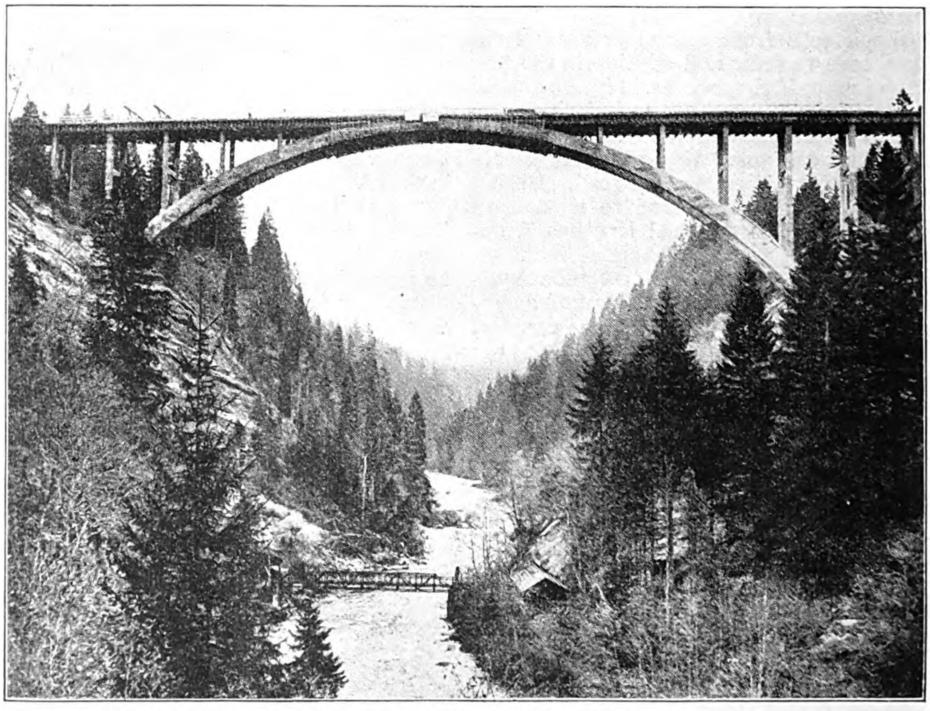
When the *Graf Zeppelin* lands at Pernambuco she will demand a "square meal" before turning northward to the United States. The American firm supplying both the lifting and fuel gas, the Carbide and Carbon Chemicals Division of the Union Carbide and Carbon Corporation, first assured the flight sponsors that the gases would be ready for them in Pernambuco, and then set about to find out how it could be done.

The Carbide and Carbon Chemicals Corporation had already perfected a fuel gas which had been used more successfully by the *Graf Zeppelin* on her previous flights than the blau gas originally used in Germany but now discarded in favor of the American type gas, even for use in Germany. This gas is a mixture of six parts hydrogen, and four parts Pyrofax. Pyrofax is a gas used commonly in the United States for cooking and lighting in sections not served by the gas mains. In refueling the Zeppelin in Tokio and Los Angeles, the Pyrofax was condensed to liquid form and shipped in tanks. Enough for the Brazilian refueling could be sent to Pernambuco in only 700 steel cylinders.

The hydrogen needed for combination with the Pyrofax has always been obtained at the refueling point. It is usually made in an electrolytic plant along with oxygen.

The refueling problem in Brazil seemed simple enough until it was learned that Pernambuco has no facilities for supplying hydrogen. The next difficulty encountered was the fact that to ship enough hydrogen to Brazil would require more than 4000 steel cylinders, more than could be spared in the entire United States. Furthermore, hydrogen cylinders may leak during the shipment and even if this were not so, the cost of shipping would be prohibitive. With no hydrogen available at Pernambuco and the impossibility of sending it there, Union Carbide officials were for a time checkmated.

But again lessons learned in the World War saved the day. Portable hydrogen generators had been successfully constructed and used during that crisis. This type of generator produces the hydrogen by the interaction of a caustic soda solution on ferro silicon in a covered tank. And so it happens that on two of these unpretentious looking generators, which have been built and are now on their way to South America, hinges the success of the entire undertaking. It is the first time since the war that a generator of this type has been used to any great extent, this time making



Near Echelbach in South Bavaria, this bridge, which is nearly complete, is said to be the highest concrete bridge in the world. It is 597 feet long, **246 feet high, and has a width of 52.5 feet. Built especially for automobiles, it will expedite vehicular traffic to the Passion Play at Oberammergau in 1930** the long ocean voyage in the cause of science and man's conquest of the elements.

The problem of refueling the huge ship centers on the fact that the lift must be kept constant at all times. This must be accomplished, furthermore, without valving off and consequently wasting the levitating gas, which in the case of the *Graf Zeppelin* is hydrogen. Although the fuel supply naturally diminishes as the flight proceeds, the Zeppelin's weight must nevertheless remain constant. The *Los Angeles*, using the non-explosive helium for levitation, accomplishes this by condensing the water of combustion from her exhausts. The gas perfected for the *Graf Zeppelin* is, like blau gas, about the same density as air and therefore no change in weight occurs as the gas is consumed.

Watermelon Seed Makes Useful Drug

An extract made from watermelon seeds and given the technical name of cucurbocitrin has proved its usefulness in relieving many cases of high blood pressure, Drs. T. L. Althausen and William J. Kerr of the University of California Medical School have reported. These scientists stated that their work confirmed the results obtained with the watermelon seed extract by its discoverer, Dr. I. S. Barksdale, of Greenville, South Carolina.—*Science Service.*

Manna of the Exodus was Plant Exudate

The manna which the children of Israel ate during their sojourn in the Sinai wilderness was the sap of a desert shrub, the tamarix, drawn off and predigested by insects and dried to hardness in the desert air.

The vexed question of just what was this food, which seemed miraculous to the hungry refugees from Pharaoh's wrath, has been investigated by a special expedition sent out by the Hebrew University of Jerusalem, under the leadership of Dr. F. S. Bodenheimer and Dr. O. Theodor. A brief report of their results has been sent to the English scientific magazine *Nature.*

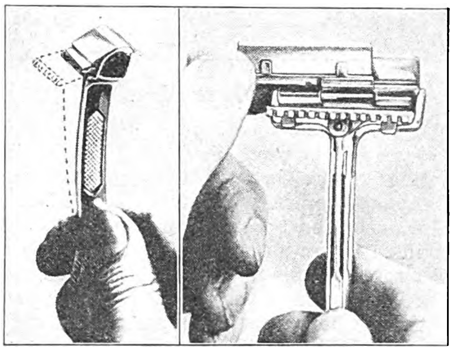
There has always been a dispute among scholars as to whether manna was an edible lichen, a low form of plant life that grows on the desert soil of the Sinai region, or whether it was the hardened sweet sap of the tamarix shrub. The studies of the expedition established that it is the same thing known elsewhere as "honey-dew"—the sap of the plant drawn off by aphids and exuded from their bodies. It is produced by one or two species of aphids on a single species of tamarix in sufficient quantity to form large drops that harden into sweetish grains of solid substance. Chemical analysis showed that it contains three varieties of sugar, as well as other compounds. —*Science Service.*

A Safety Razor That Sharpens Its Own Blade

As you read the above title you will probably be as incredulous as we were when we first heard of it. Perhaps you will say "Impossible! Just a bit of hokum—another novelty to dupe unwise women looking for something new to give unsuspecting husbands." But we have examined this new safety razor thoroughly and it seems to be all that it is claimed to be.

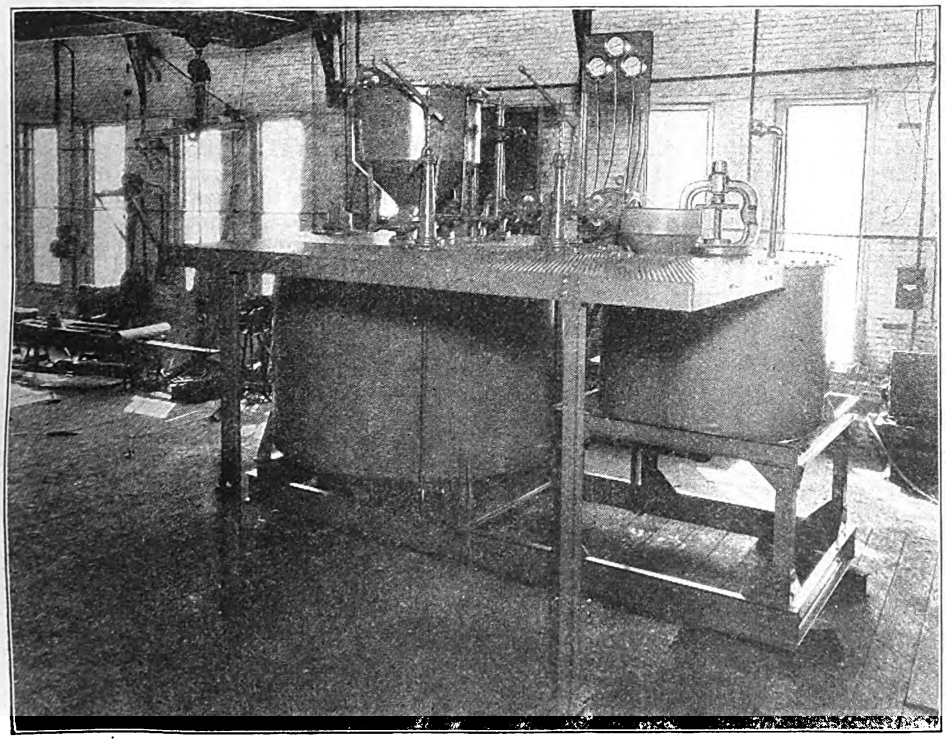
Despite the fact that a great deal of research has been done on razors and safety-razor blades, very little is known concerning them. There is no formula by which a man with a certain type of beard may select a suitable razor. A man with a thickly growing beard may require a blade that has been sharpened with relatively large microscopic saw teeth, while one with a light beard may get a smooth shave with a wire edged blade, that is, one that has been sharpened down to an extremely thin and fragile edge. This new safety razor was designed to satisfy all types of beards. Because of the construction of this razor, which is produced by the DeHaven Razor Corporation, the edge is variable. The owner will, after a few mornings' experimentation, discover the edge most suitable to his particular beard and thereafter will sharpen his razor accordingly. Thus the razor has the quality of perpetual freshness.

In appearance, the DeHaven razor seems but a variation of a conventional type of safety razor with a single-edged blade. The frame consists of a handle proper, with an upper cap which holds the blade and which may be snapped open for cleaning or removing the blades. Inserted in a longitudinal slot of the main handle is a secondary handle which has a crossguard at the top just beneath the blade, and is pivoted at the lower end of the main handle so that it may be swung forward and backward in the main frame. Just beneath the edge of the blade on the guard is a piece of alloy steel which is roughened so that, when the swinging portion moves backward and forward, it hones the edge. The manufacturers supply a paste, to be rubbed on this honing surface, which contains a microscopic abrasive. A small amount of this paste wiped on the honing surface, a few jerks of the wrist, and the blade is sharpened.



At left: sharpening the new safety razor by shaking. At right: removing the blade for cleaning

Besides these features, the DeHaven razor is self-cleaning because when the movable part is flipped forward the underside of the blade is wiped clean. For final cleaning, the upper cap may be snapped back and the blade removed by sliding to one side. The stropping is always even due to the fact that the honing surface is swivel-mounted.



One of the generators which will "feed" the *Graf Zeppelin*

Australian Bushmen

Having purchased several months ago a photograph of a South African bushman with which a caption was supplied, erroneously describing him as an Australian bushman, we inadvertently allowed this error to be published. Realizing the mistake and having received from Mr. W. Lutge, Pinnaroo, South Australia, a letter on the subject, we desire to make amends and at the same time to correct the widespread impression that the Australian bushman is an aborigine. Part of Mr. Lutge's letter follows:

"It should be known that there is only one race of aborigines in Australia. They were of magnificent physique. They rarely interbred with the whites and are now nearly extinct. Colored people are so rare in Australia as to be regarded almost as a curiosity.

"The term 'bushman' is common enough and is synonymous with the American and Canadian 'backwoodsman.' In Australia, the bushmen are a fine type of white pioneers and belong to the class from which your much esteemed Lincoln was descended."

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

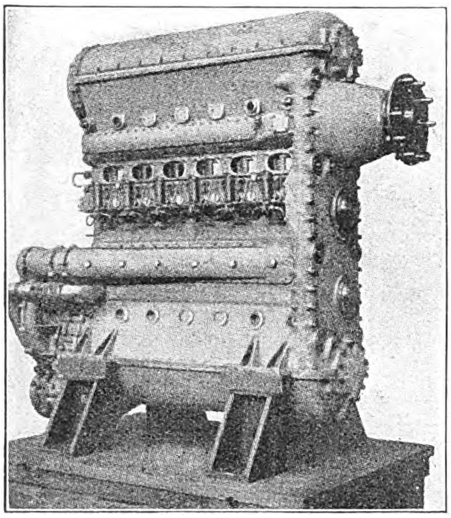
CONDUCTED BY ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York City

The Junkers Diesel

AT the last meeting of the *Wissenschaftliche Gesellschaft für Luftfahrt* in Germany, Dr. Gasterstadt of the Junkers Company presented some preliminary information on the Junkers aircraft Diesel engine. A summary of this paper appears in a recent issue of *Automotive Industries*. The interest in aircraft Diesels is so keen at the moment that even partial information is valuable to us.

The engine is of the two-stroke double-piston type, originally developed by the Junkers company for stationary purposes. Thanks, in part, to the high piston speed of 2160 feet per minute, the engine weighs only 2.6 pounds per horsepower and develops a total of 650 horsepower. There are six cylinders arranged vertically in a single block of a light alloy of aluminum and silicon. Two crankshafts are used, one at the top and one at the bottom of the vertical cylinder block. The block includes not only the cylinders but most of the two crankcases and the gear case at the forward end. Roller bearings are used on the crankshafts to save weight and make the engine compact. Five spur gears at the forward end connect the two crankshafts to the propeller. At an engine speed of 1500, the propeller turns at 1100 revolutions per minute. A double duralumin piston controls the exhaust and inlet ports.



Side view of the Junkers Diesel aircraft engine, with the cylinders cast in a single block. The propeller shaft is geared to 2 crankshafts at the top and bottom

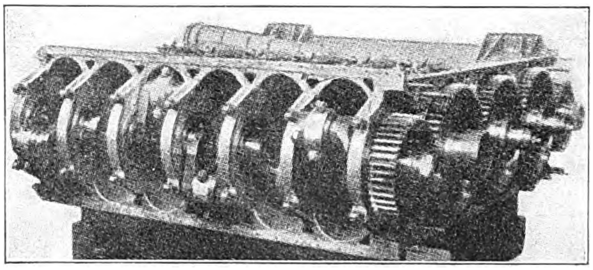
A supercharger blows the air into the engine at 17 pounds per square inch, through scavenging ports so shaped that the air enters tangentially and keeps up its swirling motion until the end of the compression stroke. The supercharger is of the centrifugal type with the impeller driven from the rear end of the crankshaft.

Four fuel nozzles are used for each cylinder, served by two pumps, one on each side of the cylinder. The nozzles are so shaped that the fuel leaves them in a fan-shaped spray inclined at 45 degrees to the piston heads. Owing to the quadruple spray and the swirling motion of the air induced by the inlet passages, there is a rapid intermixture of fuel and air, and low fuel consumption.

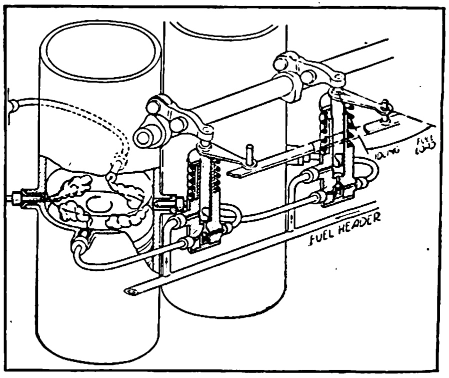
The fuel pumps are of straightforward design, with a simple mechanism for varying their stroke. The fuel consumption is only .365 pounds per horsepower, which is far less than that of a gasoline engine. The engine has seen 50 hours' flying service, including one non-stop flight of 8 hours' duration. Starting is accomplished by compressed air admitted to the engine cylinders, no special starting facilities being required.

An Interesting Ski

THE design of an airplane ski is a question of real engineering ability. The ski has to have such a surface that the impact on landing is sufficiently distributed, it must be able to stand up in rough landings, and it must be so pivoted that the airplane can change its attitude, as required, for the get-away or landing. The airplane landing gear employs shock-absorbing struts, and tires which are also capable of taking up shock. Hitherto skis have been built without the use of shock-absorbing devices but the Aircraft Products Corporation of America has now introduced a shock-absorbing member in its latest ski which is illustrated below.

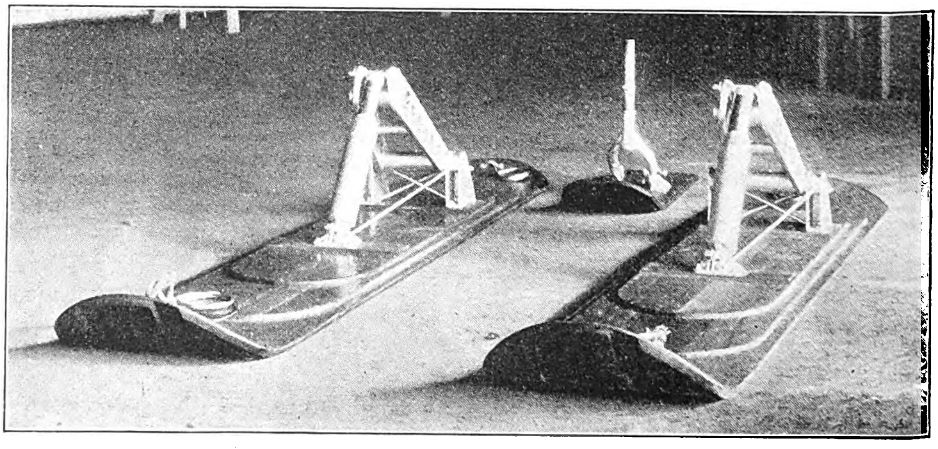


The Junkers Diesel with crank-case and gear covers removed, showing, at right, the gears which transmit power to the propeller

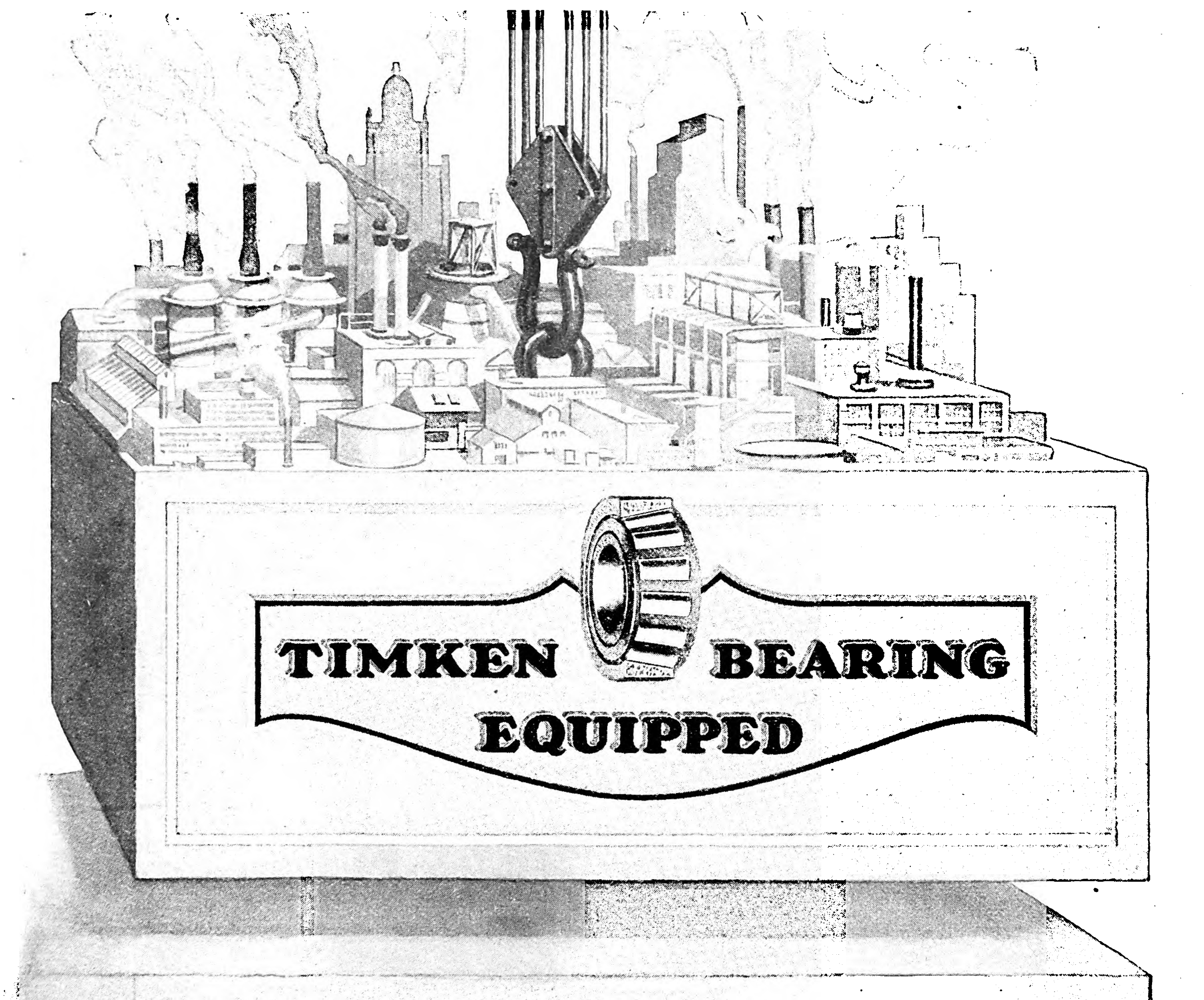


Fuel injection in the Junkers Diesel. Four nozzles, supplied by two pumps for each cylinder, supply a whirling spray which gives a quick mixture of fuel and air

The axle of the airplane is freely mounted in a rugged metal structure, the lower end of which is mounted on the after part of the ski, but which is free to turn about this lower end. Between this metal frame which is free to turn and the center of the ski proper, a shock-absorbing strut on the oil-hydraulic principle is introduced. Accordingly when the airplane lands, the shock is absorbed by the strut, which becomes shorter, while the metal frame moves down a little. The two coils of rubber cord at the front and rear ends of the ski are attached to the fuselage and prevent too great an angular motion of the ski as a whole. The introduction of shock-ab-



Airplane skis equipped with shock-absorbing struts



The Corner Stone of Industry

Friction or anti-friction is the difference between building upon a *sand* foundation or upon a *sound* foundation . . . "Timken Bearing Equipped".

Industry either lays itself wide open to Waste and pays a heavy friction-tax . . . or sets up a safeguard and reaps the resulting profits.

The kind of anti-friction protection is important . . . to select the bearing that carries *all* burdens, whether the load is all radial, all thrust, or both in any combination—the bearing that gives full protection based squarely upon Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken-made steel.

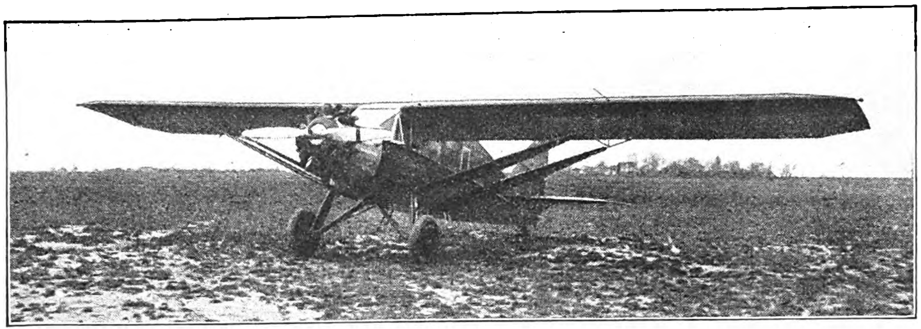
This group of exclusive Timken advantages puts production on a modern basis. Machine life becomes self-perpetuating. Power loss, lubricant and maintenance costs lose their significance and dwindle to decimals.

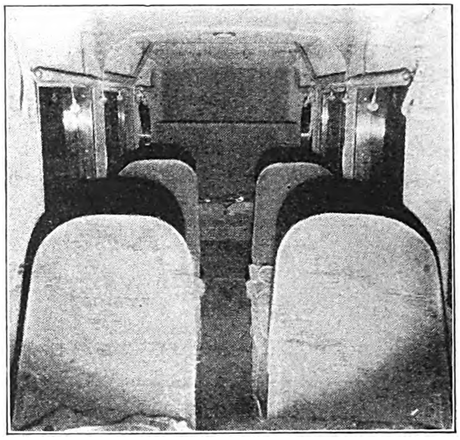
In lathe spindles or rolling mills; in steam shovels or mine cars or railroad trains—a wave of replacement surges over the nation—a protest against Waste—headed by the national symbol and safeguard—"Timken Bearing Equipped", the Corner Stone of Industry.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

© 1930, The Timken Roller Bearing Co.

TIMKEN *Tapered Roller* **BEARINGS**



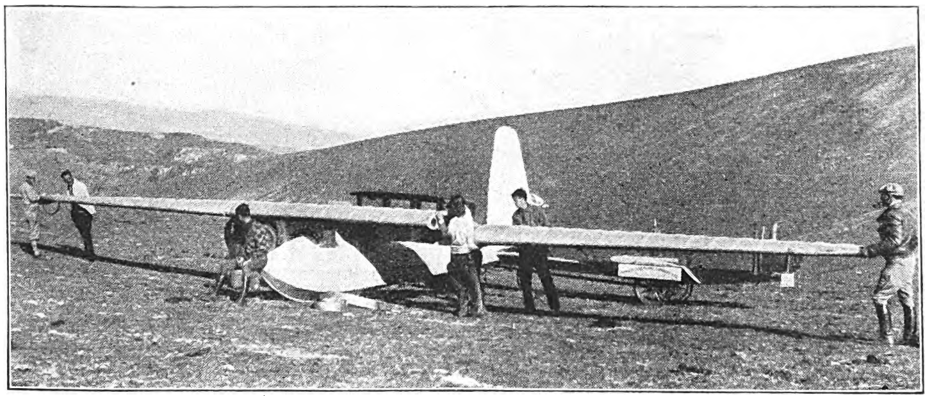


Above: A three-quarter front view of the Bellanca *Pacemaker* described below. *At Right:* Looking backward from the pilot's seat into the comfortable cabin

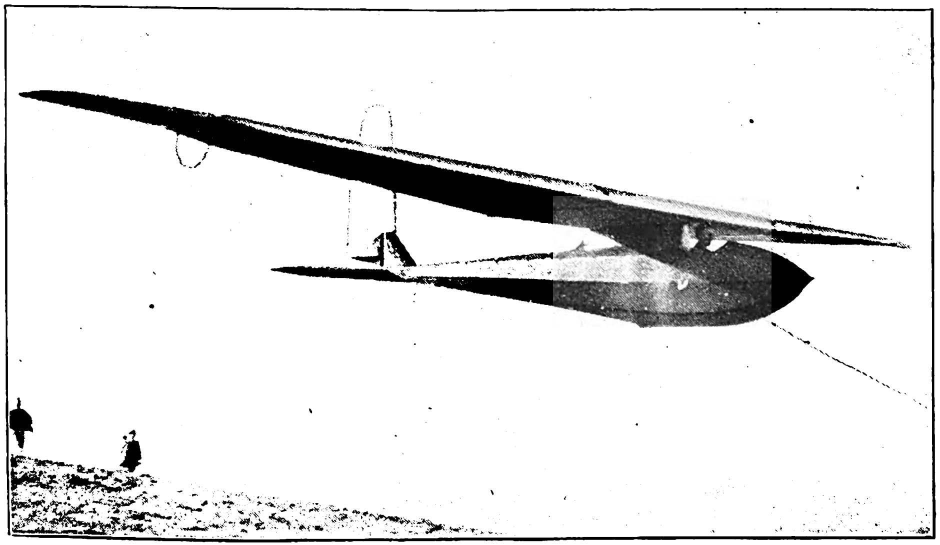
sorption in the ski is decidedly a step forward in cold weather operation.

Bellanca "Pacemaker"

AIRPLANE design has settled down to a steady process of evolution. There are no radical changes in appearance to be observed, but steady improvement in performance, carrying capacity, strength, and flying characteristics. Those of our readers who have seen the earlier Bellanca monoplanes will note from our photographs that the latest product, the *Pacemaker*, has apparently very similar features. The lifting struts, which combine the functions of bracing members with those of lifting surfaces, are still employed but there is a more graceful blending of wing and fuselage. The vision at the front end of the cabin almost attains perfection. The interior of the cabin, by skilful engineering, is freed of all obstructing structural members.



Lindbergh takes to gliding! *Above:* Installing a new wing on the Bowlus sailplane glider. *Below:* The same glider just after the take-off, with Col. Lindbergh at the controls



The performance and carrying capacity, as given by the company, are excellent. With a Wright J-6 of 300 horsepower, the *Pacemaker* has a useful load of 1937 pounds, which includes a pay load of 1042 pounds (pilot and 5 passengers), 112 gallons of gasoline, and 7 gallons of oil. Fully loaded the plane weighs 4300 pounds. The wing area is only 270 square feet. Even allowing for the lifting struts, the loading per square foot is high. Apparently our designers are willing to increase high speed even with the necessity of somewhat high landing speeds. Their argument is that the ever-increasing number of airports and landing fields makes the use of high landing speeds fairly safe.

The interior of the cabin is evidently quite attractive from the passenger's point of view. No effort has been spared to make the cabin of the *Pacemaker* as attractive and as comfortable as possible. The seats are built of light steel tubing, which makes them completely free from the weaving and deterioration of wicker chairs, and are covered completely by deep comfortable upholstery. The non-shatterable glass windows are equipped with silk roller shades and solid mahogany frames. The rear windows may be opened for ventilation. The cabin interior is upholstered in two tones of high-grade automobile fabric, light in shade above the belt line and slightly darker below. This combination of coloring aided by the large sky-light window in the top of the cabin gives a bright and cheerful appearance to the interior. The sky-light window also permits the pilot to see above and to the rear. Leather safety belts are provided on all seats and a heater keeps the cabin snug and warm in the coldest weather.

Teaching Elementary Aerodynamics

ONE of the most interesting educational developments of the day is the extent to which elementary aerodynamics, the science of air flow, is being taught to the youth of the nation. We would, of course, expect aerodynamics to be taught in ground and flying schools and in the universities and technical schools offering courses in aeronautical engineering, but what is remarkable is that aerodynamics is now an accepted subject in a number of secondary schools engaged in general education.

Since the science of air flow has many applications outside of aviation, as in windmills for generating power, in sailing vessels, in the determination of wind loads for buildings, in the streamlining of racing automobiles, and in the design of air fans of various descriptions, the spread of knowledge of this subject has value for the general industrial life of the nation.

While air is all pervading, it is generally invisible and therefore its laws are apt to appear mysterious. The instinct which enables us to understand mechanisms such as the wheel and the lever no longer suffices, and it is a matter of some difficulty to bring home fundamental principles to the student.

Theoretical exposition is insufficient and there must be methods available for visualizing air flow and forces. It is therefore gratifying to see a text specially devoted to "Elementary Laboratory Aerodynamics," written by Arthur L. Jordan, of the Polytechnic High School, of San Francisco, and published by the Ronald Press, New York.

This manual gives directions for laboratory experiments suitable for students of the ordinary high school, and assumes a knowledge of elementary algebra and geometry only. Apparently any wide-

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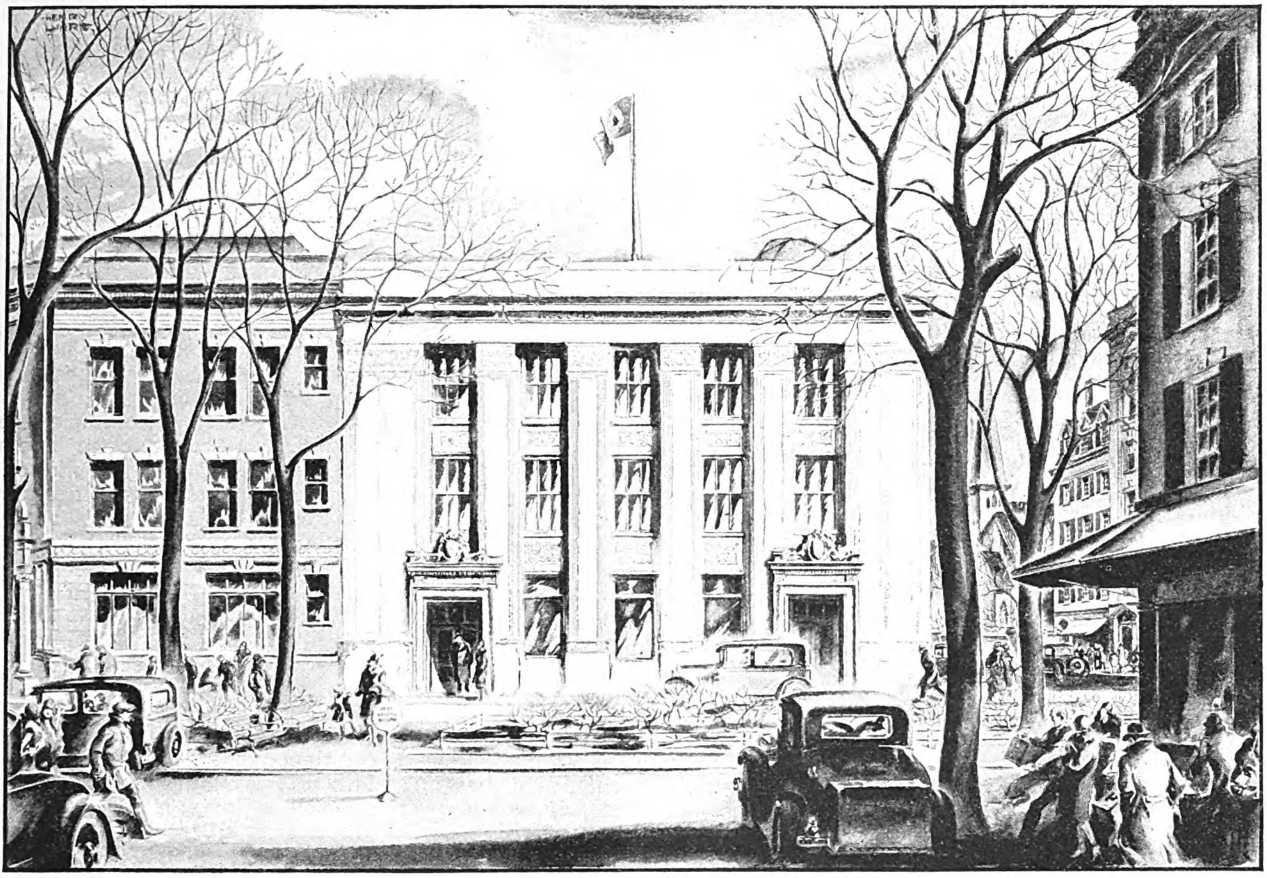


TO GIVE THE PEOPLE THE MODERN, CONVENIENT TELEPHONE SERVICE THAT THEY NEED

The Bell Telephone Company . . . of your town

An Advertisement of the American Telephone and Telegraph Company

It has its home in your town. Its operators are the daughters of your neighbors. Its various departments are in the hands of your own citizens, with years of training in telephone engineering and management. Who owns the Bell System? 450,000 people scattered over the United States own the stock of the American Telephone and Telegraph Company and 250,000 own other securities of the Bell System.

No matter how small the part of the Bell System that serves you, it has behind it research, engineering and manufacture on a national scale. The Bell System operates through 24 companies, each designed to fit the particular area it serves—to furnish the highest standard of service in a manner personal to the needs of every user.

Serving each of these 24 operating companies is the staff of the American Telephone and Telegraph Company, which is constantly developing better methods of telephone communication. Each draws on the findings of the Bell Laboratories, one of the greatest institutions of its kind in the world, for the continual scientific improvement of telephone service.

Each has the benefit of the buying power and specialized manufacturing processes of the Western Electric Company, which supplies telephone apparatus of the highest quality and precision for the entire Bell System.

Each takes advantage of every improvement in practice, equipment and economy.

The Bell System's ideal is to give all of the people of this nation the kind of modern, convenient telephone service that they want, over its wires to connect them one with another and with the telephones of the rest of the world. It is your telephone company, at your service with every resource that it commands.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Gas Industry By-Product Aids Agriculture

SULFUR, for the agricultural market, must be of finely divided particle size. For years manufacturers of spray and dusting materials have striven to produce, economically, a sulfur the particle size of which would satisfy this demand. Plant pathologists have demonstrated by careful field tests that the efficacy of sulfur is determined by its fineness—the finer the particles, the quicker the oxidation and hence the toxicity toward fungous diseases, for sulfur is primarily a fungicide; a destroyer of those innumerable plant diseases found everywhere in nature, such as mildews, scabs, and "rots."

Manufactured gas contains hydrogen sulfide gas as an impurity. This hydrogen sulfide must be removed if the gas is to be used for domestic purposes. The problem of purifying gas has engaged the energy and time of the gas industry for many years. The industry's problem was to furnish a purified gas to the American home. When, however, it was finally solved, it was realized that a definite contribution to another industry had unintentionally been made. One of the products resulting from the purification of gas was elemental sulfur recovered in an extremely fine division. Here was the product desired by the plant pathologist—sulfur with particles of colloidal dimensions, wettable, easily suspended in water or in miscible oils, and obtained in this ideal physical condition without the necessity of mechanical grinding.

An idea of the fineness of this recovered sulfur is obtained from some comparative measurements which involve commercial competitive sulfurs. Recovered sulfur has particles ranging from less than one micron (0.001 millimeter) to 15 microns. Ground roll sulfur dust particles range from 50 to 200 microns.

The essentials of the process are explained by Vincent Sauchelli, of the Koppers Company Research Laboratories, in a recent issue of *Chemical Markets*. Raw gas as it comes from the carbonization process contains hydrogen sulfide and other impurities. The gas is passed through a specially prepared chemical solution. This solution absorbs the hydrogen sulfide and is led into tanks. These tanks are equipped with submerged pipes which have many orifices through which air is forced. This aeration causes a chemical reaction which liberates elemental sulfur. The air is forced into the solution in the form of minute bubbles through the tiny orifices. These air bubbles seem to have a particular attachment for the sulfur particles liberated in the solution. As a bubble attaches itself to a sulfur particle it lifts it to the surface. The result is a neat separation and flotation of the sulfur in the form of a froth or foam. The sulfur froth may become 6 to 18 inches deep and contain from 6 to 12 percent sulfur. A sufficient air pressure is maintained in the system to force the froth to overflow into troughs. In the trough the froth subsides through the formation and release of the larger air bubbles, leaving a creamy slurry which flows into a pit or tank. The slurry is then pumped into filter presses where the sulfur is recovered as a wet cake having about 50 percent water.

Excellent results have been reported from a large number of careful tests on the agricultural value of this new product.

Gas and Holder of Blimp Both Chemical Products

THE dramatic part of chemistry in the development of aviation was stressed in a paper presented at a recent meeting of the American Electro-chemical Society. Of prime interest among the many contributions of the chemist to the art of flying is the commercial perfection of a metal known as Alclad, from which the gas bag of the *ZMC-2*, the first all-metal dirigible, is constructed. This material consists of a sheet of duralumin coated with very pure aluminum. Thus, use is made of the strength of duralumin (an alloy of aluminum, iron, silicon, copper, magnesium, and manganese) and of the superior corrosion-resisting properties of pure aluminum. The outer pure aluminum is decidedly more resistant to corrosion than the strong aluminum alloys.

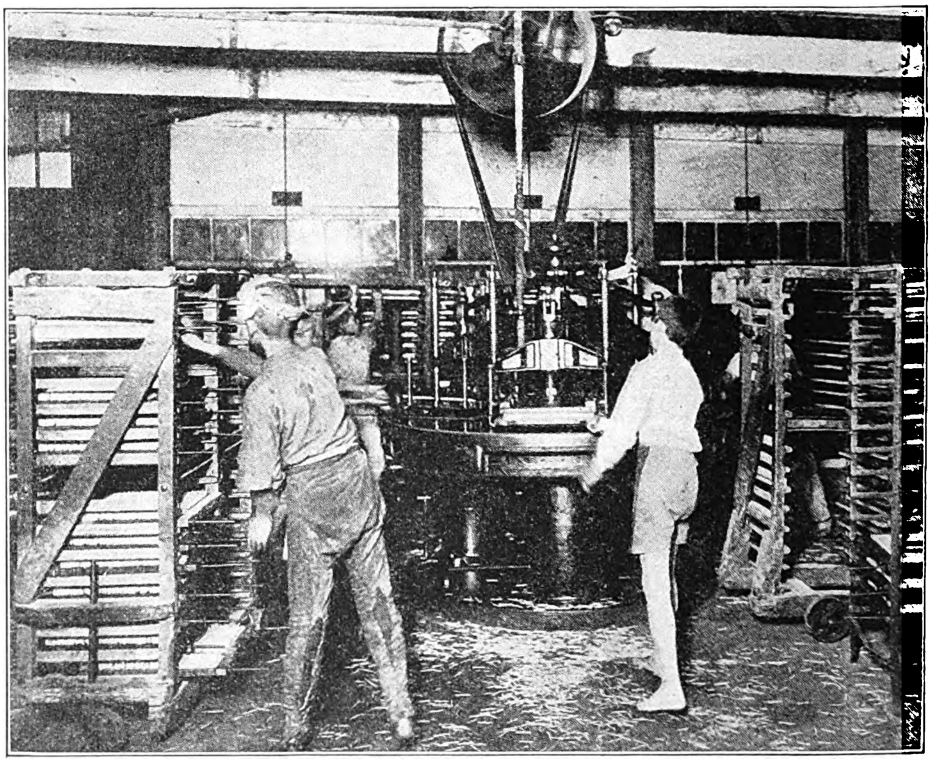
However, as Dr. Edwards and C. S. Taylor in their paper pointed out, when corrosion does occur, as for example at the exposed edges of the duplex metal sheet, it is at the expense of the protective aluminum coating and not of the alloy core. The pure aluminum is anodic to the duralumin core by as much as 0.1 to 0.2 volt, which apparently is sufficient under the circumstances to protect the core from the intergranular type of corrosion, to which certain of the heat-treated, strong aluminum alloys are subject.

The helium used in the Navy's latest "blimp," is also a product of recent chemical technology. This gas, formerly very rare and expensive, is now produced by the United States Bureau of Mines plant at Amarillo, Texas, from natural gas, where remarkable improvements in the process of manufacture have assured the Navy of adequate supplies of helium at reasonable cost. Latest figures indicate the cost to be $17.63 per thousand cubic feet of 97.7 percent pure helium. The capacity of the plant is approximately 850,000 cubic feet per month of the non-inflamable gas which supplies the "lift" for all United States Navy blimps and dirigibles.

Would Burn Coal Underground

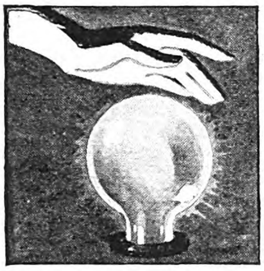
COAL mining may become a lost art if time proves the practicability of an idea of Leo Ranney, well-known in coal and oil refining circles. Mr. Ranney proposes to set fire to the coal deposits and allow the fuel to burn underground, piping the resultant gases to the surface. Patents to cover the process have been applied for.

Mr. Ranney explained that by controlling the burning coal, either petroleum or carbon dioxide may be produced. From the former, he said, gasoline can be refined;

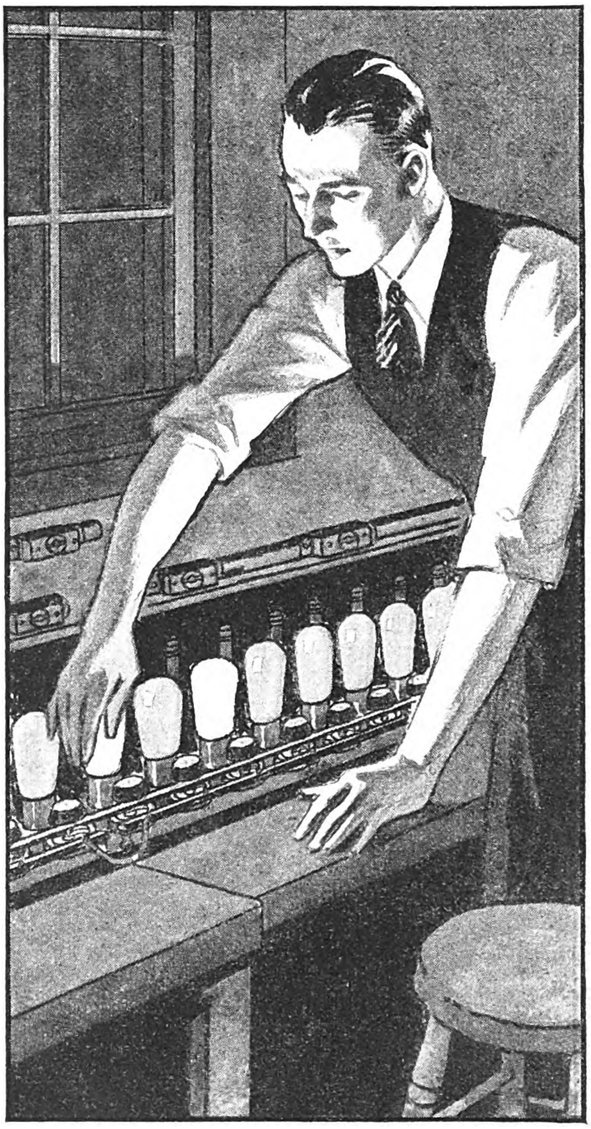


A view taken in the chemical department of the plant of the Toyo Match Company at Kobe, Japan. Here the "heads" are put on "Made in Japan" matches at the tremendous rate of 300,000,000 dozen boxes per year. Modern machinery is used in the various processes throughout this plant

FOUND . . .



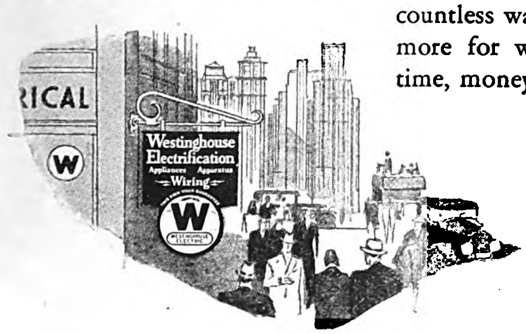
a way to improve ALADDIN'S LAMP



LESS than three years ago a row of glow tubes sat in a test rack before a window in the Westinghouse research laboratories at East Pittsburgh.

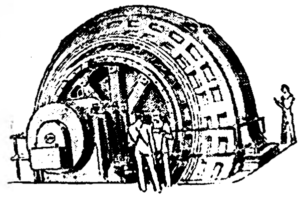
D. D. Knowles, research engineer, glanced at them one morning and noticed that some of the tubes quite unexpectedly were glowing, while others were not. Some tubes glowed when the sun was shining and went dark on cloudy days; others responded when a hand touched the glass.

It was quickly recognized that an important new electrical development had come to light. Thousands of tubes were made and tested. Shapes of various parts were altered until a relay was available—so sensitive that a tiny pulsation of energy, less than that expended by a fly walking on a window pane, was made to control enough current to operate machines rated at thousands of horsepower. Thus was born the grid-glow tube.



Because of this development a hand waved lightly over a crystal ball in New York City started giant motors in the Homestead Steel mills hundreds of miles away. Aladdin's lamp, which had to be rubbed to get results, is outrivaled by the grid-glow tube which responds to a mere wave of the hand.

To magnify human capacities is the daily work of the Westinghouse organization. In research, in the design of electrical and allied equipment, in the application of electrical power to new tasks, in the distribution of electrical apparatus for homes, business, and industry, Westinghouse is constantly active . . . to the end that electricity may continue in countless ways to help you get more for what you spend of time, money, and energy.



ELECTRIC POWER BUILDS BUYING POWER

Westinghouse

while from the latter, dry ice can be manufactured—both at low cost. It was further explained that the gas can be piped to the consuming area or burned at the mouth of the mine and used to generate electricity.

While he did not reveal the workings of his process specifically, Mr. Ranney said the first production work would start either in Illinois or Pennsylvania.

Mr. Ranney is the inventor of a system whereby oil fields abandoned as completely drained can be made to yield further through the drying of subterranean sands. These patents are owned by the Standard Oil Company of New Jersey. His latest process is said to terminate many years of experimentation in the oil industry, in attempts to control gas generated by burning coal underground.

"The World's Worst Fire"

THE photographs show successive stages in the combating of what is known as the world's worst fire—a blazing pool of highly inflamable liquid, such as oil or gasoline, into which a stream of new fuel is flowing as it burns. Of the several modern methods of fighting fire which chemists have developed in recent years, none so effectively combats a conflagration of this kind as the "blanketing" method, whereby a stream of foam is spread over the blazing liquid, shutting off its supply of oxygen.

These pictures show a demonstration of the "Foamite" system now widely used in the oil fields, in which two cans of gasoline were punctured and set afire. The last picture shows clearly how the dense foam piles up over the fire and extinguishes it, even though a stream of gasoline is still running out of the upper can.

Asphalt Emulsions Find Uses

ASPHALT, generally associated with road paving, has begun an invasion of a wide variety of manufacturing processes as a result of the discovery that this material can be used as a water emulsion. Asphalt is insoluble in water and heretofore it has been applied either by heating it until it melts or dissolving it in inflammable solvents.

When applied by heating there are fire hazards and danger to workers; also, serious impairment of the asphalt may take place as a result of careless heating. When applied by means of a solvent, there are the disadvantages of fire hazard, obnoxious fumes, inability to obtain a thick coat, and the necessity for a moisture-free surface. Emulsified asphalt overcomes these disadvantages very effectively, as shown by an article by Lester Kirschbraun in a recent issue of *Chemical and Metallurgical Engineering*.

In the emulsification operation the asphalt is dispersed in water, as exceedingly fine particles, upon which the emulsifying agent is most probably absorbed as a protective layer. The emulsifying agent may be any of a number of substances, but it has been found that the use of a selected clay-like mineral produces a dispersion satisfactory for a large variety of industrial purposes.

Unlike paints, asphalt emulsions can be made totally suspendable so that they be shipped to distant points in large drums without any danger of settling out. The material can be mixed with cement, acids, salts, other electrolytes, fibers, pigments, and so on. The application requires no heating and it is only necessary to permit the coated material to lose its water by evaporation.

Above: A demonstration of Foamite; ***below***, a view of an oil fire, in the Goose Creek Texas, field

The dried coat left is irreversible—that is, it will not re-emulsify when placed in water. It will adhere to surfaces to which asphalt generally adheres, and to others such as water-wet surfaces, cement, and wood.

One of the most interesting uses of the emulsion is as a binder in mastic flooring. The emulsion, containing fiber uniformly incorporated, is mixed with Portland cement and sand. Such materials are particularly adaptable for factory floors, trucking aisles, loading platforms, ship decks, driveway patches, and railroad car floors. Due to their resiliency and toughness these floors improve as traffic rolls over them. Forty-eight hours after such floors are laid, they will take care of heavy trucking. Their maintenance and repair are accomplished with ease.

During the past few years asphalt emulsions have been incorporated with success in moistureproof and waterproof paper. As carried on commercially the emulsion is handled with the paper stock by pumps and may be introduced into the paper-making system either by admixture with fiber in the beater or at the paper machine.

A wide variety of products has already been introduced and others are being perfected. These products include floor tiles made on a wet machine; thermoplastic boards; molded products such as pails, tubs, and the like, in which a mixture of asphalt emulsion and pulp is sucked onto molds; sheathing paper; mulch paper; moisture-proof board for containers to be used for foodstuffs, soaps, and other commodities in which it is desired to minimize the effects of change of moisture content.

One of the most important uses of asphalt emulsions is as protective coatings on structural steel and on pipe lines.

Cream-Separator Principle Widely Applied in Chemistry

THE centrifugal cream separator is familiar to everyone who has ever seen a dairy, but comparatively few people realize that the same machine plays an important role in many chemical operations far removed from the farm. Not only is the centrifugal principle applied to the separation of two liquids of different specific gravities, but it is just as useful in removing suspended solids from a liquid.

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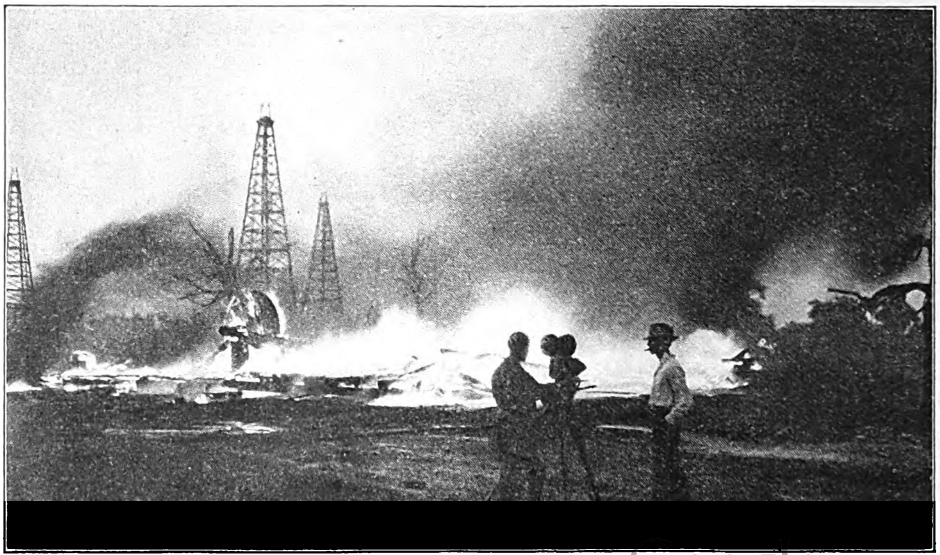
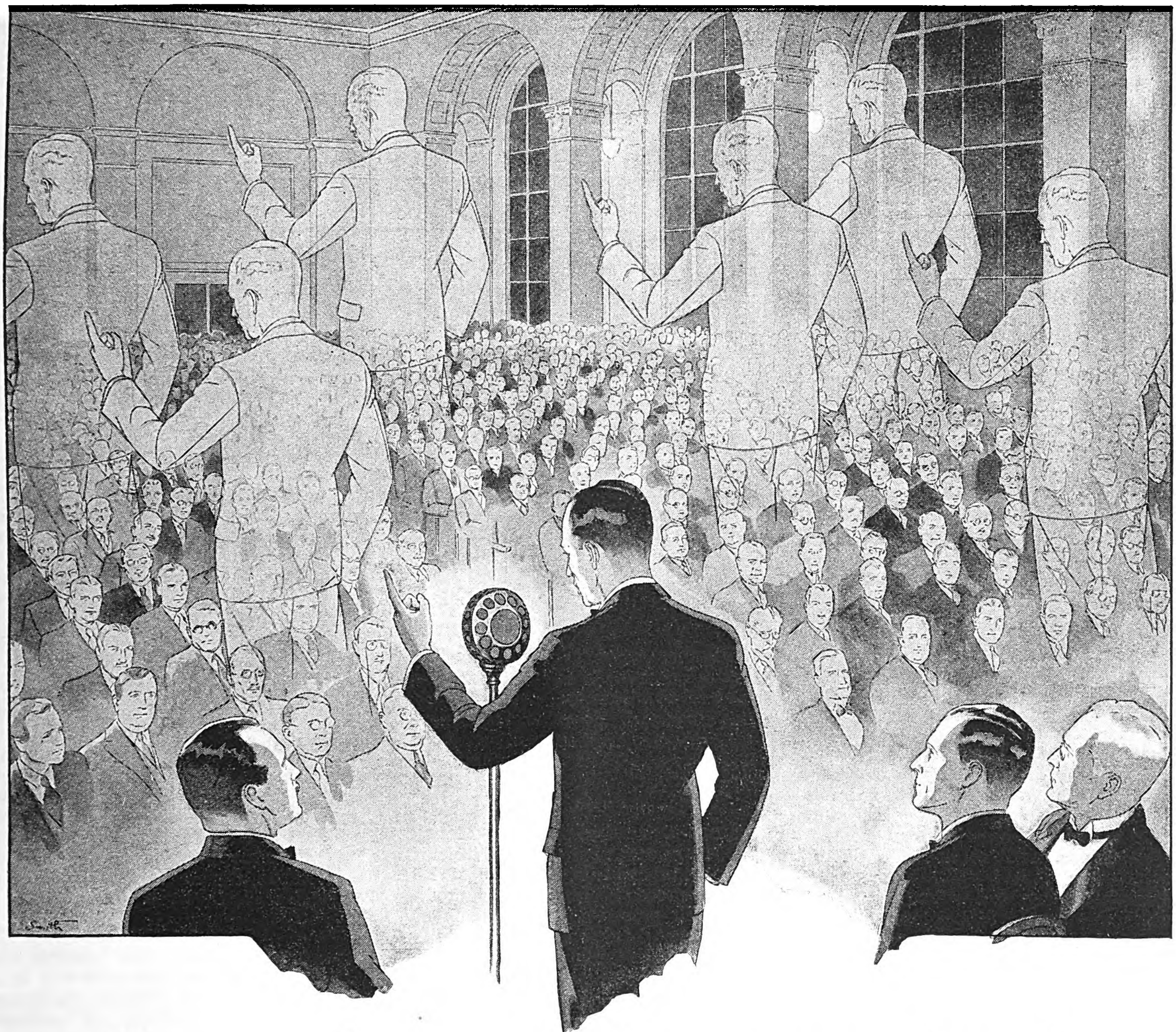
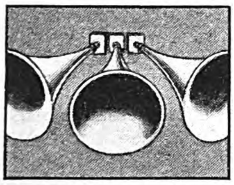




Everywhere at the same time!



Public Address System brings speaker right to you—The speaker rises—and the Western Electric installation in the huge room transforms him into a score of speakers! No matter how far away from him you sit, his every word comes to you as distinctly as though he stood right beside your chair.

Committees arranging banquets or conventions find that meetings are more interesting and effective when held in hotels where the Public Address System widens the hearing circle.

This equipment is a miniature interior broadcasting station, transmitting speech, music and entertainment *within* a building—to as many rooms as desired. Patrons of hotels thus equipped find an added attraction in getting music "on tap" in their rooms via loud speaker.

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Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Agriculture

The Use of Explosives in Blasting Stumps, Department Circular Number 191, contains 21 "dont's" for prospective blasters, with recommendations and instructions. *U. S. Department of Agriculture, Washington, D. C.—Gratis.*

The Progress of Biological Control of Prickly-Pear (Cactus) in Australia, by Alan P. Dodd, discusses the operations of the Commonwealth Prickly-Pear Board in its efforts to control the pest. This American plant has taken possession of about 65 million acres in Australia. *Commonwealth Prickly-Pear Board, Brisbane, Queensland, Australia—Gratis.*

Reindeer Grazing in Northwest Canada, by A. E. and Robert T. Porsild, is a well-illustrated report of a botanical expedition of great importance. The authors covered about 15,000 miles by dog team, canoe, motor boat, pack dogs, and snowshoes. They brought back what is probably the largest single botanical collection ever made in Arctic America, many zoological specimens, and about 1000 photographs. The United States Bureau of Biological Survey and other American agencies co-operated in the investigation. *Department of the Interior, Ottawa, Canada —Gratis.*

Electricity

Bell Laboratories Record, Cumulative Index to Volumes One to Seven Inclusive, lists by authors, subjects, and titles, the numerous research papers published between September, 1925, and August, 1929, inclusive. *Bell Telephone Laboratories, Inc., 463 West Street, New York City—Gratis.*

Public Service that Protects Property and Lives in the Electrical Field is the title of an illustrated booklet describing the high standards insisted upon by workmen pledged to adhere to the Electrical Code. *Electrical Workers' Union No. 3, 130 East 16th Street, New York—Gratis.*

Hydro-Electric Progress in Canada During 1929, Bulletin Number 1353, contains brief descriptions of all important water-power developments under construction during 1929. Undertakings now under construction, it shows, will add more than 1,600,000 horsepower during the next three years. The total for the Dominion now is 5,727,600 horsepower. *Dominion Water Power and Reclamation Service, Ottawa, Canada—Gratis.*

Lighting Fuse, by F. P. Griswold, shows the best methods of doing this type of work, and describes various types of fuse lighters. This leaflet is one of the Explosives Service Bulletins which are issued from time to time to keep explosives users posted on the latest improvements in the technique of handling explosives and blasting accessories. *E. I. DuPont de Nemours and Company, Inc., Wilmington, Delaware—Gratis.*

Metals

Oxwelded Construction for Modern Piping Services is an illustrated booklet describing the welding of steel and wrought iron piping for a wide variety of industrial applications. *Linde Air Products Company, 30 East 42d Street, New York City—Gratis.*

In Harmony with Modern Progress illustrates instances in which pressed steel can be used to advantage in manufacturing various types of goods or equipment. *Geuder, Paeschke and Frey Company, St. Paul Avenue at 15th Street, St. Paul, Minnesota—Gratis.*

Problems and Practices of Modern Steel Treating is a well-illustrated booklet containing a summary of 23 heat treatment processes used in steel production. Each process is described briefly, the treatment best suited to the need is outlined, and the types of furnaces and instruments used are shown. *Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia—Gratis.*

Centrifugal Concentration: Its Theory, Mechanical Development and Experimental Results (Technical Paper 457) reports the findings in an investigation conducted by the Bureau of Mines. Preliminary tests show the process to be a promising one, particularly for treating tailings from mills using gravity-concentration methods. *U. S. Government Printing Office, Washington, D. C.—10 cents.*

Sanitation

Municipal Sanitation is a new monthly magazine designed to serve an important field, with the intention to promote more sightly and more healthful towns, cities, counties, and states. *Municipal Sanitation, 225 West 34th Street, New York City—One dollar a year.*

Report of the Westchester County Sanitary and Sewer Commission covers the activities of the Commission in charge of one of the country's most notable suburban expansion projects, involving the installation of some of the most modern sewage treatment plants yet constructed. *Westchester County Sanitary Sewer Commission, Court House Annex, White Plains, New York—Gratis.*

Science

High School Science Library for 1928-1929, by Hanor A. Webb, is a classified bibliography designed to fit budgets of various sizes. Each book of the list is described briefly. *Journal of Education, George Peabody College for Teachers, Nashville, Tennessee—10 cents.*

Serpents of the Eastern States, (Bulletin No. 3, Vol. XXXII) by Raymond L. Ditmars, is a comprehensive study of the harmless and dangerous snakes in the region covered, which includes New England, parts of New York and Pennsylvania, and New Jersey. *New York Zoological Park, New York City—Gratis.*

Miscellaneous

Thermal Properties of Petroleum Products, by C. S. Cragoe (Bureau of Standards Miscellaneous Publication Number 97), is a paper containing the results of a critical survey of existing data on this subject, a project of the American Petroleum Institute. The tables contain what appear to be the most reliable values available. *U. S. Government Printing Office, Washington, D. C.—15 cents.*

Literature of American School and College Athletics (Bulletin 24) is a bibliographical study following the Foundation's famous Bulletin 23 entitled, "American College Athletics," which revealed the professionalism prevalent in intercollegiate sports. Professor A. Carson Rayon, of Swarthmore College, is the author of Bulletin 24. *Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, New York—Both gratis.*

Photographing Invisible Writing is the title of an item reprinted from the *Literary Digest*, explaining the part ultraviolet rays play in detecting the original writing on old parchment manuscripts. With this description is sent a catalog listing the latest types of ultra-violet light equipment and auxiliaries, quartz laboratory apparatus, and laboratory furnaces, for use in studying fraudulent paintings, sculptures, antiques, minerals, and other materials or objects. *Hanovia Chemical and Manufacturing Company, Chestnut Street and Railroad Avenue, Newark, New Jersey—Gratis.*

Bilby Steel Tower for Triangulation, Special Publication Number 158 of the U. S. Coast and Geodetic Survey, gives full descriptions of the new-type towers and other equipment and apparatus used by government engineers in making surveys. *U. S. Government Printing Office, Washington, D. C.—15 cents.*

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EIGHTY-FIFTH ANNUAL STATEMENT

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I wonder if you know how important you with other Policy-holders have collectively become in the economic life of the world. You think of your life insurance as an important factor in your plans for yourself and your families but I doubt whether you yet comprehend what you are actually doing for the world at large.

I am speaking to you now as a part of the 70,000,000 people insured in all companies in the United States and Canada. I am speaking to you as part owner of the $19,000,000,000 which has actually been assembled for the protection of beneficiaries under the $110,000,000,000 of coverage which now exists. Never before in the history of the world have individuals voluntarily, privately and co-operatively pledged such a sum for mutual protection or for any purpose.

This coverage exceeds the total resources of all the banks in the United States and Canada, including savings banks, by about $34,000,000,000. It is equal to all the resources of all our Foundations and Endowments for Education and Research, multiplied many times. Our educational, medical, scientific and charitable institutions are in the hands of trustees whose powers are wisely limited by the terms of the instruments on which the trusts rest. The Trustees of these foundations seldom have any very wide discretion as to how funds under their control shall be distributed. Neither have we.

New York Life Insurance Company
BALANCE SHEET DEC. 31, 1929

ASSETS		LIABILITIES	
Real Estate Owned and First Mortgage Loans on Farms, Homes and Business Property..................	$593,633,002.37	Reserves—ample with future premiums and Interest to pay all insurance and annuity obligations as they become due...........	$1,465,664,828.22
Bonds of the United States, Other Governments, States, Cities, Counties, Public Utilities, Railroads, etc...	672,665,159.31	Dividends Payable to Policyholders in 1930........	71,796,857.00
Preferred and Guaranteed Stocks................	52,414,042.00	All other Liabilities......	7,859,164 31
Policy Loans, Cash and Other Assets..........	346,991,407.36	Total Liabilities..........	$1,545,320,849.53
		General Contingency Fund.	120,382,761.51
Total Funds for Policyholders' Protection..	$1,665,703,611.04	Total..........	$1,665,703,611.04

Outstanding life insurance ($110,000,000,000) is the greatest trust ever created. It, too, is managed by Trustees. The Trustees are the Directors of the various companies with whom continuously sit certain familiar figures. They are Life, Death, Disability, Necessity and Old Age.

Death has heretofore been a terrible figure because life was not organized against him. Now life is so organized. Death will ultimately come to all of us. Nobody doubts that and nobody can change it. The terror of Death (I am not now considering any religious question) lies in his cruel, remorseless and uncertain stroke. In that has been his victory.

Life Insurance faces Death not as a Terror but as a fact and deals with him just as it deals with bonds or real estate mortgages.

Let me show you how vital those $110,000,000,000 are. Back of these pledged billions lie three great forces.

First—the $19,000,000,000 in cash and securities in hand;

Second—the seventy million people who have contracted, directly or indirectly, to pay future premiums;

Third—the power of compound interest.

Together they make that $110,000,000,000 the most vital and useful force in all sociology.

Now try to visualize what is coming. Outstanding Insurance will become $200,000,000,000, $300,000,000,000, possibly much more, but it will always have those three great forces, the first two correspondingly increased, behind it. Because of its peculiar relation to the weaknesses and needs of human life it is and always will be worth more than a like sum in cash. To illustrate—

Death sits with this great Board of Trustees and Death still strikes but, in your case, not as of old. Life also sits with the Board and by quickly translating individual productive power into cash it despoils Death of his old and faithful servitor, Poverty.

Disability, crueler than Death, also sits with that Board and demands and receives stipulated sums when the bread winner fails and becomes a burden.

Necessity and Old Age also sit with that Board and are covered by the underlying instruments.

All these benefits are specified in the Great Deed of Trust: the policies in force.

Some of you, most I hope, will agree when I say that Life Insurance has come to be the most important beneficial enterprise in the manifold problems of living.

My main point is that you, beginning with your individual needs and obligations, have not only minimized the terrors of Death, Disability and Old Age but you have come, as a group, to be one of the largest holders of useful securities in the world.

You are the only group that ever existed having the courage and sanity in the current problems of living to rob Death of his terrors by dealing with him as an ultimate fact.

As a group you are not capitalists, yet you have become the greatest of capitalists.

Following your impulse of self-protection you have created the greatest of all beneficial institutions.

Seeking to banish the need of charity from your own household, you have shown how the need of charity may be completely banished from every household.

DARWIN P. KINGSLEY, President.

DIVIDENDS Payable in 1930	NEW BUSINESS 1929	TOTAL RESOURCES Dec. 31, 1929	Insurance in Force Dec. 31, 1929
$71,775,000	$953,000,000	$1,665,000,000	$7,266,000,000

Branch Offices in most of the Larger Cities of the United States and Canada.

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.

Editor of the Journal of the American Medical Association *and of* Hygeia

Carbon Monoxide Poisoning

A SPECIAL committee appointed by the American Medical Association to consider the cases of poisonous gases in industry has just made its first report which covers particularly the use of carbon monoxide and its dangers. The committee consists of: H. Gideon Wells, M.D., chairman; Yandell Henderson, Ph.D.; Paul Nicholas Leech, Ph.D.; Carey P. McCord, M.D.; and L. R. Thompson, M.D. It is pointed out that poisoning by carbon monoxide gas is one of the hazards of modern life that can never be entirely eliminated because the generation of that gas is associated with the operation of automobiles and stoves, the combustion of wood, and the manufacture of many products. Whenever wood, coal, or petroleum products are burned, carbon monoxide may be a by-product. If a coal fire is lighted and the coal is too deep for air to pass easily, or if the air supply is checked in any way, carbon monoxide may be produced by taking away some oxygen from the carbon dioxide developed in the lower layers.

Manufactured gas in most cities contains about 20 percent of carbon monoxide and burning a flame near a cooking utensil or a pipe containing cold water stops the combustion at its first stage and liberates large amounts of carbon monoxide. Cooks working over stoves are sometimes affected with headaches as a result of inhaling too much carbon monoxide. This danger can be reduced by increasing the distance between the opening of the gas burner and the cooking utensil. The cooking utensil filled with cold water should be just above and not in the visible flame.

The chief source of deaths and poisoning from carbon monoxide is illuminating gas, and the prevention of such deaths must depend largely on better inspection of devices used in the handling of illuminating gas.

There have been a number of deaths, particularly in the winter months, from the carbon monoxide in automobile exhaust gas. Every year before cold weather begins drivers of cars must be warned again about starting the engine of an automobile before opening the garage doors. For a little while it is more comfortable to have the garage doors shut, but in the same little while the person becomes unconscious from inhaling carbon monoxide and unless he is discovered in time, he will die of the effects. Recent evidence indicates that even in the streets people inhale enough carbon monoxide on some occasions to make them sick. When inhaled, this gas produces headache and nausea, and no one really knows what the effect of repeated intoxication to a mild degree may be if continued over a period of years. Various attempts have been made to develop methods of preventing the exhaust of carbon monoxide from the automobile, but thus far no practically successful method has been developed.

When a person becomes a victim of carbon monoxide poisoning, the first thing to do is to give him immediate artificial respiration. He should also inhale a mixture of oxygen and carbon dioxide until his pulse and temperature are normal. He should be kept warm and prevented from making any muscular effort, because in his weakened state this may be fatal. Simple attention to the dangers that have been mentioned is bound to diminish accidents as a result of this new hazard of modern life.

Dislocations of the Neck

EVER since chiropractic took the basic idea of osteopathy and launched it as a separate science, there has been a good deal of general interest in dislocations of the bones of the spine. The actual fact of the matter is that the spinal bones are ordinarily so well held in place that any dislocation must be brought about by a considerable force.

When there is an actual dislocation of a spinal bone, the results may be exceedingly serious. In several cases described by Dr. Mitchell Langworthy before his recent death, the symptoms were exceedingly severe. A woman aged 55 fell down stairs, striking her head on the floor. Her neck became stiff and caused great pain. In her case the X-ray showed that the second vertebra in the neck had slipped forward. Her neck was straightened out by proper manipulations and held in place by sand bags put around her head while she lay quietly. She stayed in bed two weeks but had some stiffness in her neck for three months after the manipulation.

A man 33 years old was given a sudden jerk in an automobile accident. He had immediate pain and stiffness in the neck and weakness in the use of his arms. Some bones in his neck were discovered to be out of place and by proper scientific manipulation and the subsequent use of a plaster cast he recovered, although after many months he still has limitations in his neck movements.

Another type of cause of such accident was that which was responsible in the case of a boy five years old who was grabbed by a big boy about the head and shaken. The next day his parents noticed that his head was crooked and his neck stiff. An X-ray showed that the bones of his neck had been dislocated. By manipulation, the bones were thrown back in place and he had to wear a plaster cast for three weeks before it remained in place.

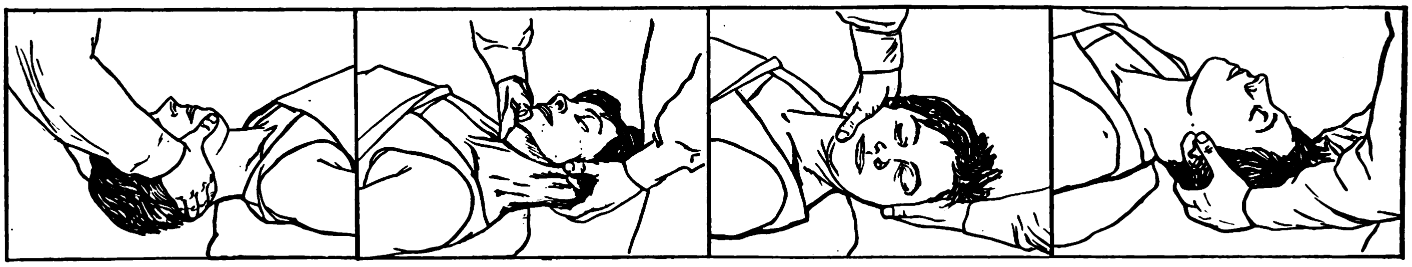
In Doctor Langworthy's discussion of the subject he illustrates the manipulations necessary to restore such dislocations in some cases, and from these pictures one can see how highly technical and serious a matter this really is.

The Gerson Diets in Tuberculosis

NEWSPAPERS have recently contained much concerning the diets developed under the famous German physician Sauerbruch and Doctor Gerson in Munich for the treatment of tuberculosis. In order to check the claims made by the German investigators, Drs. Edgar Mayer and I. Newton Kugelmass at Saranac Lake submitted 30 patients to similar methods. These were patients with far advanced tuberculosis of the lung who had previously been given all of the various special methods of treatment, but without success.

Patients with tuberculosis must be supplied with 50 calories per 1000 grams of weight, or 50 calories per day for every two pounds of weight. The diet must contain all of the important vitamins. The waste which takes place in tuberculosis tends also to rob the body of its important mineral salts, such as calcium, magnesium, potassium, phosphorus, and sulfur. The diet planned by Gerson proposes to take particular care of this demineralization and also to supply the body with the essential vitamins.

The German investigators were inclined



Steps in the manipulation done to reduce a left-sided dislocation between cervical vertebræ. From left to right, the illustrations show in proper order: 1—the side of the hand used as a fulcrum over which the head is bent to the right as in 2; 3—the head rotated to the left; and 4—head hyper-extended to prevent redislocation.

to emphasize that the Gerson diets had acid-forming qualities, whereas the controlled investigations at Saranac Lake indicated that the diet was primarily base-forming in character.

Under the Gerson diet, eight patients of the 30 gained in weight; ten showed some diminution in the quantity of sputum, and four, a lessened fever, whereas two who had not previously had fever developed it. Eight patients showed some clearing in the lungs and two with intestinal tuberculosis lost the symptoms of this complication. There was some diminution in the amount of fatigue, in the pain in the chest, and in the symptoms of tiredness.

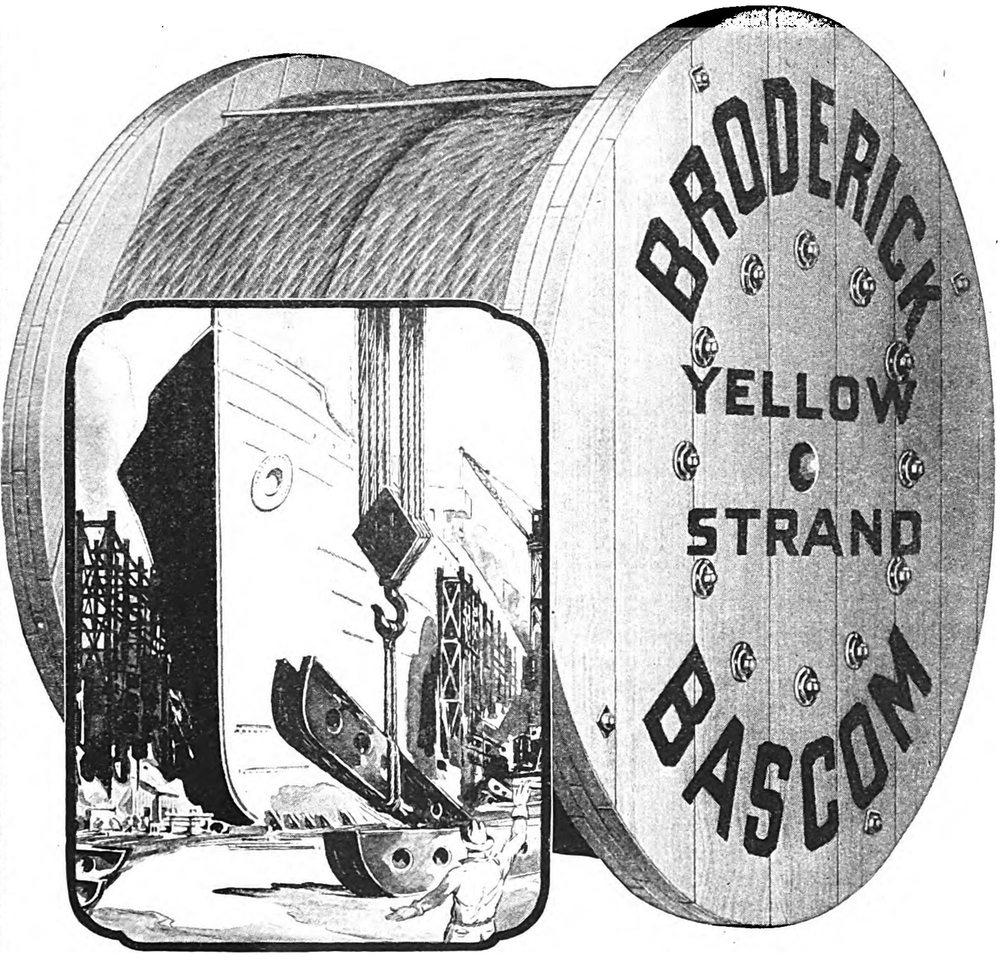
Prof. Felix Klemperer, the well known tuberculosis expert of Berlin, is willing to grant that the Gerson diet may have a favorable effect on tuberculosis of the skin, but he has not been impressed by the results in tuberculosis of the bones and joints, and he does not feel that the method is of importance in treating tuberculosis of the lungs. His view is also supported by that of Doctor Schwalm, who is in charge of one of the largest sanatoriums for the tuberculous in Berlin. Doctor Schwalm treated 20 patients with tuberculosis of the lungs by the use of this diet, and says that in not one of the 20 did he find any noticeable improvement in the condition, and also that the increases in weight were only such as were regularly seen in the sanatorium in patients on the usual diet. His final statement is: "We have not been able to discover that the Gerson diet is superior to the diet commonly used in German sanitariums, which also takes due account of the vitamins and includes plenty of milk, fruit, and vegetables."

Phosphorus Poisoning from Roach Paste

ONCE upon a time phosphorus poisoning was fairly frequent, due to the use of this substance in the manufacture of matches. Of late, such cases are seldom seen. In most instances they are due to taking a poison prepared for animals, by a child who has not understood the danger. Doctors McLean, MacDonald, and Sullivan have reported a case of a baby 18 months old who had formed the habit, not infrequent in babies, of picking up pieces of coal, matches, or other materials lying on the floor and putting them into its mouth.

The mother had spread a thick layer of roach paste on slices of bread and pieces of potato which had been put under the icebox in the kitchen. She noticed that two potato chips on which roach paste had been spread were missing, but did not associate their absence with the sudden symptoms that developed in the child. It had become drowsy and vomited. Its eyes became yellow. Its abdomen became distended, the wrists and ankles swelled and blood was passed both in the vomiting and in the excretions. Finally the excretions failed to flow. The baby died, and the postmortem examination indicated clearly that it had been poisoned by phosphorus. The typical changes in the liver, which had been practically destroyed through the formation of fat, were observed in this case.

The roach paste was found to contain 1.19 percent elementary phosphorus, and the container was not marked in any way to show the danger to human beings possible through its use.



You and Wire Rope

Although you may never travel by sea, ocean transportation is as necessary to your economic life as rail transportation. Yet the mammoth steel ship of today scarcely could be built without the great strength that is encompassed within the comparatively small diameter of wire rope.

Nor could the cargoes of these ocean liners be handled so quickly and economically without this flexible means of connecting power and load.

For over a half century this company has made wire rope exclusively. And in Yellow Strand Wire Rope, we believe we have attained the finest balance of strength, flexibility and resistance to wear ever developed in a rope for heavy duty. Long life and great economy are the natural result.

This company also makes all standard grades of wire rope.

B. & B. Aerial Wire Rope Tramways are an economical means of transportation under many conditions. Investigate!

Broderick & Bascom Rope Company
St. Louis, Mo.
Eastern Office and Warehouse: 68 Washington Street, New York, N. Y.
Southern Warehouse: Houston, Texas
Western Offices: Seattle and Portland, Ore. Factories: St. Louis and Seattle

Manufacturers of nothing but wire rope for over half a century.

Yellow Strand
WIRE ROPE

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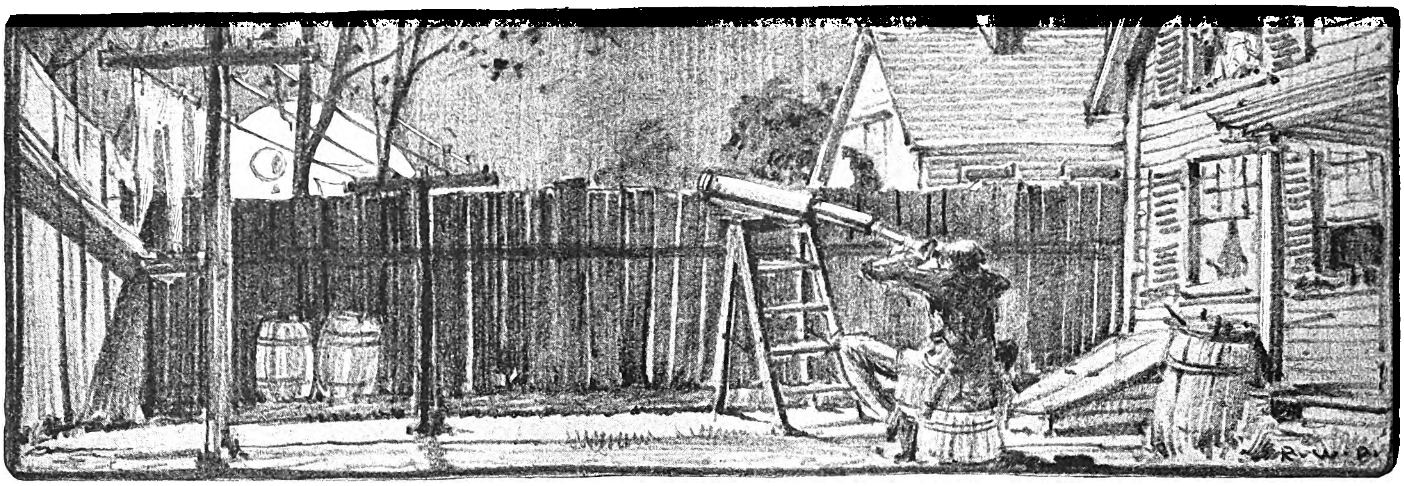


The Amateur Astronomer

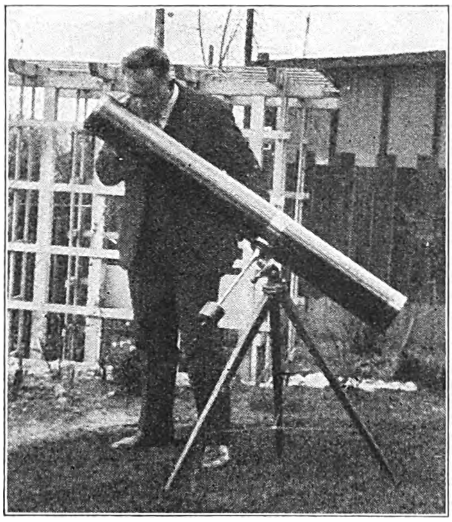
"NOW that my reflecting telescope is completed," writes M. S. Groh, 33½ Thorncliffe Avenue, Toronto, "I believe my experience will be of value to others. I commenced grinding the glass (which I obtained locally) more as an experiment than anything else. The grinding progressed favorably and the elbow grease employed shortly transformed the rough surfaces into a beautiful concave of about 50-inches focal length. The development of the accurate surfaces as the grinding advanced," continues Mr. Groh who, like hundreds of other readers of this journal, has been making an astronomical telescope from practical instructions in the SCIENTIFIC AMERICAN book, "Amateur Telescope Making," "was a feature of increasing interest, perhaps more fascinating than can be appreciated by anyone who has not experienced it. This is particularly true of the final polishing and parabolizing.

"Having completed the concave mirror in good shape it did not take long to mount it temporarily and, after a few crude attempts at seeing the moon, using a small looking glass for the diagonal, I commenced to believe that the job was worth finishing. So I made a prism of ordinary plate glass, to replace the rough diagonal mirror, bringing each face of this prism flat to within a wavelength of light. Two eyepieces were made from lenses secured from a local camera repair man and these when used with the telescope gave magnifications, respectively, of 80 and 130 diameters.

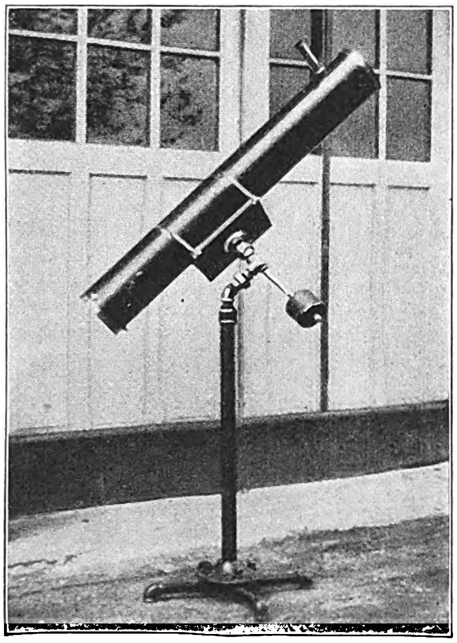
"The mounting I finally made is admittedly a bit light but is satisfactory when there is no breeze to shake the telescope. It has 3½-inch dividing circles which were indexed from a 72-tooth gearwheel. This gives me a fairly accurate line for every five degrees of declination and every 20 minutes of time in right ascension. The finder is an eight-inch length of half-inch tubing with the eye end stopped down to an eighth of an inch. No lenses are needed and it works well enough.

"How much did the telescope cost? Well, all my spare time for six weeks, some gibes from my family (previous to completion; afterwards quite the reverse) and the exercise. The moon provides an interesting sight. So also do Jupiter with his four visible satellites, Venus, a number of double and other interesting types of stars, and a myriad of stars where to the naked eye there is blank nothing."

Mr. Groh requests the Telescope Editor to comment on the glass he used, that is, common plate glass. This is the kind used by all amateurs (and by professionals, too) on sizes up to 12 inches in diameter. Expensive optical glass would not serve the purpose better. For a six-inch mirror the glass disks should be three fourths of an inch thick. These disks may sometimes be secured locally, but they can be obtained from a special dealer, all put up in ready-to-begin-work form, with the correct kind of pitch and abrasives, for about ten dollars. Other parts, required several weeks later after the essential concave mirror is complete, may run the cost up to about twenty-five dollars, but the finished product should perform on a par with a 300-dollar instrument. A six-inch reflector equals a four-inch refractor in general performance.


Mr. Groh and his reflecting telescope

F. L. SCARBOROUGH, 2105 Fourteenth Avenue North, Birmingham, Alabama, has made one of the telescopes of the type described by John M. Pierce, in "Amateur Telescope Making." Mr. Scarborough writes, "This simplified design was followed closely because the writer's knowledge of mountings, upon beginning the job, was negligible. There was only slight difficulty in any part of the work. My first attempt to make a polishing lap was a


Mr. Scanlon's six-inch telescope

Mr. Scarborough's tubeless telescope

failure, but on reference to 'Amateur Telescope Making' it was decided that the pitch of which the lap was made was too hard, so it was tempered slightly with turpentine and a softer lap prepared from it. Polishing with this lap was uneventful and the job was soon finished. (In the average case this takes about six hours—*Ed.*)

"Silvering by the Brashear process, as per instructions, was successful upon the first attempt. The directions for silvering were followed explicitly, using every precaution against contamination of the solutions.

"The results obtainable with this simple instrument are surprisingly good, amply repaying the slight expense, in this case about fifteen dollars which included the ready-prepared mirror outfit. The topography of the moon is strikingly clear and the effects due to changes in its phases are a wonderful sight. The planets are a delight. One view of Saturn with his rings and satellites, is generous compensation for the production of a telescope of this kind. These sights, together with others too numerous to mention, inspire one to a systematic study of science."

Mr. Scarborough's experience is typical of many others. It is perhaps difficult to believe that a raw beginner, with no more skill than is implied by the ability to do various handy jobs and with the possession of a little patience, can make an astronomical telescope that is more than a mere toy. But a six-inch mirror—the size best suited for the beginner—will magnify 100 diameters, and even at the large observatories it is seldom that more than 400 diameters magnification is used in studying planetary detail. That much magnification can be had with a 12-inch mirror which the amateur should be able to make after making first a six-inch mirror and preferably another intermediate size. Usually the beginner inclines in advance to regard the job of making the mirror as a task, but soon finds it is a real pleasure and wants to do more of it, so he makes a second and larger telescope; some have made several.

THE letterhead of Thomas F. Scanlon, 1405 East Street, N. S. Pittsburgh, Pennsylvania, gives evidence that he is a plumbing and heating contractor, but in his letter he says "I am a plumber, and I admit it." Mr. Scanlon's telescope is mounted almost entirely with various pipe fittings and plumber's accessories. This, of course, has been done before, though not so thoroughly, and this method has amply made good. These fittings are inexpensive and readily obtainable anywhere. The yoke that holds Mr. Scanlon's telescope tube was stated to be part of an old toilet tank and the retaining bands came from an old bricklayer's level. Their ends consist of brass sink bolts soldered on.

"The tube," writes Mr. Scanlon, "was made of 22-gage galvanized iron and cost one dollar fifty-six. The mirror is a six-inch and was completed during the evenings of two weeks. The eyepiece socket is part of an old wash-stand drain and some pieces of lead sink waste pipe, while the extension was made of nickeled tubing from an old wash-stand trap.

"The cell is a seven-inch perforated brass ring, a stock item in our business, having a raised seat on which the mirror rests. Three brass sink bolts were soldered radially to the circumference. These bolts fit into slots in the lower end of the tube

Facing Metal With Wood

***for* Manufacturing and Industry**

a modern development made possible with

PLASTIC WOOD
[Reg. U. S. Pat. Off.]

Insulation of Metal Plastic Wood is rapidly becoming a product of universal use, not only in the home, but for industrial purposes of all kinds. A most interesting application is for insulating metal surfaces against heat, cold, and electricity.

Electrical Resistivity Tests made by an Instructor of Physics of the Massachusetts Institute of Technology show a resistivity of 10^{12} ohm centimeters, 100 times greater than mica.

Non-Conductor of Heat and Cold When applied to metal surfaces in a thin layer, Plastic Wood will adhere indefinitely. After hardening it can be sanded, polished, painted, lacquered, varnished, or stained with oil stain to give as high a finish as any natural wood. It is, like wood, a non-conductor of heat and cold.

Weather-proof and Waterproof Tests have been made to prove its weatherproof quality when so applied to metal. Metal slabs coated with Plastic Wood have for six months been treated by submergence under the waters of Long Island Sound and by exposure on land to sun and rain. In neither case has there been weathering or decay of the Plastic Wood, nor has it separated from the metal in any way.

Metal Boats, Cars, Furniture and Aviation Practical working experiments are now being conducted with Plastic Wood for facing metal in numerous industries—it is being tested under actual sea conditions for decks on metal ships; it is being tested for railroad and electric cars; it is daily used in aviation for covering metal turn buckles; extensively used in automobile body manufacture; the possibilities of its use with metal furniture are under consideration.

Inquiries Invited Manufacturers and others interested in the application of Plastic Wood for facing metal are invited to communicate with the factory. Plastic Wood is made for industrial purposes in oak, light mahogany, dark mahogany, gum wood, walnut, cedar, ebony and other selected woods, and can be supplied in any standard paint colors.

PLASTIC WOOD
(Reg. U. S. Pat. Off.)

Handles Like Putty ~ Hardens Into Wood

At Hardware and Paint Stores ~

Tube, 25 cents; ¼ lb. can, 35 cents; 1 lb. can, $1.00

Plastic Wood Solvent, 25 cents

Special Bulk Prices to industrial users on application

Addison-Leslie Co., *Mfrs.*, 51 Bolivar Street, Canton, Mass.

Deafness

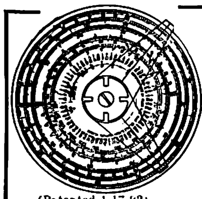
What reading-glasses are to weak or tired eyes, a scientific electric hearing-aid is to ears that hear faintly. Sounds that seem far away are amplified and brought to the ear with satisfying volume. For occasional or regular use, the hard of hearing will find comfort and satisfaction in

PHONAK

The Articulate Hearing-Aid

PHONAK, the articulate hearing-aid, is the result of more than 12 years of development work, and employs electric principles new to hearing-aids. The result is an exact reproduction of the original sounds—words or music, without distortion—clear, quiet, natural, and with ample volume.

PHONAK agents will gladly demonstrate the different models. Then if you wish, a ten day trial in your own home can easily be arranged without cost. If there is no PHONAK Agent near you we will be glad to show and demonstrate PHONAK in our consultation rooms or arrange for trial by mail. Write The French Electric Co., Inc., George Barton French, President, 654 Madison Ave., New York, N. Y.

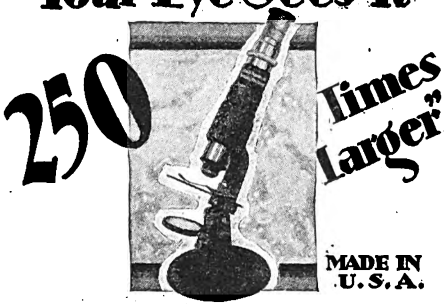


(Patented 1-17-22)

The Midget "Five-in-One" Slide Rule

is a combination Mannheim, Polymetric, Log-Log, Binary, Add and Subtract Slide Rule. It will instantly add, subtract, multiply and divide any combination of whole numbers, fractions, mixed numbers and decimals. Gives every root and power, also Logs, Sines and Tangents. Made of aluminum with scales on white celluloid. Size 4 in. Approved and adopted by colleges. Price with instructions, $1.50. Fabrikoid Case, 50c extra. Sent C. O. D. if desired. Catalogue Free. GILSON SLIDE RULE CO., Stuart, Florida

"Your Eye Sees It—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Times Larger"
MADE IN U.S.A.

WOLLENSAK MICROSCOPE $16.50

SOLVE the mysteries of insect, plant and mineral life with the Wollensak Microscope. Reveal to yourself the beauties of nature hidden from the unaided eye. One of these fine microscopes should belong to every student, dentist, physician, or scientist and should be part of the equipment of home, office, school, or laboratory. *It gives a range of magnifications from 100 to 250 diameters in steps of 25.* Elaborately finished tilting stand, nickel trim, plush lined case, prepared slide, complete instructions. Ask your dealer, or, we will send you one postpaid. *Money back guarantee.* Lower powered Wollensak models $2.50 to $8.50. Catalog free.

WOLLENSAK OPTICAL COMPANY
911 Hudson Avenue Rochester, N.Y.

and are held by wing nuts with washers. Similarly the mirror is held to the brass ring by three more sink bolts on which it rests. This perforated cell allows half an inch clear all around the mirror, permitting ventilation of the mirror at all times. (A fine idea, as it controls the temperature changes that may distort a mirror and affect its performance—*Ed.*)

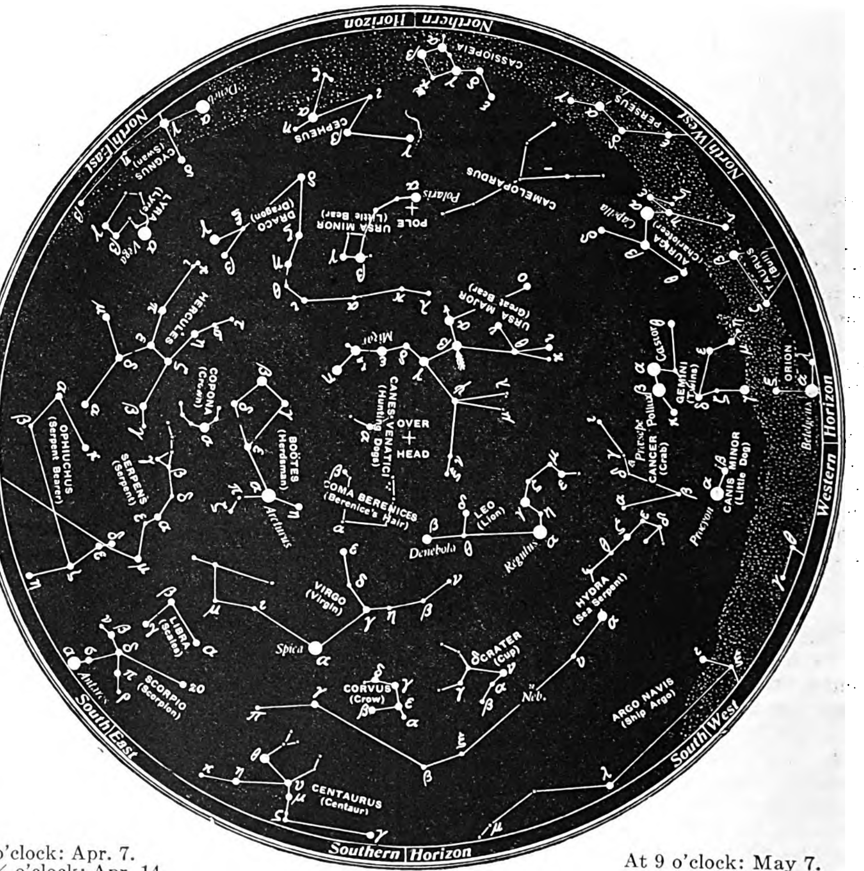
"Results?" Mr. Scanlon inquires. He answers his own question, "Yea, bo!"

THIS letter shows what a wide variety of picked-up second-hand dingbats an ingenious amateur can adapt to use in a home-made telescope. Most plumbers, in our own experience, are not half so resourceful, at least on jobs you get them to do for you. This, however, may be why Mr. Scanlon, who describes himself as a plain plumber, is really a plumbing and heating contractor. Readers having a nasty disposition may wonder whether a plumber, when he is doing this kind of work for himself, ever has to "go back for his tools." How does he figure up his time, and does he charge himself any profit on it? An anxious, breathless world would like to obtain these scientific data from a brother telescope maker who is presumably on the "inside."

All telescope makers are invited to send in photographs of their completed telescopes.—*A. G. I., Tel. Ed.*

The Heavens in April

By PROF. HENRY NORRIS RUSSELL, Ph.D.


Northern Horizon
North East
North West
Cassiopeia
Cepheus
Cygnus (Swan)
Lyra (Lyre)
Vega
Draco (Dragon)
Polaris
Pole
Ursa Minor (Little Bear)
Camelopardus
Perseus
Capella
Auriga (Charioteer)
Taurus (Bull)
Ursa Major (Great Bear)
Mizar
Hercules
Corona (Crown)
Canes Venatici (Hunting Dogs)
Over Head
Boötes (Herdsman)
Arcturus
Coma Berenices (Berenice's Hair)
Leo (Lion)
Regulus
Denebola
Castor
Pollux
Gemini (Twins)
Orion
Betelgeuse
Cancer (Crab)
Praesepe
Canis Minor (Little Dog)
Procyon
Eastern Horizon
Western Horizon
Ophiuchus (Serpent Bearer)
Serpens (Serpent)
Virgo (Virgin)
Spica
Libra (Scales)
Scorpio (Scorpion)
Antares
20
Hydra (Sea Serpent)
Crater (Cup)
Corvus (Crow)
Neb.
Argo Navis (Ship Argo)
Centaurus (Centaur)
South East
South West
Southern Horizon

At 11 o'clock: Apr. 7.
At 10½ o'clock: Apr. 14.
At 10 o'clock: Apr. 22.

At 9½ o'clock: April 30.

At 9 o'clock: May 7.
At 8½ o'clock: May 15.
At 8 o'clock: May 23.

The hours given are in Eastern Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on April 7, etc.

NIGHT SKY: APRIL AND MAY

MERCURY is in conjunction behind the sun on the first and is an evening star thereafter, on and about the 27th, when he is at his greatest elongation. He should be easily observable, as he does not set until 8:30 P.M. He is then in Taurus not far from the Pleiades and appears as bright as Capella or Procyon. Venus is an evening star and is steadily growing brighter. By the end of the month she stays in sight until 8:30 P.M. and dominates the evening sky. Mars rises about 4 A.M. in the middle of the month, but is not a prominent object in the sky. Jupiter is an evening star, setting about 10:30 P.M. in the middle of the month, and is very prominent in the evening sky. Saturn is in quadrature west of the sun on the 2nd and is observable in the morning. Uranus is in conjunction with the sun on the 1st and is unobservable. Neptune comes to the meridian a little before 9 P.M. in the middle of the month and is well placed.

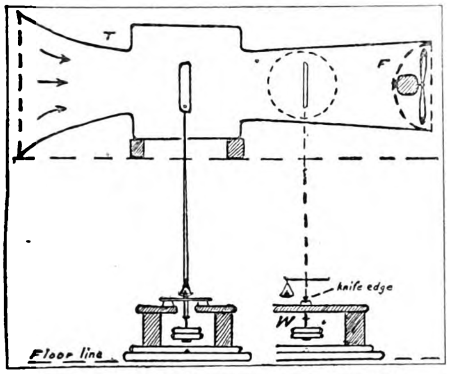
The conjunctions this month are with Jupiter on the 4th, Neptune on the 9th, Saturn on the 19th, Mars on the 25th, Uranus on the 26th, and Mercury and Venus close together on the 30th. The two planets are 2¼ degrees apart and the moon passes between them.

Learning to Use Our Wings

(*Continued from page 312*)

awake physics teacher can organize a course in practical aerodynamics, if he has at his disposal a physics or mechanics laboratory and a shop with carpenters' and mechanics' tools and supplies.

A small demonstration wind tunnel can be built so that it will fit on any good-sized lecture table. The cones can be made of thin wood strips, with wood barrel hoops on the outside. The exit cone is built to fit any electric fan available. A hinged door on one side of the channel, and a large sheet of window glass are desirable. A rough balance of the type shown in our diagram can be readily constructed. With a little ingenuity students can make measurements of lift and drag on wings and other surfaces. Airflow lines can be made visible by smoke-screens and by very fine silk threads.



A small wind tunnel, from "Elementary Laboratory Aerodynamics"

Mr. Jordan lists an imposing number of experiments which can be performed simply: measurement of lift and drag; tests of longitudinal stability; tests of directional stability, et cetera. His manual will be invaluable both to teachers and to students of the subject.

Passenger Rate Reduction

THE Transcontinental Air Transport-Maddux Air Lines have recently reduced their transcontinental passenger rates until they are no higher than those of rail and Pullman travel.

It had been previously believed in the industry that rates were not of as much importance as were the questions of safety and reliability. Yet in the week following the reduction in rates, the number of passengers increased in most surprising fashion and 222 revenue passengers were carried over some portions of the line. Forty-six of these were through-passengers, moving from coast to coast. These figures would appear to indicate that travelers have been waiting for more favorable rates.

Ice and Snow Landings

A FLYING boat can apparently take off from ice or snow. The ice was delaying tests of an Eastman flying boat, but it was found that the metal hull skidded along the ice so easily that it got off in about one half the time used in taking off from water. Subsequently the boat landed on the Grosse Ile Airport in about three feet of snow.

The event has some importance from the point of view of general adaptability of the flying boat.

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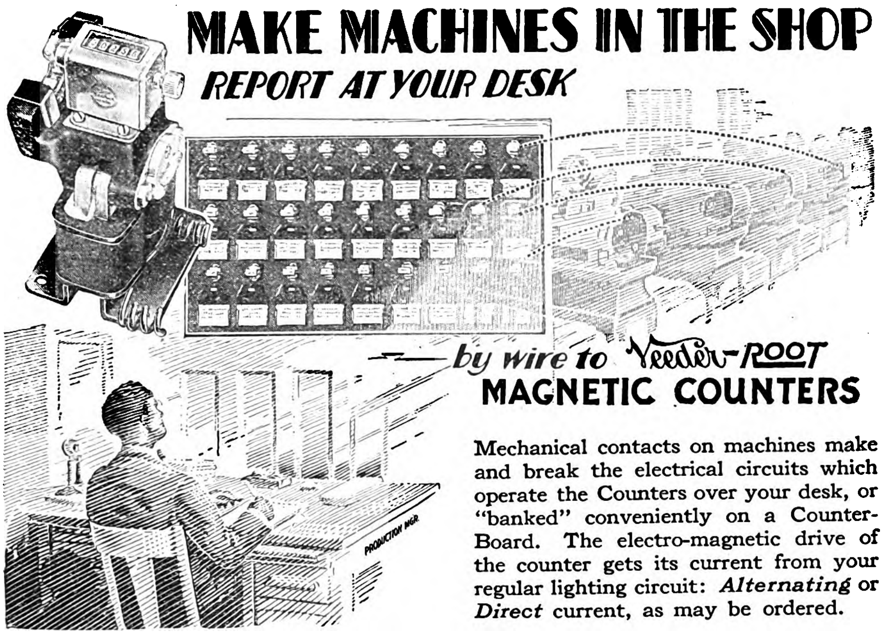
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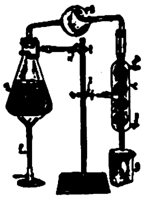

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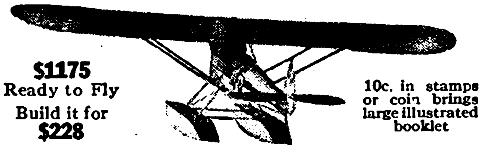

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Chemistry in Industry

(*Continued from page* 316)

The increasing applications of the centrifugal separator in industry is partially due to the improvement of the machine from its early state in which it developed a centrifugal force of only a few hundred times the force of gravity, to a model which produces a force 15,000 times that of gravity. E. M. James describes some of the applications of centrifugal separation in a recent issue of *Chemical Markets*.

In printing the color designs on leather, a paste or gum is used to hold the color and prevent it from running. The paste is mixed with the color and applied to the leather from copper rolls. It is extracted from certain species of shrubs, and in a crude form is likely to contain woody fibers. If these shreds of wood are not removed from the paste, the dye would show in streaks and the copper rolls might be blemished. Such a product would be difficult to filter, but is easily clarified with the centrifuge. The centrifuge discharges continuously a clarified paste, removing dirt, sand, and shreds of wood.

Centrifuges are used for the clarification of fuel oil used in the manufacture of glass bottles. Uncentrifuged oil contains a small percentage of tiny black particles. When the oil is burned such particles form incandescent "sparks" which fly into the glass, causing defects in the bottle. These particles are removed by a simple process of centrifuging.

The clarification of baking enamels used by manufacturers of automobile bodies is being handled very successfully by centrifuges. The body parts are dipped, and any dust and other speck-forming particles would contaminate the paint. The used enamel from the dipping vat is reconditioned by the centrifuge, coarse foreign material being removed without disturbing the pigment. The process has invariably resulted in a reduced cost for a smooth, brilliant finish. In a typical plant but one half of the labor formerly required in rubbing is needed as the surface dries with a smooth finish.

The presence of small amounts of water and impurities greatly accelerates the deterioration of fatty oils. The result is the production of free fatty acids with consequent unpleasant flavor. This is often accompanied by undesirable bacterial action. The dehydration of butter oil is typical. Butter oil containing over 0.11 percent moisture does not keep well unless preserved. Butter oil separated from butter or cream oil and dehydrated with the centrifuge may be sealed in cans and kept indefinitely without deteriorating.

The clarification of lubricating oils for all types of machinery—Diesels, compressors, turbines, and machine tools—provides one of the most wide-spread and profitable uses of centrifuges.

Concrete Without Sand or Stone

LIGHT-WEIGHT concrete, made without sand or stone, is one of the latest achievements of chemists in the field of construction materials which has resulted in the production of a pre-cast slab for roof construction now on the market. The new slabs are said to weigh only about two thirds as much as similar slabs made from sand concrete. At the same time, the thermal conductivity is only about 37 percent that of sand concrete.

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It is said that ordinarily no additional insulation is required for a roof made of this material. The slabs are easily laid and require only a composition covering. Such a roof, it is claimed, is permanent, fireproof, and prevents condensation.

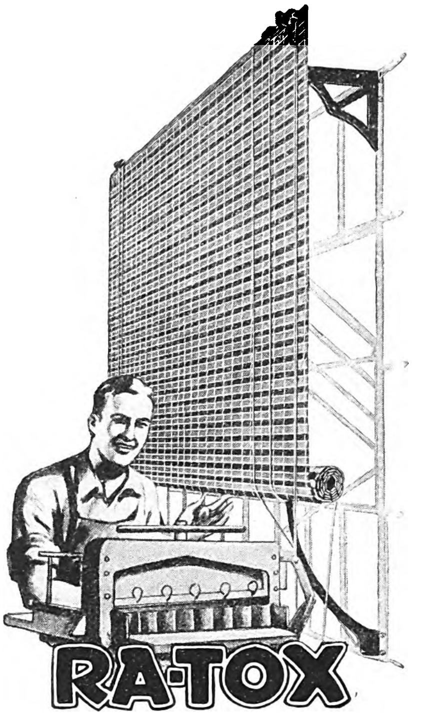
Minute Impurity Explains Riddle of Photographic Film

AMATEUR photographers, and professionals also for that matter, little realize the tremendous amount of involved chemical research that enables them to take a picture by merely pressing a button. The writer spent two years in the manufacture of photographic film, a sufficient experience to convince him that for pure cussedness and unexpected vagaries, there is nothing in chemistry to beat the behavior of photographic emulsions.

Photographic film consists of two layers, a thin translucent film containing a suspension of light-sensitive silver salts in gelatin, and a thicker transparent layer made either of cellulose nitrate or cellulose acetate. The light-sensitive layer is called the emulsion; the lower layer, the film base or support. It is in the making of the emulsion that the chemist finds his patience most sorely tried, partly because of minute variations in the quality of the ingredients and partly because the field is so fascinating that its exploration seems tediously slow. For example, one problem of practical as well as theoretical interest is the work done by Dr. S. E. Sheppard and his collaborators on the isolation of the sensitizing substances in photographic gelatin, described recently by G. E. Matthews in *Chemical Markets*.

For many years emulsion makers have known that certain gelatins were satisfactory and others were unsatisfactory for photographic use. Several years ago it was found that an extract could be prepared from a good gelatin which, on addition to a relatively inert gelatin, made it photographically active. An extensive investigation was then begun during which the entire process of gelatin manufacture was subjected to a thorough analysis. Hides, bones, cereal preparations, and many other substances were examined. Finally it was shown conclusively that a derivative of mustard oil, called allyl thiocarbamide, was the sensitizing substance. Its presence in minute concentrations of one part in 1,000,000 to one part in 300,000 was shown to be the cause of the suitability of certain gelatins for use in photographic emulsions.

During the emulsion making process, this substance is converted over by a series of reactions into silver sulfide which was shown to be present as small specks or nuclei and proved to be necessary in order that the grains could be developed.



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Our Point of View

Naval Conference Problems

(*Continued from page* 269)

Japan struck a discordant note by her insistence on a 10:7 instead of a 5:3 ratio in cruisers; according to the press, the Japanese delegation was reminded that any change in the 5:3 ratio would reopen the whole problem of fortified bases in the Far East as settled at the Washington Conference. As Japan is aware she was the real beneficiary of that treaty she probably will not press the point. With an army second only to the French, Japan will have difficulty in convincing the rest of the world that she is entitled to increase her naval force particularly at a time when she has difficulty in balancing her budget, and is already militarily predominant in the Far East.

ITALY has been tenaciously clinging to her claim for a parity with any other continental European State, meaning France. The informed claim that Italy would not build up to France even if she were accorded the right—that Mussolini's representatives are only engaged in a contest for prestige. France bitterly opposes any such recognition of Italy; and some say France is prepared to prevent any such agreement even if it involves breaking up the Conference.

Mr. Stimson has made a brave effort to find a satisfactory meeting ground for France and Italy by having the Conference formally recognize the right of any state to create any size army or navy it wishes, and then agree that for five or six years the five contracting powers will not exceed certain ratios in the various classes of ships. This is a constructive idea and will not only assist France and Italy to settle their present difficulties but will formally recognize that agreements reached in 1930 are not expected to bind in perpetuity the naval forces of five great and growing states, whose future naval needs can be only dimly discerned at present.

To date the most concrete proposal is that made by Mr. Stimson and apparently accepted by Great Britain; the part concerning cruisers contains a clause permitting sufficient adjustment between 6-inch and 8-inch gun classes to meet the needs of both states.

The following table indicates an approximate solution under the Stimson-MacDonald formula:

1			2			3		
UNITED STATES			GREAT BRITAIN			JAPAN		
No.	Cal., Guns	Displacement	No.	Cal., Guns	Displacement	No.	Cal., Guns	Displacement
10	6″	70,500	35	6″	193,000	21	5.5″	99,000
18	8″	180,000	15	8″	146,000	8	8″	68,000
11	6″	77,000				4	3″	40,000
39		327,500	50		339,000	33		207,000

Columns 1 and 2 show the probable result to United States and British cruisers if Mr. Stimson's plan is accepted. If Japan's contention for 70 percent instead of 60 percent of cruiser strength is granted, it would increase her cruiser tonnage to 238,000 tons which, if devoted entirely to

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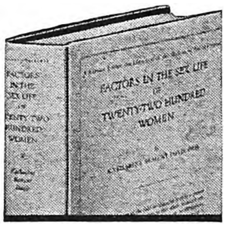
FACTORS IN THE SEX LIFE OF 2200 WOMEN

By KATHARINE BEMENT DAVIS, Ph.D.



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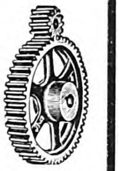

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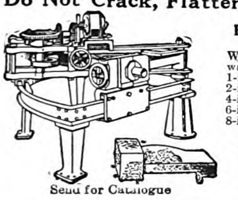

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8-inch-gun cruisers, could add 3 to her 12, giving her 15 8-inch-gun cruisers, a parity with Great Britain in that class. Australia and New Zealand are reported to object strenuously to a parity between Great Britain and Japan in this class of vessels, and it is no secret that our delegation is opposed to any increase of Japan's ratio.

The proposal to reduce capital ships to 15-15-9 by scrapping five British, three American, and one Japanese capital ships seems to meet general approval. This is a dangerous reduction for powers like the United States and Great Britain—whose fighting strength is practically limited to their fleets—for their armies are negligible compared to the conscript hosts of France, Japan, and Italy. The United States, in particular, would do well to resist the temptation to abolish the capital ship that still dominates the ocean routes and gives to a country possessing only naval power, some counterpoise to the land-powers of states with great armies.

France has good reasons for resisting the abolition of the submarine, which is the natural weapon of a weaker naval power; and it will not become us to oppose the French use of the submarine, for when our surface fleet was relatively weak we relied in large measure on the submarine as a balance. The improper use of submarines by one state during one war should not prevent the legitimate employment of an effective weapon of war. It is a curious fact that no one advocates the abolition of aircraft, yet everyone knows that, in the next war, more non-combatants will be killed by bombs from aircraft than by torpedoes from submarines.

THE American delegates have justified the country's faith in their abilities and so far have accurately reflected its desire for security and world accord. When the results of the Conference are ratified by the Senate it will remain for Congress to provide the necessary funds to carry out the modified program, and if the sum required to bring our navy up to parity seems large, we must remember that between 1922 and 1928, in modern cruisers alone, England laid down or appropriated for 162,000 tons, Japan 128,000 tons, while we constructed only 80,000 tons. We have already taken our cruiser holiday and we will soon be called upon to spend proportionately more than England or Japan, because our first plan of leading the naval powers to "cruiser disarmament by example" failed. It was an inspiring idea but the world was not then ready for disarmament by example.

Also, if our delegation obtains the right to construct one new battleship to balance the British *Hood*, we should improve the opportunity, for despite the newer weapons, the battleship is still the backbone of the fleet. In the years immediately following the World War, the question of national defense was considered from all viewpoints by the American Congress; many believed in an immense army raised by universal service, but finally in response to an overwhelming public opinion, the old system of a small, highly trained Regular Army, backed by the National Guard and Reserves was re-adopted. To shield the country while our miniature army expands, a fleet capable of meeting and defeating an enemy fleet on the high seas is necessary; and only to a fleet containing its full share of post-war battleships can such a tremendous responsibility be safely confided.

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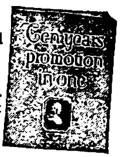
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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Trademarks in Latin-America

WITH the growth of trade between the United States and the Latin-American countries, it has become necessary to consider carefully the question of obtaining foreign trademark registrations. These registrations must be secured to prevent the loss of trademarks in all countries where the laws for the acquisition of legal rights to trademarks are based on registrations.

Many trademarks which are the property of merchants in the United States have been lost abroad because our merchants have been educated under the registration laws of the United States, which make it necessary to use the trademark before filing the application for registration. In the Latin-American republics, and in some other countries, this is not the case, and when this United States practice is followed abroad unfortunate results often occur. In Latin-America, priority rights to a trademark are only acquired by filing a formal application for registration.

Inasmuch as the trademark must be registered in each country where the trademark is to be protected, an agreement was signed at a convention in 1910 which made it possible to register a trademark at a central office which would send abstracts of the mark to the registration offices of the countries which were members of the Convention. Unfortunately, many of the Latin American countries did not join this 1910 Convention, and many of the countries which did join subsequently withdrew.

To avoid objectionable provisions in the 1910 Convention, which were the reasons for these withdrawals, a new Convention was signed in 1923. This Convention has been ratified by the United States, Brazil, Cuba, Haiti, Paraguay, Dominican Republic, and Guatemala. Under the 1923 Convention, a trademark registered in the Patent Office at Washington may be registered at the Havana Convention Bureau by paying a registration fee. This registration in the Havana Bureau may be extended to the Latin-American countries which have ratified the Convention, by paying the customary fees.

Temperature Indicating Device Patent Sustained

ALTHOUGH Harrison H. Boyce was not the first to conceive of a trouble indicator for use in the daily run of an automobile, nor was he the first to conceive of the specific means which he describes in his patent, he was the first to apply those specific means to that particular purpose. In doing so, he performed an inventive act. This decision was made recently by the District Court for the Eastern District of New York in the case of Harrison H. Boyce and The Motometer Company, Inc., *versus* Taft-Buick Corporation.

The court ruled that the Boyce patent, Number 1206783, was not anticipated by the prior use of a thermometer as a guide to better engineering practice in the construction of the radiator or engine of the automobile. This patent was found to be valid and infringed.

However, the two claims in suit of the Boyce patent Number 1275654 were held to be so broadly drawn as to be anticipated by the Fowler patent Number 1159918. The patent granted to Fowler was for a thermometer on the dashboard of the automobile in view of the driver, whereas the Boyce patent shows a thermometer on the radiator. The Boyce application was filed prior to that of Fowler, but it was held that Fowler was the first to conceive the invention. These two claims therefore were held anticipated and invalid.

Trademark Denied for Laundry Service

A PRINT which identifies a laundry service is not registerable as a trademark, according to a recent decision of the Patent Office, because it does not "identify an article of manufacture." Dinks L. Parrish's Laundry Corporation had sought registry for an identification print. This application was denied by the examiner, whereupon the applicant appealed to the Commissioner of Patents. The decision of the examiner was sustained.

Wanted: More Co-operation to Develop and Market Inventions

IN a communication to the editor of the *New York Times*, which was published recently in that paper, Joseph J. O'Brien made a number of pertinent comments on the subject of "Patents and Progress." Discussing the proportion of profitable patents, Mr. O'Brien says, "About 25 percent of all patents are assigned before their issue, thus indicating that the ratio of patents regarded as having financial value is very large. This is a higher percentage of success than general business ventures can claim."

Pointing out that most instances in which a patentee fails to achieve success are due simply to a lack of merit in his invention, Mr. O'Brien shows also that no highly successful inventor can claim that he has never made any patent failures. Thomas A. Edison has a larger list of patent failures to his credit than any other man in the country, just as he has achieved more success than most inventors. Henry Ford, Mr. O'Brien points out, probably has the highest percentage of commercially successful patents to his credit, covering his own inventions. His patents are practically co-extensive with the devices or improvements he has embodied in his motor cars.

"All industrial progress rests on patented inventions, covered by either expired or active patents," Mr. O'Brien declares. "Only the investment trusts and banks listed on the Stock Exchange can fairly be said to be outside of the direct influence of patents. But even these base their investments in concerns partly or wholly controlled by patented inventions.

"It is difficult to get accurate information on the successes which inventors achieve. Within a brief period the press announced the death of three inventors who had become millionaires: Higgins of Brooklyn, who made his start with a patented ink bottle; Hartshorn, who gave us the spring shade roller, and Conrad Hubert, who invented the electric flash lamp and empowered the Coolidge board to dispose of 6,000,000 dollars. Oscar Hammerstein made 10,000,000 dollars from his patented cigar-making tables."

The *Times* contributor states also that it should be comprehended that practically every foundation invention in this country was the product of a so-called garret inventor. He believes that many of the practical discoveries of science are lost because accurate working knowledge of them is not properly diffused, and that engineering is usually more than a decade behind successful invention. As a means to effect closer co-operation between inventors, engineers, investors, and organized industry, Mr. O'Brien urges more study of the problems faced by the individual inventor in his struggle to carry on pioneer work. Attention also should be given to the need for a modernized system of co-operation between banking interests and inventors.

In conclusion, Mr. O'Brien says, "Much of the waste by inventors could be avoided by the application of better engineering knowledge and co-operation. Much of the loss due to delayed progress could be avoided by a policy of human understanding and beneficial co-operation with inventors. A large part of all patents filed should never be allowed to mature in formal grants, and would not if their applicants had fuller information. But many inventions now suppressed would be released for development if society would properly recognize its duty to inventors."

Edison's Goldenrod and Other Rubber Producing Plants

COMMENTING on a recent press announcement that Thomas A. Edison expects soon to supply rubber from the goldenrod plant, *Solidago virgaura*, at 16 cents a pound, *India Rubber World* presents the opinion of one of Mr. Edison's aides, who refutes the statement that any price estimate has been made on the rubber from this or other plants with which the great inventor is experimenting. Newspapers have led their readers to expect too much of Mr. Edison, apparently not realizing the difficulties which beset research in that direction.

"Mr. Edison said some time ago that he sought not so much a product to compete with commercial rubber as a material of which the nation might quickly avail itself in ample quantity were the rubber supply endangered by war or natural disaster," according to the editor of *India Rubber World*. "As to the latter, recent experience with the Mediterranean fruit fly in Florida reminds us of what can happen. A generation ago a blight so devastated the Far East coffee lands that their disheartened owners abandoned coffee and sought solace and found profit in rubber growing; and although history may not soon repeat itself, it is well to be vigilant. In brief, Mr. Edison's main and laudable object is one of national preparedness. It is possible that goldenrod, long a bane of hay-fever victims, may one day prove a boon to the country.

"While much is heard about one plant's possibilities, the potential usefuless of other promising rubber-yielding growths being intensively studied on American soil by government, industrial, and educational agencies is almost overlooked. Little is said about *Crytostegia grandiflora*, the milkweed varieties, *Asclepias subulata*, the rabbit bush, *Chrysothamnus nauseosus*, and many other plants that are known to possess rubber-producing possibilities.

"The outstanding American success is, of course, guayule, *Parthenium argentatum*, developed with great pains and expense from a wild southwestern shrub into a domesticated plant, grown commercially as far north as latitude 39, which can be cultivated and harvested as a stable crop. Its rubber content has been so increased and the extraction process so improved that the product can vie in price and quality with some of the best grades from foreign sources."

Solving Britain's Patent Problems

BRICKBATS by the dozen have been hurled recently at the British patent system by proponents of reforms of one kind or another. In England, as in this country, the chief "fault" of the Patent Office is that it is over-worked. However, it is reasonable to assume that an institution as old as the British patent system might profit by a housecleaning now and again.

Of the numerous abuses of the system, two of the most objectionable are the intertwined facts that there are too many worthless patents, many of them invalid, and that the cost of patent litigation is in effect discriminatory. *Nature*, England's leading scientific journal, editorially takes the stand advocated by Dr. Levinstein in a recent address before the Bristol section of the Society of Chemical Industry. He urged that the validity of patents be settled administratively before the patent is issued, or after the lapse of a given interval. Considering the expense involved in patent litigation before the High Court and the Lords of Appeal, exception is taken to the alternative proposed by the British Science Guild—that the Comptroller should be empowered to try infringement actions by consent of the parties. This course is held to offer no real solution, because either of the parties could insist on carrying the case to the High Court, perhaps with ruinous consequences to the opposing party.

"I am convinced," says Dr. Levinstein, "that the time to determine the state of common knowledge is before the grant of a patent, not years later: the place the Patent Office, not the Law Courts."

Upholding this view, *Nature* cites the fact that "every patent agent and every examiner in the Patent Office construes hundreds of specifications in the course of a year. The number of documents relating to his special industry which he construes, and his familiarity with the technical details of that industry, far exceed the equipment in these respects of a High Court judge, who may never have turned his attention to the subject until it is explained to him by expert witnesses. The issue is one which requires technical understanding rather than profound legal knowledge."

Nature shows also the handicap under which the Court sometimes labors in determining the status of "subject matter" in a patent case. "The problem is stated by asking whether a skilled workman, possessed of the knowledge which was common at the date of a given invention, could have devised the latter without exercising ingenuity. . . . The Court has to ascertain what might have been done a long time ago by a fictitious workman, in circumstances which never occurred, with the aid of an abstraction called 'common knowledge' the limits of which nobody can any longer remember, and subject to an undefined quantitative restriction which is erroneously apprehended as being qualitative."

As an example of the uncertain and conflicting decisions which result in such instances, *Nature* cites the case of Bonnard *vs* L.G.O.C. In this case, the three judges of the Appeal Court were just as unanimous in attributing ingenuity to the invention as the five Law Lords were in denying it. It is suggested that such issues might be settled more inexpensively by the toss of a coin, and that no great injustice would result if the decision were made before the sealing of the patent. More seriously, *Nature* contends that administrative settlement of the issue would be particularly suitable if present standards of "subject matter" were to be raised, and if inventions which did not reach the new standard could be made the subject of short-term patents. The Report of the British Science Guild (see page 460, November 1929 issue, SCIENTIFIC AMERICAN) recommended the inclusion of short-term patents in the British system.

Patents Recently Issued

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Pertaining to Aeronautics

Airplane Construction—A wing construction composed of transversly disposed sets of strips spaced fore and aft, functioning as a supporting and lifting surface to allow of vertical as well as gliding descent, thereby eliminating the use of the usual ailerons. Patent 1743020. Thoralf Borgan.

Apparatus to Facilitate Aeronavigation—Whereby a sighting means mounted for oscillation, and a recording device including a stylus, will supply the pilot with the necessary data to enable him to calculate his position when flying over a partially or wholly obscured area. Patent 1742355. Adirio O. Jessen.

Parachute—Having a dilatable vent or aperture at its apex, so formed that when the air first enters the vent will be comparatively small to avoid the escape of air, assuming its proper shape as the cap becomes distended. Patent 1743951. Luigi Avorio.

Pertaining to Apparel

Supplementary Outsole for Boots and Shoes—Which may be readily applied by an unskilled person to worn boots or shoes to repair them for future use, or for preserving outsoles when worn in wet weather, or over rough roads. Patent 1744003. Edward Gallagher.

Detachable Shoe Heel—Which will permit the substitution of a new heel for one unduly worn or damaged, also the application of heels of various heights to the same shoes, for either walking or dress purposes. Patent 1743543. Manuel S. Gutierrez.

Chemical Processes

Titanium Oxide and Process of Producing Same—The process of producing pure dioxide of titanium from reactive titanium nitride Ti_2N_2 which comprises heating the same in the presence of sulphuric acid and sodium nitrate, may be used as a basis for pigments, or starting material for other compounds. Patent 1742674. Foord von Bichowsky.

Designs

Design for a Dress—Patent 80279. Dorothy Long.

Design for a Coat—Patent 80280. Dorothy Long.

Design for Leather or Similar Articles—Patent 80320. Frederick A. Kolb.

Design for a Wall Plate for Electric Button—Patent 80335. Etta M. Squires.

Design for a Spectacle Frame—Patent 80311. Dorothy S. Helm.

Design for a Coat—The inventor has been granted two patents, 80382 and 80383. Dorothy Long.

Design for a Coat — Patent 80422. Dorothy Long.

Electrical Devices

Telegraph Transmitter—Which is simple in construction, having novel means for adjusting the weight for decreasing the friction during action, thus obviating the possibility of loose connections, and means whereby the various parts may be reversed to change the device from a right-hand to a left-hand operating transmitter. The inventor has been granted two patents, 1642296 and 1742297. John R. Youngblood.

Safety Fuse Plug and Receptacle Therefor—Having terminal means in the form of keys projecting from the plug, and passing irregular openings, thus preventing the insertion of nondescript articles for bridging the contacts, and blowing out the main fuse of the installation. Patent 1743016. Emil de Bruijn.

Flash Light—Including within a single casing a plurality of batteries and illuminating bulbs with separate controls, whereby they may be separately energized for forward or rearward illumination on a bicycle or other vehicle. Patent 1743936. Ernest Segesser.

Spark-Plug Tester—For testing plugs under substantially the same degree of compression they are subjected to in practice, whereby defects will be indicated which ordinarily would not show up when the plug is not under compression. Patent 1743881. Carman S. Cole.

Dial Control—Adapted for use in conjunction with radio condensers, indicating through what revolution the plates are moving at any time, and providing the direct reading of wave lengths or frequencies in conjunction with the revolution. Patent 1743927. Otto H. Luther.

Electrical Hair Trimming and Singeing Instrument—Which includes a comb and an electrically heated singeing element, whereby the trimming of the hair by singeing the ends may be accomplished by moving the comb therethrough thus insuring a uniform finish without danger. Patent 1744525. Samuel O. Chase.

Of Interest to Farmers

Harvesting Machine—A combined harvester and shocker wherein the cut stalks are formed into shocks which are deposited on the ground in an out-of-the-way position to permit the machine to operate on the next row without interference. Patent 1743013. Theodore A. Boor.

Milk Strainer—Wherein the filtering elements are disposed in such manner that the liquid will impinge against the side walls thus preventing clogging and forcing therethrough material desired to be strained out, the parts may be readily cleansed. Patent 1742964. Hugh F. McNally.

Incubator—Comprising a casing having fresh air openings, a water pan, electric heating apparatus, and revoluble egg cabinets which make absolutely certain a thorough circulation of heated and vaporized air through the entire cabinet. Patent 1742954. Avila C. Gillette.

Peanut-Thrashing Machine—Which shreds the vines so that a loosening of the peanuts is obtained, a screen providing a rough separation, both the peanuts and the chaff being subjected to a final airblast for separation before delivery. Patent 1744906. Carl R. Livermon.

Cultivator—Comprising a main beam, and an auxiliary beam pivotally secured thereto, adapted to cultivate two rows at a time, and novel means for giving a fine adjustment for positioning the shovels to suit the rows. Patent 1739508. Elbert H. and George W. Fincher.

Of General Interest

Earring Guard—For preventing the loss of valuable earrings, particularly the type attached to the ear lobe merely by clamping means instead of passing through a perforation in the lobe, the device is inconspicuous, being concealed behind the ear. Patent 1743006. Percival C. Prescott-Richardson.

Metal Clip—Which may be used for numerous purposes, such as closing bags and the like, and also fastening together sheets of paper, cardboard, etc., the clip will serve effectively as a reusable fastener. Patent 1742989. John Fritz.

Egg Beater—Having shanks removably secured to the body portion for permitting easy cleaning of the shanks and the beater without placing the body portion in water. The device may be readily packed in a small space. Patent 1742230. Porter K. Bushnell.

Beam and Column Connection—As used in structural steel work, whereby practically all the riveting may be done in the shop rather than on the field, completing of the connections requiring but a few rivets, whereby a great economy is effected. Patent 1744600. Albert J. Wilcox.

Moistening Device—Comprising a liquid container and a rotable moistening member exposing freshly moistened portions of its periphery, for facilitating the handling and counting of money, checks and the like. Patent 1742548. Joseph H. Leal.

Spring Cover—Particularly adapted for screwing on the threaded neck of a collapsible tube, the cover instantly returning to the mouth of the tube as soon as a lever is released, thus sealing the tube contents. Patent 1743293. George W. Toft.

Road Sign—Particularly adapted for warning motorists of danger either from curves or other reasons, at night, the device will warn approaching drivers on both sides of the curve when hidden from one another's view. Patent 1743317. William A. Cannon and Howard J. Hall.

Awning—Of the marquee type, including a top sheet or roof, a valance, and a collapsible frame, which permits the awning to be extended, the frame and canvas compactly folding against the building when desired. Patent 1744563. Earl Martin.

Safety Razor Blade-Honing Device—A small device including a casing especially designed for honing the blades of Auto-Strop Razors, the blade being honed without removal from the razor, thus preventing the possibility of cutting the hands. Patent 1744752. Ernest L. Crespo.

Visible Card Index—Comprising a guide and a card formed of two interconnected parts adapted to be inserted on the guide with one part beneath the guide and the other partly underlying and partly overlying the guide. Patent 1745262. Luigi Lombardini.

Method of Decorating Walls—Whereby a multi-colored liquid film, and an absorbent plastic coating through which the liquid may penetrate, may be applied to wall-forming elements such as wall board or plaster board prior to its erection. Patent 1742332. Robert I. Vincent.

Holder for Accounting Systems—Particularly adapted for account-keeping of newspaper and periodical subscribers, wherein the accounts are rapidly available, yet effectively protected, always posted up-to-date, preventing errors and facilitating making reports to the main office. Patent 1742993. Carl A. Jettinger.

Piling for Subaqueous Constructions—In the form of hollow metallic units having U-shaped members which will interlock and may be readily assembled to produce a rigid concrete-filled barrier possessing a maximum of strength from a minimum amount of material. Patent 1742947. Victor G. Brash.

Sew Slide for Portable Electric Sewing Machines—An attachment which may be adjustably secured to the machine base, and will be perfectly level and flat with the sewing surface of the machine to which it may be connected. Patent 1742932. Robert W. Perry and Parker E. Abell.

Toothbrush—Having a removable head to permit of replacement, either end of the brush being secured nearest the handle, and having means for locking the head in a plurality of positions with respect to the handle. Patent 1742596. Edward R. Hoff.

Vacuum Cleaner—In which there is an intermittent suction produced by the admittance of air through a by-pass round the mouth of the nozzle, thus obviating danger of clogging, and the necessity of mechanism within the chamber itself. Patent 1742810. Richard T. Hosking.

Humidifying Device—A relatively small moisture-retaining casing which may be placed within a receptacle to impart moisture to the air, and prevent the drying out of tobacco, cigars or other materials, without fear of undue moistening. Patent 1742962. Donald W. McCrosky.

Hardware and Tools

Pocketknife—Wherein a proper spring action is provided for the respective blades without presenting the usual surface on the spring back, the blades co-acting with a spring means interiorly, and separate from the back. Patent 1743022. William Carman.

Cutting Tool—Wherein automatic power is employed for imparting the cutting impulses in the work, the tool being hand controlled, particularly adapted for cutting decayed tree trunks and forming cavities for the operations of tree surgery. Patent 1743988. George Van Yahres.

Rotary Core Drill—Particularly of the type by which samples are formed, producing a core of uniform diameter, facilitating its removal from the barrel, eliminating disintegration, and insuring a core with the strata maintained in its original position. Patent 1742641. Arthur L. Armentrout.

Measuring Instrument or Gauge—For engineers and mechanics, whereby shafting, piston rods and guides for locomotives, or other types of reciprocating engines may be accurately alined, the device may also be employed for determining the slope of roofing. Patent 1745252. Arthur B. Ginter.

Nail Holder for Shingles—For asbestos and other artificial shingles, which will automatically move the nail to a correct position to be driven, enabling the workman to hold the shingle with one hand and hammer with the other. Patent 1745315. William J. Parker.

Heating and Lighting

Oil Burner—Having a burner ring constructed to be raised above the fire pot thus effecting a saving of fuel also facilitating the removal for cleanings, and replacement of the ring should it become injured or require repair. Patent 1743021. William H. and Cecil E. Boston.

Forced-Draft Attachment for Fire Boxes—A blower and casing attachment for fire boxes of ordinary household furnaces, which causes an updraft through the fire, and directs air jets downwardly on the burning fuel, thus permitting the use of buckwheat coal. Patent 1743048. Frederick I. Sleaster.

Machines and Mechanical Devices

Stone-Sawing Machine—A cable saw which will cut at a comparatively increased speed, and is capable of being magnetized to pick up, and hold abrasive material such as steel shot, or metal filings, to augment the cutting. Patent 1743057. Albert E. Wienholz and Frederick Siefke.

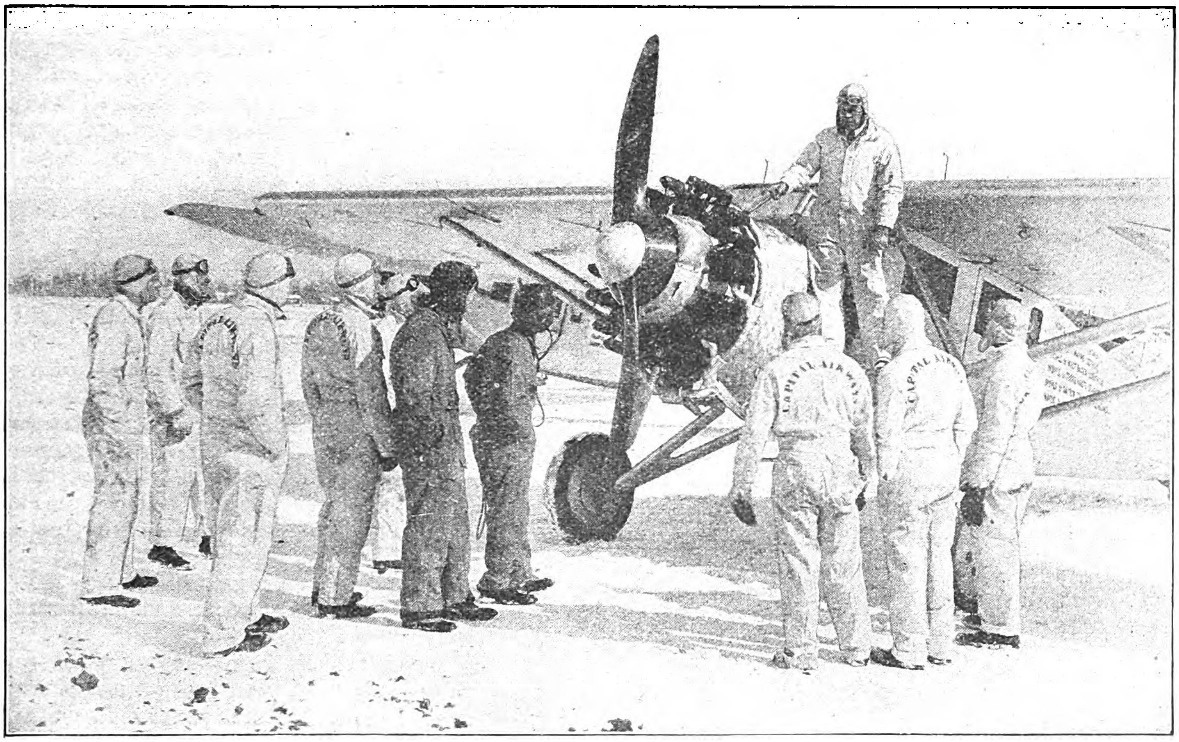
Beater Mill—In which a revolving beater forcibly acts upon heavier particles from a hydrating plant for lime, the heavier graded particles being automatically ejected in one direction, and the finer ejected by a separate path. Patent 1742511. William J. Kuntz.

Card-Display Machine—Adapted to automatically raise the front card from a group of cards and hold the card a predetermined length of time, means being provided for two sources of lighting for illuminating non-transparent and transparent cards. Patent 1741228. William A. Garlick.

Contents-Discharging Device for Pump, Drill, or other Cylinders—Susceptible of use as a general discharge support, but relating more particularly to supporting means for cylinders which may be conveniently mounted on the derrick floor, or suitable support convenient to an operator, in well drilling. Patent 1742939. Elgan S. Sloan.

Walter Franklin Prince

ELIMINATING entirely all the vast welter of unrelated "occult" hocus-pocus with which the name of genuine psychic research unfortunately has been linked by the muddled fraction of the public, Dr. Walter Franklin Prince. Research Officer of the Boston Society for Psychic Research, is a leader in the attempt to investigate without prejudice or preconception certain unexplained happenings which have the appearance of being psychic. Most men of science have chosen other fields—physics, chemistry and so on—for investigation because it is less difficult in these to obtain unequivocal findings, while valid research in psychic phenomena from first to last has been carried on among a host of besetting difficulties. Despite adverse judgments from many of the uncritical who have little or no idea of the rigorous discipline of the scientific method, or of what science means by a "proof," Dr. Prince has hewn to the line in his work. He has now been honored signally by election as President of the Society for Psychical Research (London) and will sail shortly to deliver his Presidential Address. The chair of the British organization previously has been occupied by many famous men—Sidgwick the sceptic, William James of Harvard, Crookes the physicist, Bergson, and others. For several years Dr. Prince has been a Corresponding Editor of this journal.



All photographs courtesy Aeronautical Chamber of Commerce of America

WHERE THEORY ENDS AND PRACTICE BEGINS

What Is a Good Flying School?

The Department of Commerce Has Worked Out Regulations for Rating Aviation Schools and Has Approved Many

By CLARENCE M. YOUNG*

Assistant Secretary of Commerce for Aeronautics

WHEN, on February 28, 1929, the President approved the Bingham amendment to the Air Commerce Act of 1926, authorizing the Secretary of Commerce to provide for the examination and rating of civilian flying schools, upon their voluntary application, as to the adequacy of the course of instruction, the suitability and airworthiness of the equipment and the competency of the instructors, an important obstacle—the lack of a unified, government-approved system of flight training—was removed from the path of the development of civil aeronautics in the United States.

PARENTS ask, "Where shall we send our boy for his aviation training? Claims of various schools are puzzling, and we know that the promises of some are misleading, even fraudulent. How, then, are we to decide?" Colonel Young has answered these questions by a concise and direct explanation of what constitutes a high-rating air school. Information on those that have been rated by the Department of Commerce—at the request of the schools—is obtainable from the Department. The intelligent parent will "rate" others by a careful consideration of equipment, plan of operation, and honesty of purpose in comparison with the ideal school system described by Colonel Young.—*The Editor.*

PRIOR to the approval of the Bingham amendment, Congress had authorized the Aeronautics Branch of the Department of Commerce to examine and license airplanes, pilots, and mechanics; examine and test engines and propellers; examine and approve airplanes as to airworthiness for manufacture under the Department's approved type certificate; to establish and chart airways, properly lighted and equipped with other aids to air navigation—in fact every provision had been made for the Government's assistance to the development of aeronautics and the protection of the public except in the case of the young man or woman who desired to become a pilot and make aeronautics a career or an avocation.

Up until the time authority was extended the Department of Commerce to examine and rate flying schools upon their own application, the Aeronautics Branch was deluged constantly with requests for information as to reliability, adequacy, and suitability of this and that commercial flying school. It was impossible for official replies to be given because of the absence of a known method under which some or all of the schools were operating. Consequently, the aspiring pilot was forced to choose for himself; sometimes he made a good choice and sometimes he did not.

The various schools and individuals giving courses in flying naturally adopted a method which, in their opinion, was the best; and often the course of one school embodied direct contrasts in theory and fact to the course of another, although both were intended to produce the same results. The beginner naturally was quite bewildered. Such a widespread condition could not help working a hardship on those upon whom we will rely in the future to contribute actively to the advancement and development of civil aeronautics in the United States.

ONCE the authority to examine flying schools was received, and facilities to handle this increased activity became available, we undertook the preparation of a supplement to the Air Commerce Regulations dealing

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*See "Among Our Contributors," page 341

rtis
FLYING SEI

HIS FIRST SOLO

Final instructions before the student takes off on his first solo: "Remember, don't get rattled"

entirely with the requirements to be met by the schools applying for an Approved School Certificate. This school supplement was prepared in co-operation with the schools themselves.

The first step in the preparation of the School Supplement to the Air Commerce Regulations, as it is known, was to classify the schools. Those giving instruction in flying are classed as flying schools, ground schools, or ground and flying schools. The approved flying schools are rated as follows: private pilot's flying school, limited commercial pilot's flying school, and transport pilot's flying school. Approved ground schools are rated as: private pilot's ground school, limited commercial pilot's ground school, and transport pilot's ground school, if operated in conjunction with an approved flying school.

Thus in the beginning the schools were classified according to their facilities and qualifications, so that no institution bearing the Department's approval would attempt to conduct a course in a subject for which it had not received a rating.

THE "suitability and airworthiness of the equipment" of a school applying for an approved certificate were defined in the regulations as follows:

All planes used for flight instruction in an approved school shall be planes licensed by the Department of Commerce for that purpose.

The minimum-sized field shall be one having at least 2000 feet of effective landing space in all directions, with clear approaches; or it shall have landing strips not less than 500 feet wide, permitting landing in at least eight directions at all times, the landing strips not to cross or converge at angles less than 40 degrees nor any one of the landing strips to be less than 2000 feet in effective length with clear approaches; or it shall have two landing strips, one aligned with the general direction of the prevailing wind, permitting at least four-way landing at all times and having clear approaches, the landing strips to be at least 500 feet wide and not less than 3000 feet in effective length and not to cross or converge at an angle of less than 60 degrees. The dimensions of the effective landing area and the effective lengths of the landing strips shall be increased at altitudes above 1000 feet, in accordance with accepted practice.

There shall be hangar space sufficient to house all airplanes used for instruction purposes and sufficient equipment and personnel to maintain such airplanes in an airworthy condition as required by the Air Commerce Regulations.

The total number of planes engaged in actual instruction from a given field shall not exceed 10 planes per hundred acres at any one time. The entire field should be available for take-offs and landings. Operations shall be limited solely to instruction during instruction periods where runways only are available.

Not more than 15 students shall be enrolled in flying courses for each airplane normally available for flying-instruction purposes.

Schools approved for ground instruction shall be equipped with one classroom for each hundred students enrolled, capable of seating 20 students. The classroom shall be furnished with suitable classroom equipment and facilities. Where the ground school is not under the management of, or connected with the flying school, it shall have at least three types of aviation motors in current use and three types of modern airplanes for demonstration and practical experience purposes.

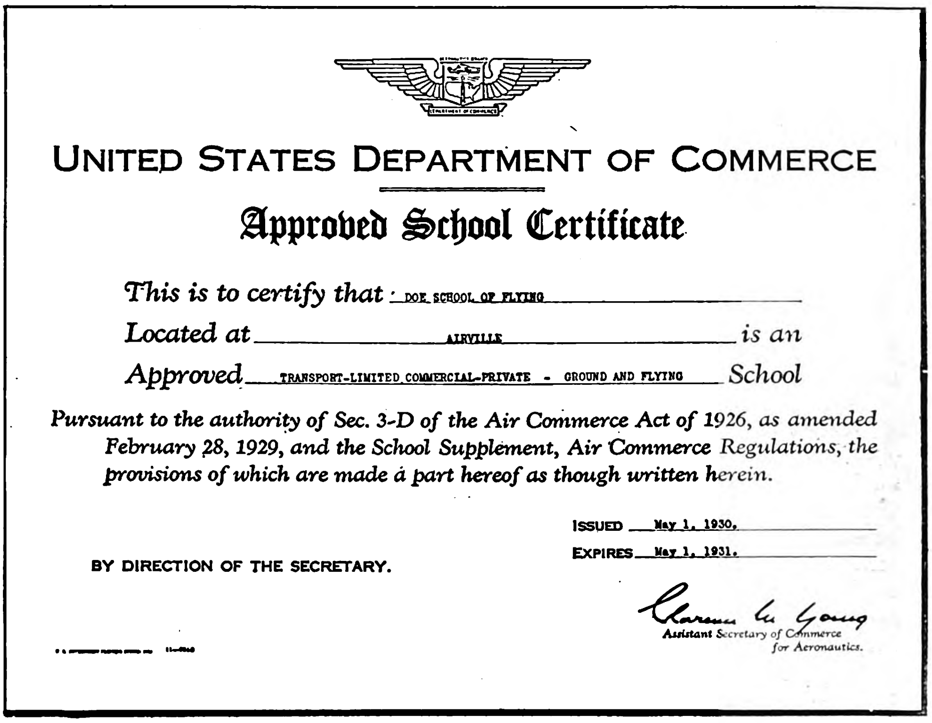
The "competency of the instructors" was set forth in the following provisions:

ALL flying instructors shall hold a rating from the Department of Commerce as flying instructors before being permitted to give instruction in approved schools.

A flying instructor's rating will run concurrently with his transport pilot's license and may be renewed semi-annually upon satisfactory evidence that he has served as a flying instructor in an approved school for not less than 50 hours in dual instruction during the preceding six months.

No flying instructor shall be allowed to exceed six hours of dual instruction in any one day, nor shall he give flying instruction more than six days per week. The school shall be responsible that the efficiency of the instructors is not impaired by continued dual instruction at or near the maximum daily allowable time.

All ground instructors, before being permitted to give instruction in approved ground schools, shall hold ratings from the Department of Com-



UNITED STATES DEPARTMENT OF COMMERCE

Approved School Certificate

This is to certify that DOE SCHOOL OF FLYING

Located at AIRVILLE *is an*

Approved TRANSPORT-LIMITED COMMERCIAL-PRIVATE - GROUND AND FLYING *School*

Pursuant to the authority of Sec. 3-D of the Air Commerce Act of 1926, as amended February 28, 1929, and the School Supplement, Air Commerce Regulations, the provisions of which are made a part hereof as though written herein.

ISSUED May 1, 1930.

EXPIRES May 1, 1931.

BY DIRECTION OF THE SECRETARY.

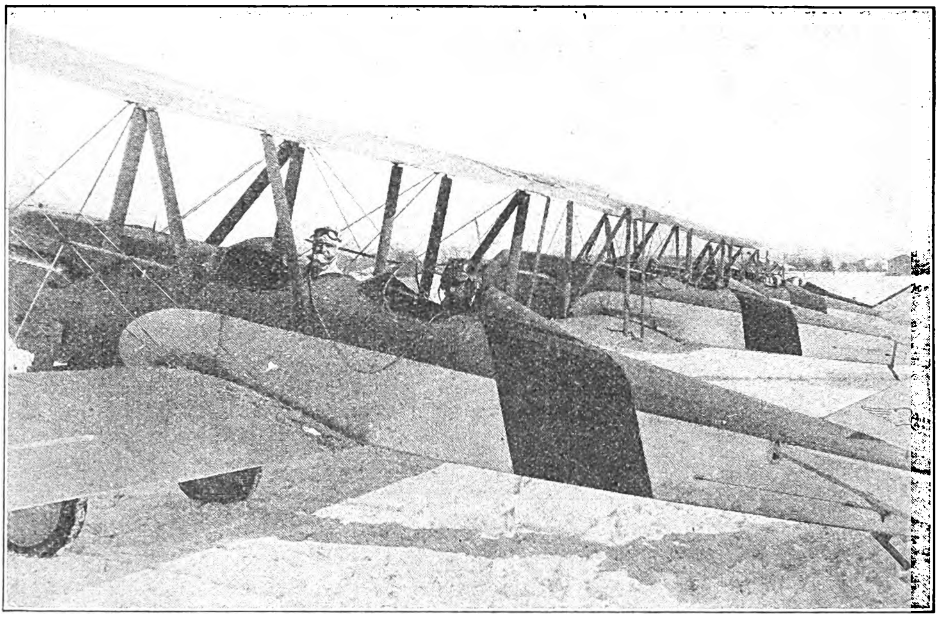
Clarence M. Young

Assistant Secretary of Commerce for Aeronautics.

INDEX TO A SCHOOL'S CHARACTER

Colonel Young prepared this sample Approved School Certificate to show how a school that has been rated by the Department of Commerce may be identified. It is nine by twelve inches merce as ground instructors. Ground instructors' ratings may be issued to those qualified to instruct in one or more ground-school subjects after successfully accomplishing examinations in such subjects prescribed by the Department of Commerce.

The minimum standards as to adequacy of the course of instruction are: When a student applies for license as a graduate of an approved school, such graduate may be privileged to count a portion of his dual and check time toward the solo-flying experience required for the Department of Commerce license, subject to the restrictions set forth in the regulations, provided he applies for license within 10 days from the date of graduation.



FLYING INSTRUCTOR AND STUDENT

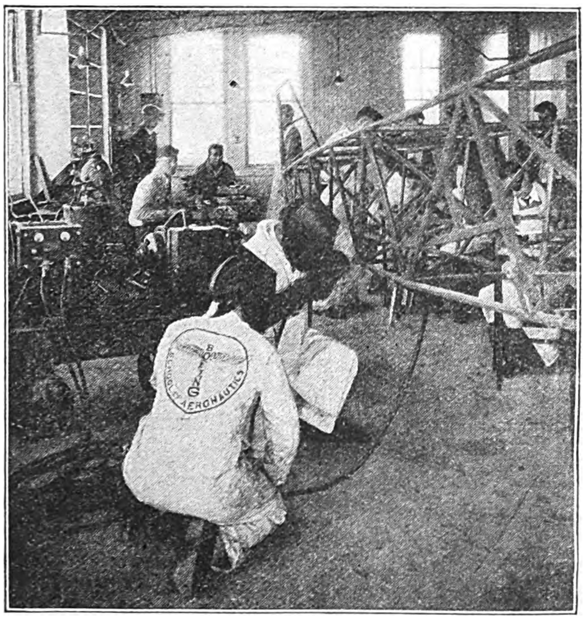
Several planes, each with an instructor and a student, ready to take off on practice flights. In the air the instructor communicates with the student by means of the system shown

THE entire course, both ground and flight, shall be completed within a minimum length of time, the maximum allowable being four months for private school, six months for limited commercial school, and 18 months for transport school. There shall be a regularity of procedure of instruction, both ground and flight.

The school shall keep an adequate individual record of each student which shall include a chronological log of all instruction, both ground and flight, the entire record to be certified to by an authorized official of the school.

Upon completion of the course in each ground-school subject the student shall be given an examination on the subject matter covered, and all grades attained in all examinations shall be made a part of the student's individual record.

A complete outline of all flying-school and ground courses shall be submitted to and approved by the Department of Commerce. A monthly report shall be submitted to the Department of Commerce by the school showing the total number of students enrolled, with a chronological log of all instruction given each student in both flying and ground courses; the names of all graduates; the names of all students dropped from enrollment, with the reason therefor.



HOW THE PLANE IS BUILT

Future pilots may be seen here studying the parts and framing of an airplane. In foreground: welding a joint

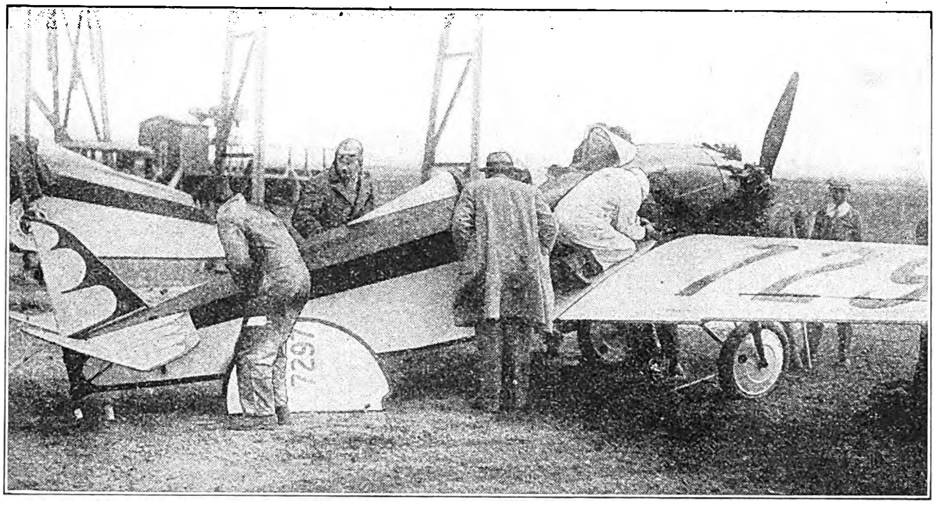
The school shall maintain a standard of ground and flying instruction to assure that nine out of 10 graduates who apply for license satisfactorily pass the Department of Commerce tests; and shall maintain sufficient personnel and equipment to assure that the student will complete the course within the prescribed time limit. It shall maintain such standards that 66 2/3 percent of the students accepted for instruction are graduated from the course for which they have enrolled, exclusive of removal for due cause prior to completion of the course.

An approved school will be privileged to give refresher courses in both flight and ground subjects for the purpose of qualifying pilots who already have had the necessary total flying time for the grade of license for which they intend to apply. Such pilots shall be subject to the same guaranty to the Department of Commerce as has already been outlined. All dual instruction shall be around the airport area, and no cross-country shall be counted as dual. Every student must be given instruction in the recovery from stalls and spins prior to his first solo. In a private pilot's flying school, the school shall give the student a minimum of 18 hours total flying time, of which 10 hours shall be dual and eight hours solo. In a limited commercial pilot's flying school, the school shall give the student a minimum of 50 hours total flying time, of which not less than 15 hours nor more than 25 hours shall be dual and check time, and as such, be counted toward the solo-flying experience required for limited commercial license.

Each graduate of a private pilot's or limited commercial pilot's flying school shall have a minimum of two hours solo experience in flying each of two distinct types of planes other than those used for primary dual instruction, one of which shall be a cabin type. In a transport pilot's flying school, the school shall give the student a minimum of 200 hours total flying time, of which not less than 35 hours nor more than 50 hours shall be dual and check time and, as such, be counted toward the solo-flying experience required for transport pilot's license.

EACH graduate of a transport pilot's flying school shall have a minimum of 10 hours solo experience in flying each of two distinct types other than those used for primary dual instruction. He shall also have 10 hours solo on at least one type of cabin plane which shall be not less than a four-place type and which shall be loaded to normal capacity during these prescribed flights. He shall also have 10 hours solo experience in night flying.

The minimum required subjects and division of time in a private pilot's ground school are: Air Commerce Regulations, five hours; aviation engines (including principles of internal combustion, carburetion, cooling, lubrication, and ignition), 10 hours; airplanes (including history of aviation,



PRACTICE

Part of the work of the ground school course in aviation consists in obtaining practical experience in the construction of a plane. Students are here shown assembling a monoplane

theory of flight, nomenclature, construction, rigging, maintenance, and repair), 10 hours.

Minimum required subjects and division of time in a limited commercial pilot's ground school are: Air Commerce Regulations, five hours; aviation engines (including principles of internal combustion, lubrication and cooling, carburetion, ignition, construction, various types, inspection, maintenance, and repair), 15 hours; airplanes (including history of aviation, theory of flight, nomenclature, aerodynamics, construction, rigging, various types, inspection, maintenance, and repair), 15 hours; aerial navigation and meteorology, 15 hours; five hours of each of the above required 15 hours on airplanes and on engines may be shop practice on the basis of three hours shop practice equivalent to one hour of classroom instruction. Shop practice shall be under the direct supervision of the ground instructor.

THE minimum required subjects and division of time in a transport pilot's ground school are:

Air Commerce Regulations, five hours; engines (including principles of internal combustion, carburetion, ignition, lubrication, cooling, aviation types, construction, inspection, maintenance, and repair) 25 hours; airplanes (including history of aviation, theory of flight, nomenclature, aerodynamics, construction, rigging, various types, inspection, maintenance, and repair), 30 hours; meteorology, 15 hours; aircraft instruments, radio and its use in aeronautics, the parachute, its care and use, 10 hours; and aerial navigation, 15 hours. Ten hours of the above required 25 hours on engines and 10 hours on the above required 30 hours on airplanes may be shop practice, on the basis of three hours shop practice equivalent to one hour of classroom instruction. Shop practice shall be under the direct supervision of a properly licensed ground instructor.

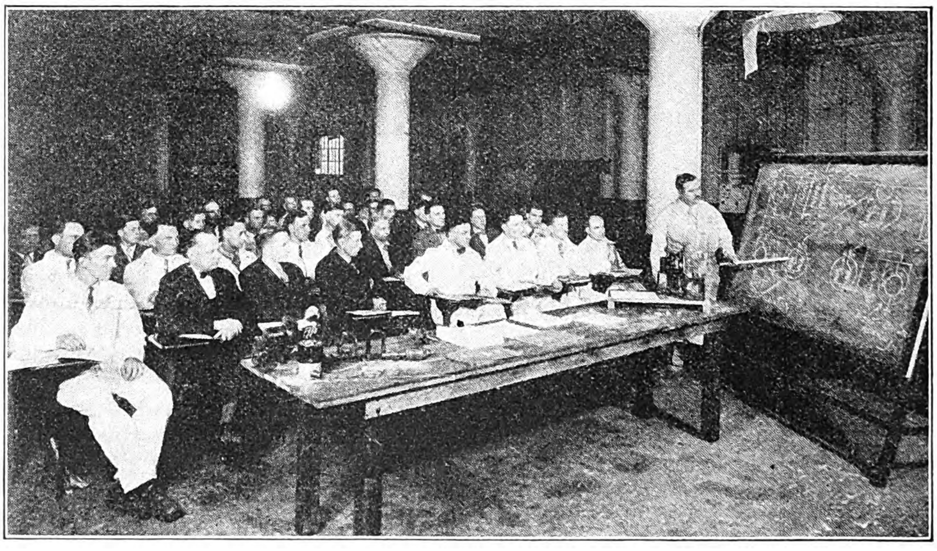
Any individual, partnership, or corporation engaged in giving instruction in flying either as a ground school or as a flying school or a combination of both, may apply for an Approved School Certificate upon a regular form provided by the Aeronautics Branch. This form, when properly filled out, enables us to determine whether or not the applicant has facilities sufficient to meet the standard of minimum requirements. If he has not, he is so informed.

THE inspector who rendered a favorable report on the application for an approved school by no means has finished his work with respect to that particular school. From time to time he will drop in unannounced on that and other institutions previously approved and make an inspection of the entire school to see that there have been no changes in the equipment, facilities, and conduct of the courses that will affect the standard of minimum requirements. Should he find a direct violation of the School Supplement of the Air Commerce Regulations, the evidence he produces would be grounds for suspension or revocation of the certificate.

Schools holding the Approved School Certificate are permitted to advertise their designations and ratings and thereby they obtain a decided advantage over competitors who have not applied for the Department's approval. The approved schools likewise are regarded by the general public as institutions worthy of patronage. For the first time since the Aeronautics Branch was established, we are in a position to answer inquiries as to adequate flying schools by forwarding the latest list of approved schools which speaks for itself and needs no interpretation or elaboration.

INADEQUATE instruction has resulted in a large number of accidents which otherwise would have been avoided had there been a definite and thorough standard of instruction followed. Our accident statistics show the human element in flying is credited with the majority of the causes of aircraft accidents, and one of the prime factors in the personnel question is proper and thorough instruction, as "errors of judgment" and "poor technique" lead in percentages of causes.

The approved schools are being looked to by the people of the country to graduate competent airmen and imbue them with sufficient knowledge of the subject to the end that they may always be able to protect themselves and others for whose lives they may be responsible, from accidents and mishaps that have resulted in the past from improper instruction and guidance. The Aeronautics Branch of the Department of Commerce, fully aware of its important obligation, is making every effort to see that the standard of minimum requirements in the approved schools is being followed constantly and consistently.



THEORY

No person who does not know something of aerodynamics, the theory of the airplane motor, and the various intricate parts of the plane would ever be given a license by the Department

OUR POINT OF VIEW

Air Rights

THERE have been many complaints against the flight of airplanes over private property and, in some sections, there has been agitation for state control of air routes to keep planes away from congested areas where a crash might endanger persons or their property or where their noise excites nervous people.

Even the most casual glance at flight regulations will bring the realization that here is a fertile legislative field that has scarcely been touched. Most cities have ordinances denying planes the right to fly below certain minimum altitudes and the Department of Commerce has made other stringent flight regulations but as yet there are altogether too few laws to exert a restraining influence on inconsiderate or foolhardy fliers. If laws are inadequate, however, it should be remembered that the industry is young and must feel its way carefully; regulatory measures will be taken as they become necessary.

The government recognizes air transportation and, by non-interference, implies that the flight of a plane over "posted land" does not constitute trespass. But the necessarily low altitude of take-off and landing may force, sooner or later, regulations as to the size of the airport or may authorize the acquisition of rights of way by the power of eminent domain. Complainants against the possible danger or annoyance of planes flying over privately owned land have at present only the weapon of city low-altitude ordinances, for the old theory that the property owner's rights extend to the skies has no basis in fact. When this theory was acceptable, no one had use for the air above building height. The rapidly growing air commerce of today, however, gives the question a different aspect.

Calendar Reform

THE Council and Executive Committee of the American Association for the Advancement of Science, speaking officially for the 18,000 members of that great association which includes the entire personnel of American science, has again gone on record as favoring calendar reform. At the last annual meeting the following action was taken:

"*Resolved*, that the American Association for the Advancement of Science approves of any alteration in the calendar that would adjust it to modern conditions for scientific work and that the Association would welcome in this connection co-operation with other bodies such as the committees of the League of Nations that are concerned with this subject, and,

WHEREAS, The Council is convinced that calendar simplification should be internationally adopted for the benefit not only of scientific work, but also of commerce and of the peoples of the earth in their daily lives, and likewise for the promotion of international and national understanding; therefore, be it

Resolved, That the Council advocates calendar simplification for international adoption as soon as may be practicable, and the calling of an international conference to report upon the best method, agreeable to all nations concerned, that will remove the serious defects of the present calendar; and favors a revision of the calendar such that the year will consist of 13 months of 28 days each and and extra day of non-week-day name, with an additional midyear leap day in leap years."

An editorial expression of opinion on the part of the SCIENTIFIC AMERICAN, regarding calendar reform, will be short: we favor it, though not necessarily in the above manner.

Under the Mediterranean

AN undersea railway tunnel, the conception of which, at first thought, seems to savor of the imagination of a Jules Verne, has been proposed by Spanish engineers and already preliminary steps have been taken looking to its ultimate construction. It would pass from Spain under the sea to the land of Spain's traditional enemies, the Moors. It would be 20 miles long—the world's longest—and 1500 feet below sea level at its deepest point.

Offhand, the economic value of this tremendous undertaking may be questioned. It may seem like more or less of a local affair, a connecting link between Spain and her north African interests. To realize its full significance, one must consider the vast commerce that is carried on between the African west coast and all of Europe. The products of the Belgian Congo, Liberia, Sierra Leone, the Gold Coast, the Ivory Coast, to say nothing of immense French and British possessions farther south, to the east, and closer to Europe on the Mediterranean—all with vast natural resources in minerals and products of tropical jungles and plantations—are rapidly assuming a very important place in the world's commodity markets. With a rail link directly through to Europe, it is certain that the future growth of western Africa would be phenomenal. And although the tunnel under the strait is as yet only in the projected stage, it is possible that within a decade or so a cargo of freight may be loaded on a train at Capetown and be discharged in Madrid, Paris, Brussels, or Berlin.

France and the Naval Conference

THE Conference has encountered only the expected obstacles but they offer more difficulty than at first appeared. In addition, the overthrow of Tardieu's cabinet provided an unexpected delay of three weeks and pointedly reminds the Conference of Mr. Macdonald's tenuous hold on the British Premiership. The domestic affairs of Great Britian, France, and even Japan are having a powerful, and may later have a decisive, influence on the outcome of the parley.

It is commonly reported in England that the Conservatives and Liberals will allow Mr. MacDonald to remain in office only long enough to convince independent British voters that the Labor Party's program will not solve the problem of British unemployment. In the last test vote in the House of Commons on one feature of this program, the Government was supported by a bare majority of eight. The necessary votes were furnished by Liberals who, anxious to prevent the premature fall of the Cabinet and the failure of MacDonald's naval disarmament program, supported domestic legislation they scarcely approved.

Tardieu's overthrow and rapid return have probably stiffened his attitude towards the Conference and it is now believed he will not reduce France's claims for more tonnage unless he is given some guarantee regarding the French position in the Mediterranean. Majority British opinion is against such guarantees and informed commentators point out that a similar agreement with France in 1907 guaranteeing French colonies and Atlantic Coasts from the German fleet, in exchange for protection of British interests in the Mediterranean by the French fleet, was the first of a series of steps that eventually involved Britain in the costly World War. This section of British opinion is firmly determined to entangle itself no further with Continental Europe. If this determination involves the failure of the Conference, they are prepared to accept the consequences and to resume their

(*Please turn to page* 402)

Revising Our Air and Our Water

A Piece of Research in Pure Science Provides an Unexpected By-product, Giving Atmospheric Oxygen an Isotope

By HENRY NORRIS RUSSELL, PH. D.

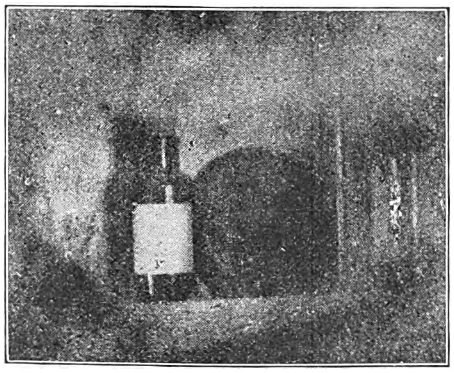
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE radiations which the human eye can see have of course been thoroughly studied. The shorter ultra-violet waves have been photographed to the limit which the opacity of the earth's atmosphere sets inexorably. But the long waves of the infra-red until very recently have been detected only by the heating effects which they produce, (see upper illustration, opposite page) and this is a relatively insensitive method which no one would think of using for radiations which could be seen or photographed.

For years, therefore, astronomers have dreamed of plates which would be sensitive not only to red light but to the slower vibrations which the eye can not see. It has long been known that plates bathed in solutions of certain dyes become sensitive to the yellow and red, and these can now be bought anywhere. But to find dyes which would extend the sensitiveness still farther is a difficult thing to do and, moreover, a very expensive one requiring the work of many trained investigators. A few years ago the search seemed at a standstill, for all the money which was available to follow up a problem of purely abstract scientific interest had been exhausted. Relief came from an unexpected quarter.

ORDINARY blue sky reflects a great deal of the shorter waves of sunlight but very little of the long waves. So if a landscape photograph is taken through a screen which transmits only deep red and infra-red light the sky looks black on it. With the plates then available this demanded an exposure of minutes which, for a scientific curiosity, was all very well. Meanwhile, however, the moving picture producers had struggled with the problems presented by night scenes in their plays and succeeded by the use of powerful floodlights, which were naturally expensive. The infra-red landscapes showed just the combination of dark sky and brightly lighted foreground which they wanted but the exposures were far too long. An emulsion highly sensitive to the infra-red thus changed from the dream of the pure scientist to a requisite of a great industry. This justified the cost of further investigation and a new dye, "neocyanine," was discovered by the chemists of the Eastman Kodak Company, which makes it possible for the producers to photograph their "night scenes" in broad daylight.

The light which is most potent in producing these pictures is not really "invisible" but lies close to the limit of the visible spectrum at which the human eye, having already sunk to something like a thousandth part of its sensitiveness for the more familiar yellow and green rays, gives up the struggle to see further. The new plates are at their best here, and their range extends far out toward the longer waves, though with gradually decreasing sensitiveness. With the aid of these new neocyanine plates Dr. Harold D. Babcock at Mount Wilson Observatory photographed the solar spectrum to about 11,500 Angstrom units, some 2000 Angstrom units farther than the limit of previous knowledge, and has measured many hundreds of lines in the new region (see cut).



A REMARKABLE PHOTOGRAPH

Taken in total darkness by Babcock, by means of infra-red (heat) radiation from three common 600-watt electric heaters under-excited so that they were invisible even to the dark-adapted eye. Exposure 48 hours with F/2 lens. The "secret" is the new neocyanine sensitized plate

It was by no means easy work. The chief trouble came from scattered light. Even in the best spectroscope a small amount of light is reflected from the surfaces of the lenses and the prisms (or the grating) and, after various vicissitudes, is distributed broadcast in the field of view. In ordinary work this produces a faintly luminous background which does no harm at all. But in the present case the plates were hundreds of times as sensitive to the ordinary red rays and even to those just beyond the limit of the eye as they were to the long waves which were to be studied, and if indeed even a very small part of the former rays were scattered the plates became fogged. It was necessary to find some screen to place in the path of the rays just outside the spectroscope which would cut out entirely the red and near infra-red while transmitting the longer waves. After many tribulations this problem was solved and step by step a new region half as long as the visible spectrum was added to the field of precise astrophysical knowledge.

After the hundreds of lines have been accurately measured, new problems arise. Some of them are produced in the absorption of light by the hot gases of the sun's atmosphere, others by the cold gases of the earth's. To distinguish between these an old but very pretty device may be employed. Photograph on the same plate in parallel strips the spectrum of the eastern and western limbs of the sun. The first is coming toward us, the second receding, and in consequence all the solar lines are slightly shifted toward the violet and the red, respectively. The lines produced in the earth's atmosphere are of course unaffected and may thus be distinguished with certainty.

THE next task is to find what substances produce the lines and this will take some time, for the spectra of even the more familiar elements have not yet been photographed in this new region. A few strong lines which had been detected in the laboratory by means of heat measuring devices already have been identified.

Nearer the visible spectrum where laboratory comparisons were available many interesting things have already been found. For example, a group of lines belonging to carbon (see spectrogram) and two fainter lines of sulfur have been identified beyond the limit of the visible red. The first of these familiar elements previously had been detected in the sun only by means of its compounds (though some very faint lines of the element itself have since been recognized in the green). As for sulfur, the new plates provide the only proof we have of its presence in the sun.

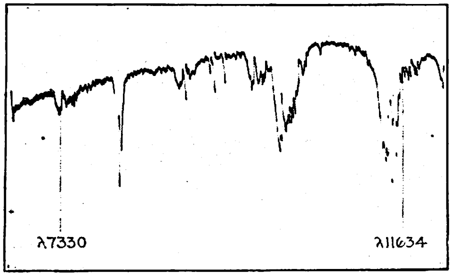
But discoveries have not been confined to the sun. The most remarkable one has been made on our earth, or rather in its atmosphere. It is of interest primarily to the chemist and yet it has been made by the very methods which the astronomer employs in analyzing the sun. In the red end of the solar spectrum there are two strong bands composed of closely grouped pairs of lines which were recognized in the very dawn of spectroscopy by Fraunhofer, who gave them the letters A and B. These are due to oxygen—not to hot atoms of the element in the sun's atmosphere but to cold molecules in the earth's. This has long been known but it is only within the last few years that the theory of such banded spectra has gone far enough to let us understand what the molecules were doing.

A molecule composed of two atoms can act in a much more complicated way than a single atom—not only can an electron "jump" from one state to another but the two atoms may vibrate, changing their distance from one another, and the molecule as a whole may rotate. Both the vibration and rotation are quantized and may change from one state to another by jumps, and each set of jumps gives a different line in the spectrum. Different changes in the vibratory motion of the oxygen atoms, for example, give rise to the A band in the deep red, the weaker B band in the red, and the fainter bands in the orange and green, while different changes in the rotation of the molecules give the separate lines in each of the bands. This sounds complicated, but so are the spectra! The complications, however, open the way to find things that would otherwise be quite out of reach.

IT is a familiar enough fact nowaday that many—indeed most—of the chemical elements are really mixtures of different kinds of atoms called isotopes. The isotopes of any given element are exactly alike in their chemical properties but different in weight. Thus, for example, there are two kinds of chlorine of atomic weights 35 and 37, the observed value 35.46 being an average for the two which are present in unequal proportions.

Aston, with his ingenious "mass-spectrograph," has with great skill identified the isotopes of a great number of elements and determined their atomic wights. Is there any perceptible difference between the spectra of two isotopic atoms—for example, the two kinds of chlorine? When we have to deal with the spectra of free atoms the differences are of extraordinary minuteness—just perceptible in one or two cases with the most powerful apparatus, but practically negligible. This means that the energy involved in jumps of the electrons within an atom depends almost wholly on their own arrangement and hardly at all on the mass of the heavy nucleus at the atom's center.

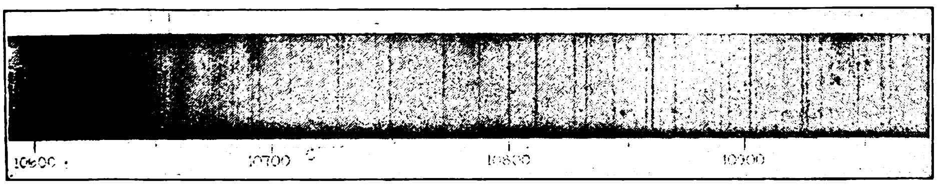
But when two atoms are united in a molecule things are different. The energy of vibration of the two about their average distance, or the energy of the rotation of the molecule, does depend to a considerable degree upon the actual weights of the vibrating or rotating particles, and there are corresponding differences in the spectrum. For example, there are two kinds of atoms of boron, of atomic weights 10 and 11. When combined with oxygen (to form the incomplete molecule BO) each of these isotopes gives a complete band spectrum. The two sets of bands are just alike in structure but shifted in position sometimes by a good many Angstrom units, so that they may easily be separated on the photographs. In this way the existence of a number of Aston's isotopes has been confirmed independently.



OLD TYPE OF RECORD

Not a spectrogram but a bologram of a portion of the infra-red solar spectrum, made with a bolometer, by Dr. C. G. Abbot. The varying heat as different parts of the spectrum were passed changed the resistance of platinum wires, actuated a galvanometer, and cast a beam of light on a laterally moving photographic plate. The limit of Rowland's former photographic study of the spectrum, also the new limit with neocyanine, are indicated at wavelengths 7330 and 11634 A. U.

Now in the vicinity of the strong lines of the A band of oxygen there are some much fainter lines also produced in the earth's atmosphere. Two young investigators at the University of California, Giauque and Johnston, using Babcock's measures, have found that these lines are exactly where the bands due to an isotope of oxygen ought to be. The ordinary atom of oxygen has a weight of 16 standard units, and the common oxygen molecule O_2 is composed of two of these. Molecules composed of one oxygen atom of weight 16 and one of weight 17 account for the new bands.



INFRA-RED SPECTROGRAM MADE PHOTOGRAPHICALLY

The range of radiation included here—half as long as the visible spectrum—would be totally invisible to the eye and would not affect an ordinary plate. Other spectrograms have been measured as far into the infra-red as 11634 A. U. Line in margin near 10700 is almost certainly due to atomic carbon in the solar atmosphere. Spectogram kindly furnished by Babcock of Mount Wilson, the astronomer to whom Dr. Russell refers in the text

A new kind of atom in the air which we breathe has therefore been discovered by spectroscopic observation of the sun. Moreover, the spectra showed how much of the new kind of oxygen was there. By comparing the strength of the lines of the new molecule produced when light traverses the whole thickness of the atmosphere, with those of the familiar kind produced by layers of air a few meters thick, Babcock found that only 1/1200 as great a thickness of air was required to match the lines. Hence only one oxygen atom in 1200 is of the heavier sort. This explains the otherwise disconcerting fact that Aston's very careful work did not detect the new isotopes, for according to his own estimate his apparatus could not have shown it up if it had been less than 1/1000 as abundant as the principal isotope.

It is probable that the spectroscopic method may detect other isotopic atoms present in too small amounts to be found otherwise. If there are two kinds of oxygen there must also be two kinds of water, ordinary H_2O with an atom of O_{16} and a rarer kind with O_{17}. Is there hope of detecting the latter among the numerous water-vapor lines which are produced in the earth's atmosphere? Some day perhaps, but a deal of work remains.

WATER is an amazingly complicated thing, even in its simplest form of vapor. Its molecule contains three atoms and such a system still defies the best efforts of theory. All three atoms attract one another and they may all change their mutual distances when they vibrate, so that a great many different modes of vibration are possible. And when such a molecule rotates it will not in general rotate smoothly and uniformly but will wobble in accordance with definite mathematical laws and in a very complex fashion. We should therefore expect the spectrum of water vapor to be complicated and it is exceedingly intricate—full of bands extending from the visible spectrum up to wavelengths more than 100 times as great. The recent photographs show that the infra-red bands are composed of a multitude of lines too closely packed to be separable except by the photographic method.

To work out the complicated changes in the molecule which produce these lines will try the mettle of the best investigators, and it may be a long time before all the problems which the new photographs of the spectrum offer have been solved.—*S. S. Leopolis, Gulf of Corinth, Dec. 9, 1929.*

When You Buy Your Plane

What Details of Construction, Features of Operation, and Factors of Safety to Consider

By LIEUTENANT (j.g.) H. B. MILLER, U. S. N.

THE uninformed non-flyer who is in the market for the purchase of an airplane is immediately astounded with the number of models and types from which he may choose. As in the automobile industry, each particular type has its adherents.

The prospective purchaser finds that every professional aviator is a potential salesman for some airplane company. His arguments are generally shaded by a possible commission. True, however, if he does not believe in the type of plane he himself flies and sells, no one else could be expected to have any confidence in the ship.

As a matter of fact, each particular type of plane probably has one or more good features. All the best points can not be incorporated in any one ship. Every plane is a compromise. For instance, if a high top speed is desired, a high landing speed necessarily results. But, it happens that a low landing speed is also desirable. Both cannot be had in the same plane. The designer gets to work. He adopts a safe landing speed and must accept the maximum speed which is then attainable.

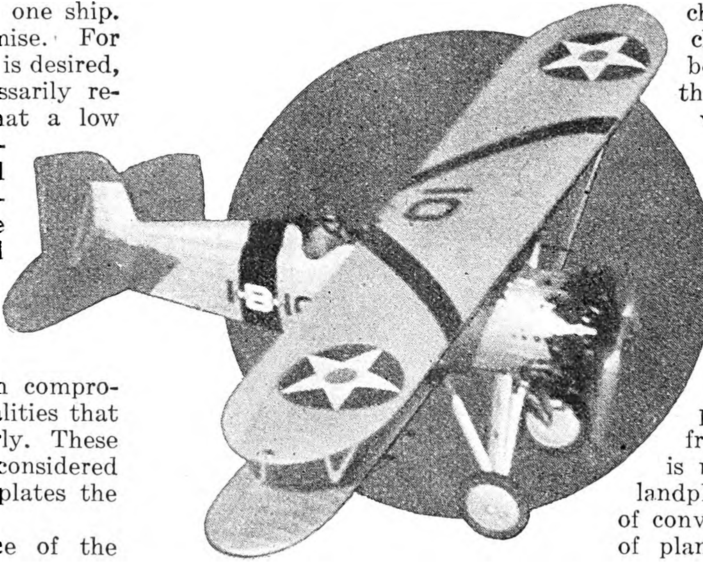
Each type of plane is the result of a number of such compromises. Certain definite qualities that are desirable stand out clearly. These points should be thoroughly considered by the person who contemplates the purchase of an airplane.

The order of importance of the various desirable features is a matter of circumstances and requirements. Take for example, the man who has hired a capable pilot to fly his plane. A high top speed with a reliable pilot will more than offset the combination of a slow landing ship and a less capable pilot.

EACH designer of the 170 licensed types of planes on the market has tried to make his ship the best of its class. He has endeavored to incorporate in it maximum performance, highest efficiency, and the greatest possible safety. Some of the resulting planes are better than others. A discussion of the various features which should be observed and considered may prove of interest to the man who has begun to read airplane advertisements with a personal interest.

The very first consideration is naturally one of money. The sale of any article usually depends upon the cost price. The American custom of time payments has reduced in importance somewhat the economic value of this factor. To a transport and passenger company the initial cost must be subjected to the other items such as safety and payload.

Time payments have been applied to practically all industrial products. Now even aeronautical corporations are taking advantage of this system of financing to increase their sales. The future of aviation is closely related to the youth of the country. It is unlikely that young men will have the capital necessary for the outright purchase of a plane. On the other hand, they probably will be able to make the first payment on a new ship. Final payments will be made with money earned in carrying passengers or in their usual occupations.



OFFERED FOR PRIVATE USE

This Navy fighter, offered as a sport model, is fast and easily maneuverable

Wide price ranges are now available to the buyer. The cost price of a plane is generally a fair index of the power, speed, and finish supplied by the manufacturer. It parallels the automobile to an amazing extent in this respect. Quantity production will naturally lower the sale price, but that day still lies in the future. Planes are available for a sum as low as 900 dollars. If you will recall the discussion concerning compromises, however, you will realize that you get very little but a low initial cost. The plane will lack power, safety, comfort, speed, and payload. You will obtain, however, a low landing speed and economy of operation.

Sales prices run up to six figures. The cost price is influenced most by the power plant with which the plane is equipped. A fairly accurate thumb-rule is available for the uninitiated. Everyone knows the relation existing between the market values of automobiles and their performances. An airplane proportionately equal in comfort, speed, and operation to an automobile can be purchased for approximately three times the cost of that particular car.

THE kind of territory in which a plane is to be used decides the general type which must be purchased. In some localities a choice of land or seaplanes must be made. Here convenience is the criterion. Safety, of course, will influence a transport company to use seaplanes. On the other hand, seaplane terminals are often difficult of access—both for the passengers and for the planes. Corrosion resulting from salt water is difficult to combat. Power being equal, the payload of a landplane is greater than that of a seaplane because of less take-off friction. If the over-water flight is not too long, multiple-engined landplanes can be used for the sake of convenience. The amphibion type of plane is particularly adapted to this class of work. The safety factor of a seaplane is enjoyed while the advantages of a ground terminal are retained.

A young flyer is more likely to desire an open cockpit type of plane. The wind rushing around his ears creates a happy illusion of immense speed and power. This type of ship is best built as a two-seater, though it often comes as a three-place job. Few provisions are made for the carrying of luggage. It is the roadster of the air.

Any number of planes are available for sport purposes. One can be found to suit the experience of any pilot. The latest navy fighter is offered by one company as a commercial sport model.

The cabin ship can be had with any number of seats. Plenty of room is always available for suitcases and picnic lunches. Flying clothes are unnecessary, for ordinary clothing will not become soiled. Conversation is possible and a cigarette can be enjoyed while at the controls. Maps can be studied at leisure without fear that they will blow away. The children will not fall out upon unsuspecting pedestrians.

If a plane is to be used for training, certain definite qualities are required. The best all-around type is the open-cockpit two-seater. A low stalling speed is desirable. High top speed is not necessary for the student. The ship must be sturdy to withstand the terrific shocks to which it will be subjected. In order to permit a thorough course of training, the plane should be designed for stunting. A medium sized power plant is sufficient. Since a student is likely to have minor crack-ups, the training plane must be easy of upkeep. The engine should be accessible from all angles. Ease of maintenance and upkeep are paramount.

The terrain over which your plane is to operate must be considered. If a ship is to operate only at sea-level, its ceiling is of little importance. However, if mountains are likely to be encountered in any of your trips, reserve climbing power must be available.

The Rocky Mountain range was nicknamed "Jenny Divide" in the days when the wartime JN-4 was in its prime. Only a good Jenny could get sufficient altitude to fly over these mountains. Even those that did succeed in making the grade had to dodge around the higher peaks.

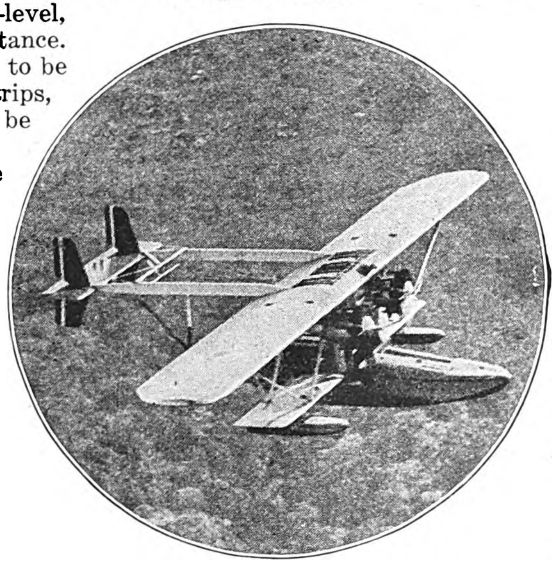
As a plane climbs higher, its stalling speed increases. In practical terms this means that a ship must land at a faster speed than normal on a field situated at high altitudes. A long roll necessarily follows a fast landing. Unless a long field is provided, brakes should be installed. Conversely, a long run is also required for the takeoff. Requirements for a high-altitude plane are maximum power, maximum wing area, and minimum weight.

The argument concerning the relative merits of the biplane and the monoplane will long continue. Generally speaking, the biplane has more strength than the monoplane. For straight commercial work, however, where no undue stresses are placed on the ship, the monoplane is sufficiently strong. The advantage of all around visibility appears to belong to the biplane in spite of the extra wing.

The monoplane has less parasite resistance because of the absence of brace wires and the extra wing. Accordingly, it is generally faster. On the other hand, where maximum wing area is necessary, as in carrying heavy loads at high altitudes, the span of the single-winged ship becomes enormous and unwieldy. The Boeing Company, which operates over the Sierras, continues to use large biplanes for passenger work. The enormous amount of wing area permits greater loads to be carried and allows a slower landing speed.

Most people are very apt to think of safety as a quality which can be built into a plane at will. The airplane designer can contribute a great deal to safety. In the end, however, it is the pilot who builds or destroys the reputation of a plane. A poor and untrained pilot may crash a plane which has always been considered very safe.

As long as gravity continues its work, crashes will result. The best pilots have cracked up a plane or two sometime in their career. The desirable plane, then, is one which will best withstand a crash. It is one that will insure the greatest protection to the pilot and his passengers.



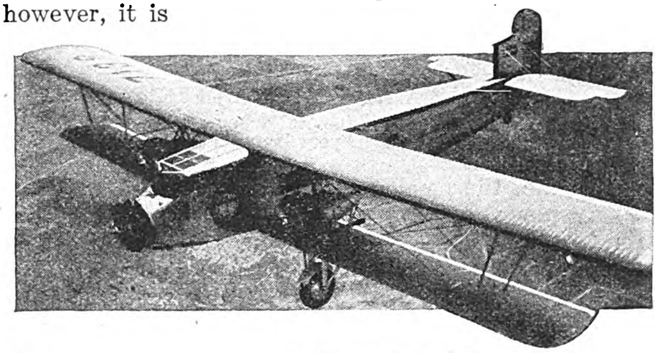
VERSATILE

The amphibion type of plane, used for flights over either land or water is, in some respects, the ideal

Modern steel and alloy construction has replaced wooden strength members. No longer are cockpits likely to fold up on the pilot to pin him in. Fittings and wing bracings should be sufficiently strong to withstand necessary shocks. Component parts of the landing gear such as wheels, axles, and struts should be especially strong. A split-axle type of landing gear is particularly helpful in forced landings. It will straddle bushes and stumps instead of causing the plane to nose up.

Planes can be and have been built that will not spin unless deliberately forced into this condition. Peculiarly, planes that are difficult to spin are also generally very hard to bring under control once they have been worked into one. Unfortunately, a ship of this design invariably sacrifices its maneuvering qualities. Maneuverability is necessary along with a fair amount of stability.

It is assumed that parachutes will be standard equipment for a single-engined plane. Preparations for abandoning a plane in mid-air are best made when selecting the plane. If an open cockpit job, is the cockpit under the wing? A plane that is hard to climb into is even more difficult from which to jump in an emergency. The Department of Commerce now requires one door in a cabin plane for every six passengers.



GREATER WING AREA

Relatively larger loads and slower landing speeds are possible with this transport

A plane to be worth consideration must have good visibility for the pilot. Otherwise potential collisions on the ground and in the air will exist. Certain blind spots are unavoidable, but careful design will reduce these spots to a minimum. A ship that maneuvers well permits the pilot to uncover the necessary blind spots quickly.

The fire menace has decreased due to proper plane and engine design. Battery ignition has been eliminated. Fire walls between the engine and the fuel tanks are protective. Electrical insulation must be such that it can be easily maintained. Gasoline and oil lines should be short and free from vibration, otherwise they will crack and increase the fire hazard. The addition of metal control surfaces in the future will insure control of a plane in the air even though it should catch fire. A pressure fire extinguisher is essential. A liquid (CCl_4) under high pressure in a small cylinder can be released by the pilot in the cockpit. This is discharged through small jets at critical locations about the engine, such as the carbureter.

A minimum upkeep and operating expense is essential to commercial aviation. To the person who operates a plane for pleasure, expenses are a necessary evil to be reduced as low as possible. The lighter the plane and smaller

EASE OF MAINTENANCE AND INSPECTION ARE PARAMOUNT

Since the student flyer will inevitably have minor crack-ups, the training plane must be of a type easily maintained and yet sturdy. It must be capable of "taking much punishment"

the engine, the smaller the expenses. A light plane compares favorably with a medium sized car in gasoline consumption. Fuel consumption increases with power and load. A thorough understanding of engines by the pilot results in increased economy in the operation of the plane.

Hangar fees are nearly constant for the standard size small plane. This increases rapidly, however, with wing span. Folding wings offer some solution to this problem, especially if a person erects his own hangar and has but limited space.

Service stations are now springing up all over the country. It is no longer necessary for each pilot to be able to serve as a mechanic on his plane. True, he must know a few fundamentals and rules in order to obtain proper operation of his engine. Both top and major overhauls can be done by qualified aviation service experts at a reasonable cost. Rigging and fabric jobs can be done equally well by these staffs of experienced men. In fact it is now possible to have practically any kind of repairs made by experts in any section of the country without serious loss of time in waiting.

EASE of maintenance and inspection is essential. Control wires should be run so that there is no danger of their jamming in unguarded pulleys. No trick gadgets which hide working parts should be tolerated. The engine cowling must be such that it can be easily removed and other parts should be easily accessible.

Above all, the plane must be essentially rugged. The best pilots occasionally make poor landings. Poor pilots invariably make poor landings. In either case, the landing gear takes a beating. Some form of oleo shock absorbers will often save a broken landing gear. Another aid is the adoption of oversized wheels and tires. They will cushion a hard landing. In a soft field they will keep the plane from sinking into the soil. A plane so equipped will be able to get in and out of fields the condition of which would otherwise cause a crackup.

Most engine mounts of planes are convertible and the manufacturer allows the customer a choice in the selection of the power plant which is to be mounted in his ship. The amount of power needed depends directly upon the weight of the plane and the performance the buyer desires.

The engine that is chosen, whether for a single or multiple-engined plane, should be one that has proved its reliability in actual service. Past performance will indicate what you might expect from it. As with all machinery the results are proportional to the care and upkeep given them. Flying with wide open throttle may bring you to your destination quicker, but it will bring very little return for your investment. Top speed operation will necessitate more frequent overhauls.

An engine easy of maintenance is especially desirable. It indicates first of all a simple and orderly type of construction. This can be interpreted to mean that the designing engineer knew what he was about. A mechanic can check over and service a "clean" engine installation quickly and in a satisfactory manner.

Comfort while in the air makes flying a pleasure and decreases weariness. It is a short cut to safety, because it permits the pilot to devote his entire time to piloting. All manually operated controls must work easily. A long cross-country flight will develop all points of discomfort to a very marked degree.

The frequency of well-equipped airports in this country makes the endurance of a plane of minor importance. Fuel capacity of from three to four hours is desired, however, in order to reduce the servicing of the plane. The endurance of large transport planes is seldom over five hours, although they could fly much longer. However, it would be necessary to leave many pounds of payload behind in order to carry additional fuel which pays no dividends. It is thus more economical to have the planes land and refuel more often while they carry a larger pay load.

THERE are planes for every one—for every purpose. Prices fit all pocketbooks. Different makes and models satisfy different needs of the buyer. All desirable requirements can not be had in any one plane. Some points must be sacrificed during the design compromise. The prospective buyer, however, will discover a plane in the market of today which will cover the majority of his demands.

After the plane is purchased its performance depends almost entirely upon the pilot. A good flier will fly the ship in a way that will bring satisfaction to the owner. A poor or inexperienced pilot will obtain poor results from any plane. So, in addition to careful consideration in the buying of your plane, handpick your pilot!

Courtesy Bellanca Aircraft Corporation

FOR GENERAL PURPOSES

A typical small cabin plane. Comfort and cleanliness, which make flying a pleasure and decrease weariness, are exemplified in this plane. Many good features are noticeable

Florida's Lusty Infant Industry

Tree Producing Invaluable Tung Oil Now Naturalized American

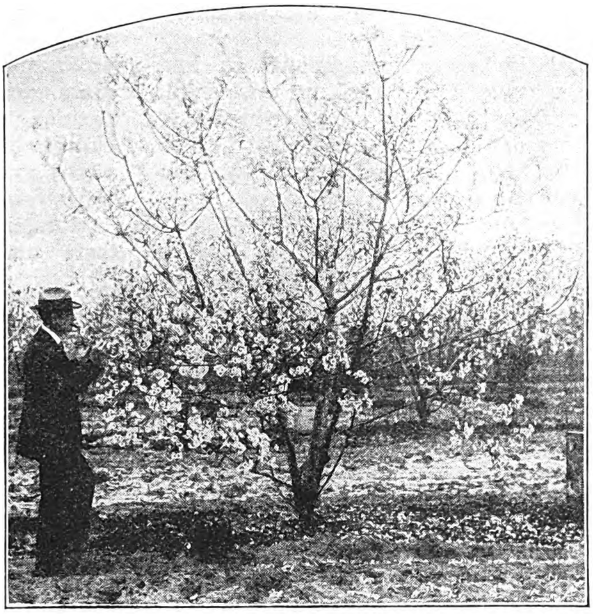
A CENTURIES-OLD Chinese industry may soon be forced to yield its hold on the American market to an infant competitor in Florida, according to Professor M. Ogden Phillips in an article in *Economic Geography*. Each year American manufacturers pay from 10,000,000 dollars to 15,000,000 dollars to Chinese producers for this oil which is superior to linseed oil for the production of high grade paints and varnishes, and is used in the making of linoleum, insulating materials, soaps, water-proof cloth and paper, and many other products.

The first tung oil tree in Florida was planted in 1906 and in 1913 the first tung oil to be produced on the American continent — 2.2 gallons — was extracted from a bushel of the seeds. In the fall of 1928, over 160,000 trees had entered commercial production. Florida tung oil trees three and a half years old have produced over 300 nuts per tree in contrast to 130 nuts from a 10-year-old tree in one of the best groves of China. Certain individual trees in Florida have produced as much as four gallons (32 pounds) of tung oil in a year.

The peculiar qualities of tung oil make it superior to linseed oil and give it a higher market value. Flax, from which linseed oil is obtained, must be planted each year while tung oil trees are planted only once for a production of 25 to 30 years. Flax is susceptible to disease when planted continuously on the same land and is hard on the soil, requires plow cultivation and thus invites erosion, and must be harvested promptly when mature. Tung oil nuts can be left on the ground for weeks and gathered at the convenience of the grower, and the trees retard erosion of the soil.

The crop of nuts is gathered, husked mechanically, and then allowed to dry thoroughly. The seeds are then cracked and pressed whole without removing the seed coats. Before pressing, they are heated sufficiently to make the oil flow readily.

The maximum yield of oil from flax seed is 255 pounds per acre while the yield from an acre of nine-year-old tung oil trees is 1800 pounds.

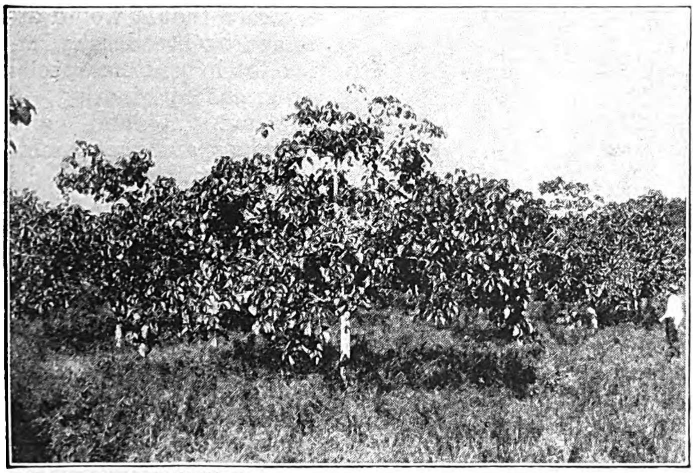


◄ A YOUNG PRODUCER

The tung oil tree does not differ much in appearance from common fruit trees

A HEALTHY START IN LIFE ►

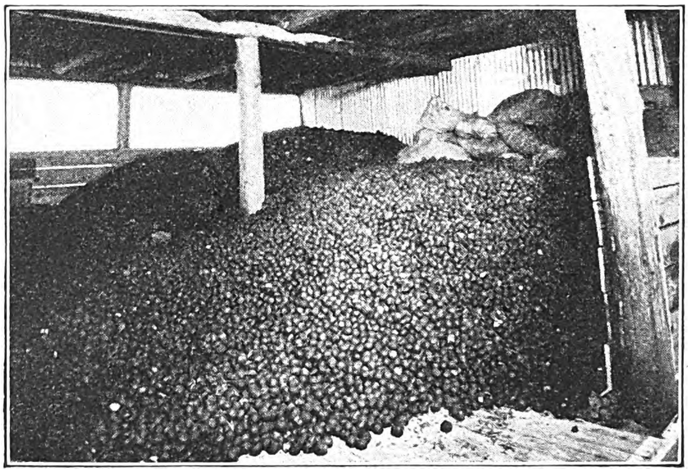
Tung oil trees are grown in outdoor nurseries, then planted 116 trees to the acre



Photographs courtesy B. F. Williamson

A TYPICAL TUNG OIL TREE GROVE

Trees begin to bear within three or four years. After the seventh year, when crowding begins, they are thinned to 60 trees per acre



DRYING PREPARATORY TO PRESSING

Part of a recent crop of tung oil nuts. They are stored until dry. It will be noted that they are about the size of small apples

Voices Across the Sea

The Successful Exchange of International Programs Places Another Milestone on the Path of Radio Progress

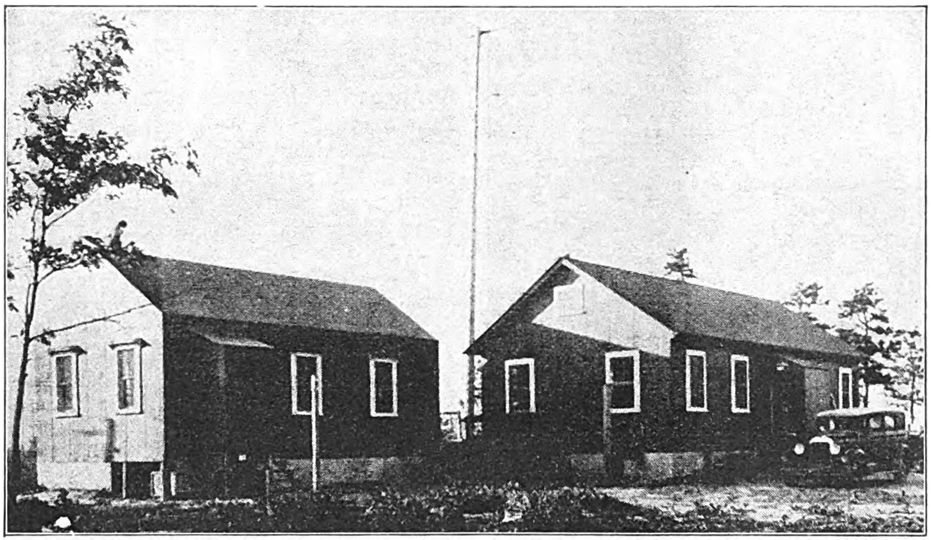
IT will probably surprise some people to learn that the groundwork for the recent international exchange of radio programs was laid about the time crystal radio receiving sets were the rule rather than museum curios. Ten years ago, when engineers and business men first realized that the baby radio showed promise of becoming a giant in a decade, engineers of the General Electric Company, the Westinghouse Electric and Manufacturing Company, and the Radio Corporation of America began to experiment in long distance transmission. These engineers declare that engineers abroad should share equally in the glory of the achievement.

First experiments were conducted with the so-called long waves, many of them of the same frequency as those used for regular broadcasting in the United States today and others even longer. Then the short waves, more or less overlooked, were picked up by the experimenters and it was discovered that they had tremendous possibilities for covering great distances. To date, short-wave transmission is considered the best available method of sending radio signals from continent to continent.

THE early work of the engineers who dreamed of a world united by radio signals was more or less haphazard. Haphazard for engineers, that is. The first objective was to exchange speech with Europe by means of radio. This, after a number of experiments, was accomplished in 1924, when the British Broadcasting Company relayed a program from KDKA for the first time.

While these experiments in long-range work were going on, regular broadcasting was developing at a tremendous speed in the United States. Distortion of sound was being eliminated and in a short space of time the presentation of a symphony orchestra on the air was as much a matter of routine as the reading of weather reports.

The ether path across the Atlantic proved to be a rough one at best, the engineers discovered, and they quickly found out that music was too fragile a thing to send long distances without serious things happening to it. And the rebroadcasting of the music from one continent for listeners in another continent was the immediate goal of the advocates of international exchange of radio programs. Equipment was improved, huge sums were appropriated for experimental work, and various types of transmitters, receivers, and antennas were tested under all conceivable conditions.



All photographs courtesy National Broadcasting Company, Inc.

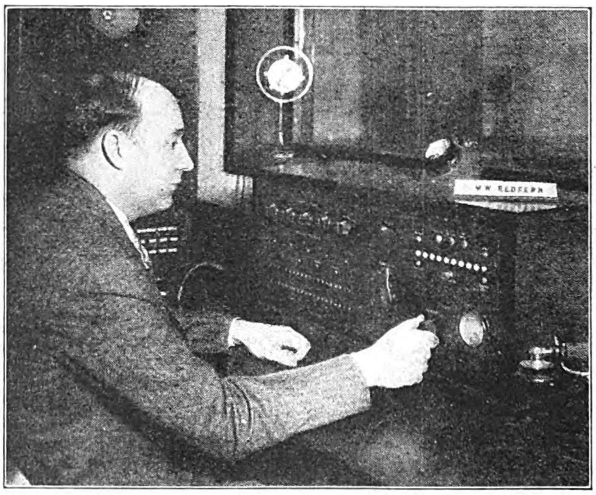
THE RECEIVING END ON LONG ISLAND

In these two buildings the radio signals from England, Holland, Germany, and Sweden are monitored daily. All foreign programs to be rebroadcast are picked up at this point

WITH the organization of the National Broadcasting Company several years ago, the work of the three aforementioned electrical groups was co-ordinated and, as a result of this co-ordination, progress was speeded. Engineers began to pick up programs from England and Germany and at times the reception was comparable to that from regular commercially operated transmitters in the United States. Little of this was revealed to the public. Then on February 1, 1929, with only a few hours' notice, a program of symphonic music, originating in London, was successfully picked up and rebroadcast through a network of NBC stations. The dream of the engineers was realized. From time to time other programs from England were heard through the American network and later came programs from Germany and Holland. Rarely were these programs planned as much as a week ahead—the engineers still were not certain of what they could do.

Christmas Day, 1929, marked the beginning of a new epoch in international exchange of radio programs. More than a week before Christmas the NBC announced that it would attempt to rebroadcast, within a few hours time, special programs originating in England, Holland, and Germany and that American programs would be sent on short waves to those countries. Though fairly confident that the programs would be received successfully, the word "attempt" was not eliminated from the announcement.

Christmas Day came and with it came three programs from abroad. The reception was better than even the most opti-



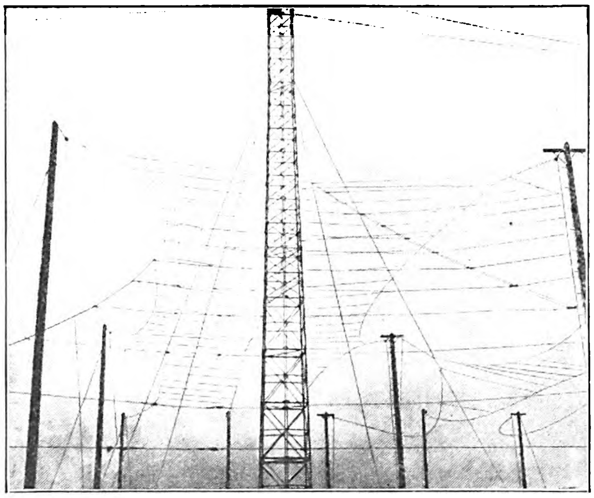
CONTROL BOOTH

All programs are monitored by studio engineers before being transmitted by the wire lines to the network mistic had expected. Throughout the quality was comparable to the reception from domestic broadcasting stations and the American listeners' approbation was expressed in no uncertain terms.

There were several reasons for selecting Christmas Day for the great experiment. One was in order to send and receive messages of international goodwill. Another was that the atmospheric conditions were favorable. At this time the most exhaustive survey of north Atlantic radio transmission problems ever attempted had just been completed and the engineers had data never before available. Two years previously a complete record of atmospheric conditions and other matters relative to trans-oceanic broadcasting had been started by engineers. The next year a similar record was kept and the records of the first year checked against the second year's survey. The data thus obtained enabled engineers to figure on what conditions to expect at a given time, current conditions being taken into consideration.

SOME confusion seems to exist in the minds of listeners as to the exact path followed by a radio program in its journey from a foreign studio to an American home. It is well at this point to trace the route of the program. The presentation from London, received in the United States the afternoon of Christmas Day, may be taken as an example.

The artists gathered before a microphone in the London studios of the British Broadcasting Company. The program was picked up for transmission and was heard by British listeners through the regular BBC transmitters. American listeners, however, did not hear the program from the same transmitter used to send it to English listeners. Instead, the program went on land wires to station G5SW, experimental short-wave transmitter of the BBC located at Chelmsford on the coast of England. From this point it went on the air on short waves. The wavelength selected was one that long and careful experiments had shown was best picked up by the experimental short-wave receiving plant of the Radio Corporation of America at Riverhead, Long Island. These signals from abroad, when received at Riverhead, had not sufficient strength to be passed on directly to American listeners by re-transmission. At Riverhead they were carefully monitored, rectified, and then amplified and sent to the main control room of the NBC at 711 Fifth Avenue, in New York City. Here they were subjected to further attention and again amplified before being sent out on the thousands of miles of network wires that carry programs to the scattered transmitters. Amplified again at the transmitters, the program started on its last lap through the ether, to be picked up and reproduced by the receiving sets in American homes. Despite the circuitous route, the continuous amplification, and the necessary monitoring, the quality of the program heard in America differed little, if at all, from that heard by British listeners.



ANTENNAS

This forest of wires intercepts the short-wave signals from abroad, for rebroadcasting in the United States

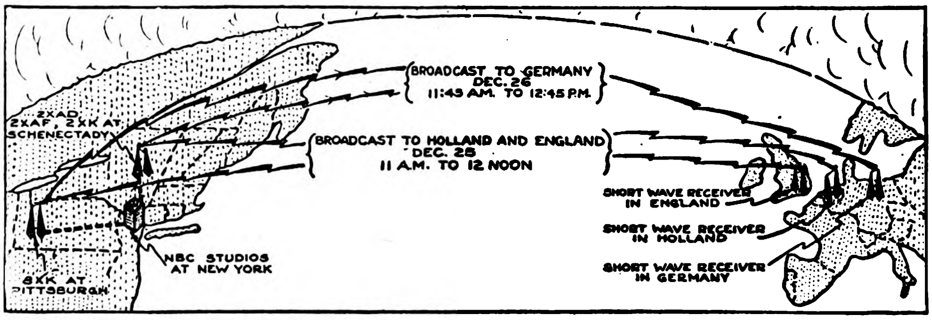
THOUGH started on their transatlantic journeys from different short-wave transmitters located in the respective countries, the programs from Holland and Germany followed the same general route.

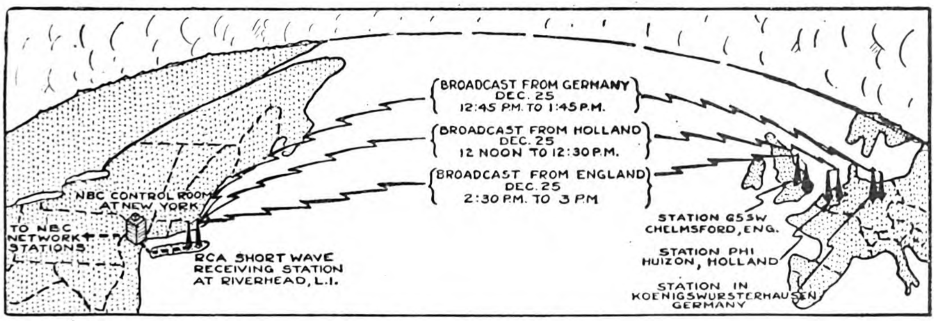
Of the special equipment used in this international exchange of programs little can be written. Much of it still is being improved and construction details are jealously guarded secrets. Though engineers have known for a long time that static can no more be eliminated than snow or rain, they have learned much about shielding the delicate signals from atmospheric disturbances.

Standard antennas do not give the best results in the reception of short-wave signals, engineers discovered, and the result has been the development of a new type of antenna, covering acres of ground and resembling a huge spider web. Similar problems in every technical phase of the program interchange brought radical changes and developments in equipment. There is as much difference in the equipment used for regular broadcasting and for short-wave transmission and reception as between a stock model automobile and a machine built exclusively for racing.

Of great assistance to the progress of international broadcasting has been the establisment of new and powerful short-wave transmitters in Europe. German broadcasters recently put into service a transmitter designed especially to send programs to America. England and Holland have similar transmitters and other European nations are expected to follow the lead.

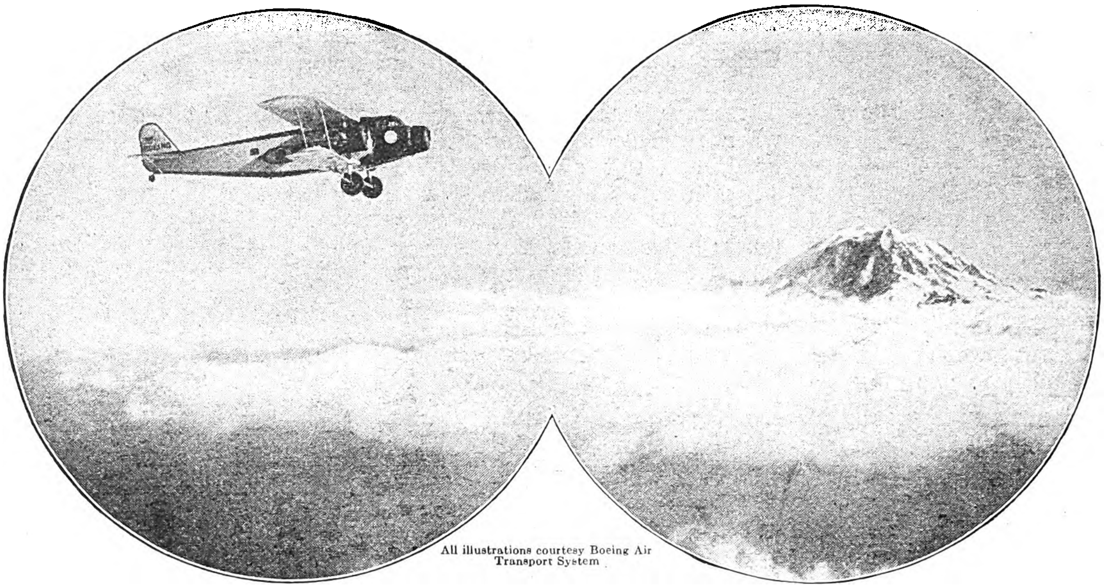
While much work remains to be done before programs from abroad are heard on as regular a schedule as those originating in American studios, the actual pioneering is history and the public has had proof that it is possible.


2XAD, 2XAF, 2XK AT SCHENECTADY
BROADCAST TO GERMANY DEC. 26 11:45 A.M. TO 12:45 P.M.
BROADCAST TO HOLLAND AND ENGLAND DEC. 25 11 A.M. TO 12 NOON
SHORT WAVE RECEIVER IN ENGLAND
SHORT WAVE RECEIVER IN HOLLAND
SHORT WAVE RECEIVER IN GERMANY
NBC STUDIOS AT NEW YORK
8XK AT PITTSBURGH


BROADCAST FROM GERMANY DEC. 25 12:45 P.M. TO 1:45 P.M.
BROADCAST FROM HOLLAND DEC. 25 12 NOON TO 12:30 P.M.
BROADCAST FROM ENGLAND DEC. 25 2:30 P.M. TO 3 P.M.
NBC CONTROL ROOM AT NEW YORK
TO NBC NETWORK STATIONS
RCA SHORT WAVE RECEIVING STATION AT RIVERHEAD, L.I.
STATION G5SW CHELMSFORD, ENG.
STATION PHI HUIZON, HOLLAND
STATION IN KOENIGSWURSTERHAUSEN GERMANY

TRANSMISSION AND RECEPTION

The upper illustration shows diagrammatically the Christmas broadcast from this country to Europe. The lower drawing indicates the reception and rebroadcasting in this country


All illustrations courtesy Boeing Air Transport System

FAR ABOVE THE CLOUDS

To the right is Mount Rainier-Tacoma, 14,408 feet above sea level. The three motors of the transport plane at the left enable it to rise above the crest of this famous mountain

An Air-Transport Operator Speaks

"It Is the Operator's Obligation to Employ Every Known Device to Make Air Transport Safe and Speedy"

By P. G. JOHNSON*

President Boeing Air Transport System

WHEN at the end of 1929, pilots of the Boeing system, operators of the two longest airmail routes of the country, completed 8,000,000 miles of flight, the first time any company in the United States has achieved that honor, it prompted reflection on the lessons learned in flying these 8,000,000 miles.

The Boeing Airplane Company, which started 13 years ago with a one-room factory employing 30 people and grew into the largest plant in the United States devoted exclusively to the production of airplanes, had done no commercial flying prior to 1927. We had been making airplanes, most of them for the government, but when the government decided to retire from the operation of airmail planes and called for bids on the Chicago-San Francisco leg of the transcontinental route, we decided to become operators.

We knew in a general way that this route (which is the longest regularly operated mail-passenger line with daily service in the world), would call for a heavy investment, the best type of plane which could be built or bought, and eternal vigilance and care in the operation of these planes. We put in a bid and won the award.

We then found that, to operate this route successfully and build up patronage, the types of plane then available would not be adaptable for our use. In 150 days we designed and built 25 mail-two-passenger planes, distributed them along the line with preliminary test flights over the route, organized operation and traffic departments, and at midnight of June 30, 1927, started flying the airmail. Now we have more than 8,000,000 miles behind us. The lessons we have learned and the methods employed have a bearing on air transport operations in general.

The theory of our system is that the mail must be put through on schedule if possible within the margin of safety. That we have been quite successful is evidenced by the fact that in the flying of 8,000,000 miles there have been only three fatalities. Our plan of servicing planes really begins at the factory, because the designers have the benefit of suggestions from men who are flying our planes 10,000 miles a day. Consequently, our high-speed, large-capacity cargo planes, the mail-two-passenger, mail-four-passenger, and large tri-motored transports, represent not only the designers' opinions of what a plane should be but incorporate suggestions received in actual operations.

IT requires a fleet of 53 planes and 64 pilots to operate these two lines, and we are as careful in the choice of pilots as in the equipment. It is our policy not to employ a pilot who has had less than 2000 hours' experience. Most of our pilots have had from four to eight thousand hours in the air, and they are men who know how to act quickly and correctly when emergencies present themselves.

Another feature of our operations, which is quite different from that of the ordinary air transport line, is our extensive night flying. Each night our planes fly 4600 miles between dusk and dawn, and of our total mileage of 8,000,000, approximately 3,600,000 were flown at night.

Recently we completed eight month's successful operation of the first night tri-motored passenger transport service on a regular schedule over an established airway. We determined that this type of dark-to-dawn flying was not only feasible, but that the public will patronize these night planes when flown by an experienced company with proper equipment and personnel.

It is logical to expect that the percentage of night flying done by the transcontinental line will increase, because air transport reaches its maximum efficiency when it extends over the entire 24 hours.

By flying at night we are able to deliver mail and passengers between points as distant as 1200 miles, without the loss of any business hours. Night flying, however, calls for supplementary equipment and also the training of pilots for this type of flying.

Another important thing that we have learned from flying 8,000,000 miles is that we can now get more

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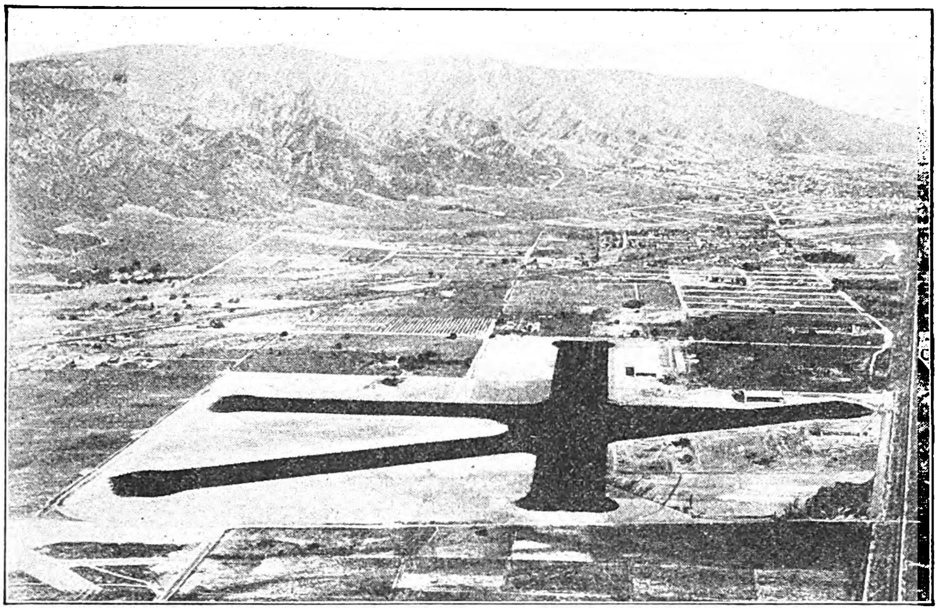
*See "Among Our Contributors," page 341.



UNITED AIRPORT, BURBANK, CALIFORNIA

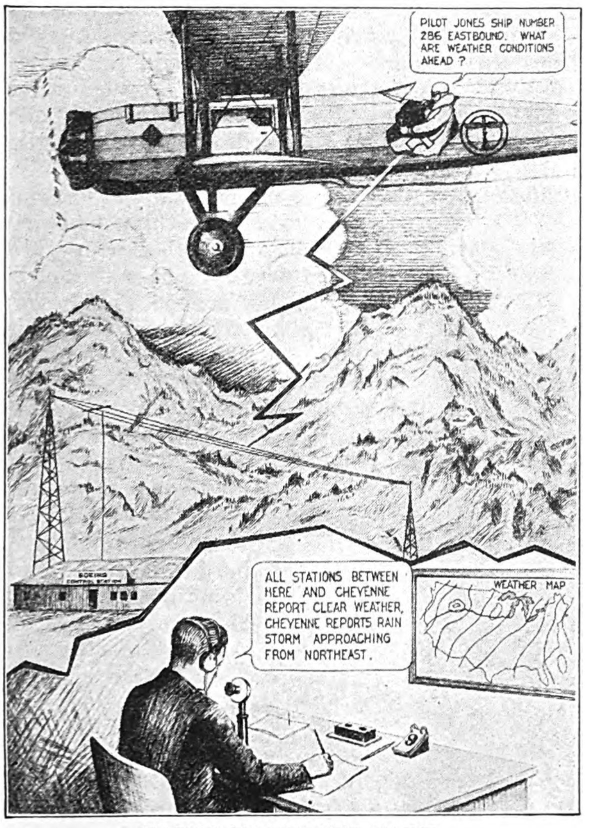
Modern terminals such as the one shown above are essential to the safe and consistent operation of a transport line. The dust-proof runways 300 feet wide are prominent features

service out of airplanes than formerly. Until recently we used five planes, one for each division, in transporting a load of mail and two passengers from Chicago to San Francisco. Because of improved equipment and engines, and more experienced personnel, we are now using two planes to do the work of these five. This means that we have made a step towards reducing the unit cost of transportation, a factor in promoting the use of the airplane.

Our experience has also taught us that most of the delays to air transport occur on the ground, and are entirely apart from structural or engine troubles, which account for only 4 percent of delayed schedules. The chief reason for delay has been the uncertainty as to flying conditions due to weather.

For months we experimented with a radiophone system, so that the pilot could have voice communication with the ground. We wanted a set which would be workable under all conditions. During the months of tests, we ran into many exasperating situations. We found that reception varied at different altitudes; that there were areas of radio shadows, skip distances, and blind spots; spark plugs and motors set up disturbances which had to be eliminated.

Our communication department, however, whipped those problems. We are now completing the most extensive radiophone installation in both ground stations and plane equipment used by any air transport line in the world, and by the time this article is published we expect to be operating 22 ground stations in nine states, and pilots on our Chicago-San Francisco and Los Angeles-Seattle planes will be able to have continuous voice communication with the ground, and between planes in flight. Radiophone is a profitable investment because of its great safety factor and the extent to which it expedites the service.


PILOT JONES SHIP NUMBER 286 EASTBOUND. WHAT ARE WEATHER CONDITIONS AHEAD ?
BOEING CONTROL STATION
ALL STATIONS BETWEEN HERE AND CHEYENNE REPORT CLEAR WEATHER, CHEYENNE REPORTS RAIN STORM APPROACHING FROM NORTHEAST.
WEATHER MAP

RADIO PLAYS ITS PART

Radiophone systems are important links in airlines. The pilot can talk to ground stations 200 miles distant

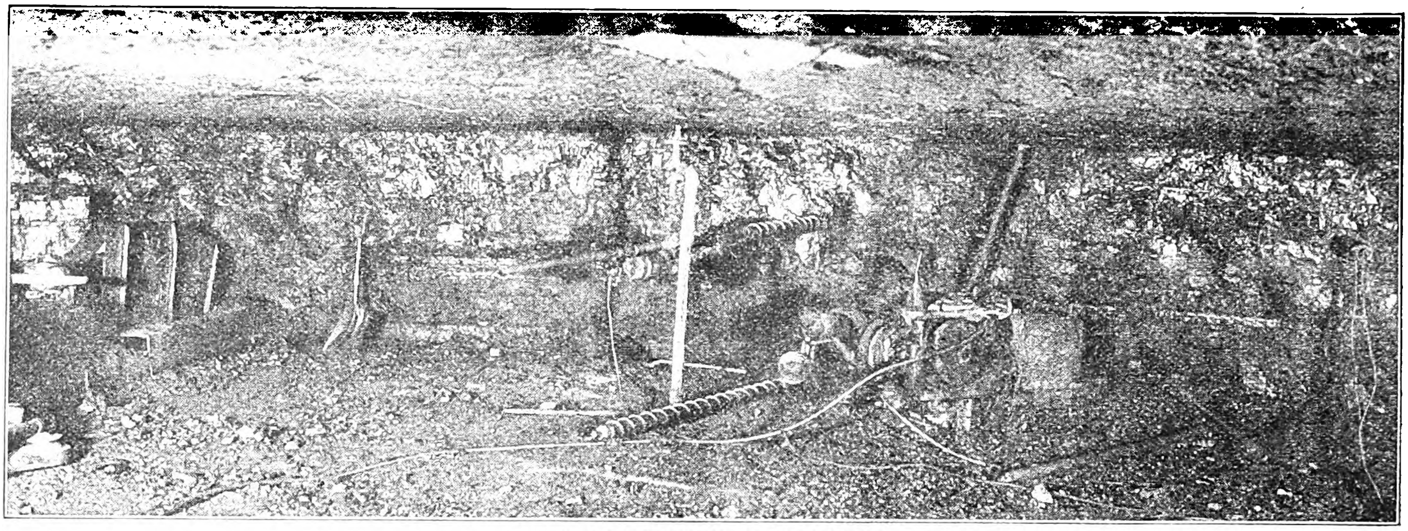
Our pilots are talking from an altitude as great as 12,000 feet to ground stations 200 miles distant. This voice communication between the pilot and the ground, and between pilots of planes in flight, has these advantages; it adds much to the safety of flying; reduces the number of emergency landings due to uncertainty as to weather ahead; enables pilots on regular routes to complete a larger number of scheduled trips on time; and increases the pay load by reducing the amount of excess gasoline now carried to give pilot ample cruising radius when he is uncertain as to weather. Radiophone is also of considerable value in dispatching planes and giving orders to pilots in the air.

Our pilots on the Chicago-Oakland-San Francisco route not only have the above described voice communication between plane and ground, but can take advantage of directive radio beacon and weather report service maintained on the transcontinental route by the Department of Commerce. In this system, a radio beam is broadcast by transmitters known as equi-signal beacons. Transmitters employ two cross loops, radiating a characteristic "dot and dash" signal. When dots and dashes blend into a continuous series of "dashes" the pilot knows he is on the course fixed by the beacon. If he hears "dot-dash" he knows he is to the left of his true course, and when he hears "dash-dot" he learns he is to the right.

We have also put into the field to supplement the present Federal weather reports several mobile weather broadcasting radio trucks. They are placed north and south of our east and west transcontinental line, at points where they can detect storms which will sweep down on our line, and by advising us in advance we can know when to keep our planes on the ground, or when to leave our regular route and fly around the storms.

We have made these preparations in advance of starting, this spring, a 20-hour night and day passenger service between San Francisco and Chicago, using 18-passenger (or 12-passenger and mail) planes. It is the operator's obligation to employ every known device to make air transport safe and speedy, as it is logical to expect that the airplane will be developed to the point where it will be commonly used not only for the transportation of mail and express, but of passengers as well.

We have not defeated every problem in our path, but the progress we have made in the last few years would indicate that the words "it cannot be done" have been stricken from the lexicon of the air-transport operator.



ON A LONG FACE IN INDIANA

With the new carbon dioxide shell, the coal may be shot as soon as it is undercut, the machines following each other closely, as shown here. On the left is the loading machine; next comes the shot drill; then the mining machine; and at right, the new shell

Blasting Coal Without Explosives

Inert—Flameless and Non-inflammable—Carbon Dioxide in New Shell Blasts Coal With a "Slow" Heave

By FRANK H. KNEELAND

IN some kinds of industrial blasting, shock of detonation is of distinct advantage; in others it has a decidedly adverse effect and should be avoided by all possible means. Shock produces a shattering effect on the material blasted. Consequently, dynamite or some other "quick" explosive is usually employed in quarrying rock or other mineral where it is desired to break it into small fragments. If large pieces are wanted, a "slow" explosive gives far better results.

In coal mining where the lump sizes usually bring a higher price than the slack or fine material, a comparatively slow, heaving action gives much better results than the quick, shattering, disruptive effort of high explosive. For this reason black gunpowder has been almost universally preferred in the past by miners and mine operators.

A NEW device on the American market, particularly applicable to coal production, is not an explosive and is not so classed by the United States Bureau of Mines, although it possesses some of the general characteristics of explosives. This device, known as Cardox, utilizes the expansive force of an inert and harmless gas for breaking down the coal at the working face. No smoke, flame, or noxious odors are produced, and the results obtained are unquestionably superior to those afforded by even the slowest of explosives.

The means employed to render an inert gas effective for this purpose are extremely simple. If we could make a miniature steam boiler—small enough so that it could be loaded into a bore hole like a charge of explosive—provide it with one weak plate that would rupture under a predetermined pressure without injury to the rest of the boiler shell; if we could fill this boiler with water; and if, after it had been placed within the coal to be shot down, we could quickly apply enough heat to evaporate the water, the pressure within the boiler shell would rise until the weak plate would give way. In other words, the "boiler" would "explode," and the surrounding coal would be broken and heaved down by the expansive force of the steam. This action on the coal would be far less disruptive than that of any explosive, just as the ordinary industrial boiler explosion is less destructive than that of a powder magazine.

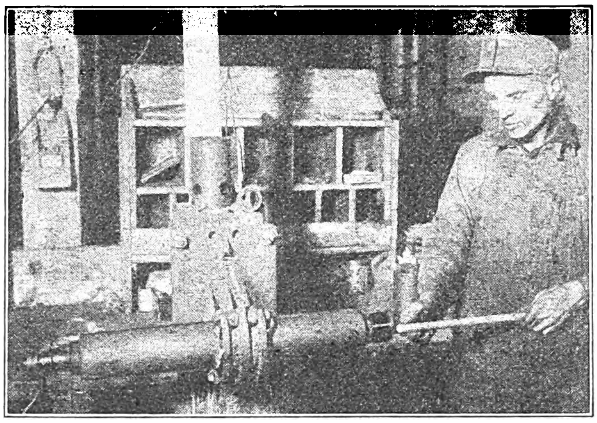
IN LARGE LUMPS

The comparatively slow shot of the Cardox shell does not shatter the coal into cheapened small grades

Roughly speaking, the Cardox shell or cartridge is nothing more nor less than a small boiler provided with a weak plate and an instantaneous furnace. The "boiler" is a hollow, one-piece forging of high-grade alloy steel.

IT is roughly bottle-shaped and provided with a filling valve at one end. The opposite end, or mouth, is closed by means of a soft steel disk—the weak plate in the boiler shell—which rests against a hardened steel shear ring. The joint gasket of fiber, disk, and shear ring are held securely in place by means of a steel cap that is screwed onto the shell neck.

The "instantaneous furnace" previously mentioned consists of a paper tube containing chemicals—sodium chlorate, charcoal, and powdered aluminum—capable of reacting with each other and producing intense heat. This



PREPARING THE SHELL

An operative is here shown inserting into the shell the paper tube—the "furnace"—containing chemicals

heater also contains an ordinary electric match-head or squib, the wires from which terminate at either end. When in place within the shell, one end of this heater rests within and makes electrical contact with a support that is insulated from the body of the shell, while the other end makes similar contact with the sealing disk, which is in electrical contact with the shell body.

Because of its low disintegration energy—latent heat of vaporization—as well as its inert nature and harmlessness while in the gaseous state, carbon dioxide is the material employed for charging the Cardox shell.

Today carbon dioxide is a fairly common article of commerce. Its use in soda fountains is familiar to everyone. It may be readily liquefied under pressure, provided its temperature is kept below the critical temperature, approximately 88.7 degrees, Fahrenheit. Above this critical temperature, it cannot be liquefied regardless of the pressure placed upon it. This is only a little above normal coal mine temperature, and, consequently, only a small amount of the heat evolved by the heater is taken up in raising the temperature of the liquid contents of the shell while the rest goes to superheat the gas formed when the critical temperature has been reached.

DEPENDING upon its model, the shell is capable of holding from 3 to 4½ pounds of liquid carbon dioxide. The heater normally contains from 125 to 175 grams of heating compound, the exact weight varying with the thickness of the disk employed and the charge of carbon dioxide. These three elements — weight of charge, weight of heater, and thickness of disk—may be varied to suit the nature and texture of the coal to be brought down, and best results are secured when a proper balance between the three has been established.

In practice a shell is brought to the charging station where the heater and disk are renewed. The shell is then placed in a rack and liquid carbon dioxide pumped into it at a temperature of about 0 degree, Fahrenheit, and a pressure of approximately 900 pounds per square inch. When the desired charge has been loaded into the shell (as determined by weighing) the filling valve is closed, the shell removed from the rack, and the cap covering the valve end screwed lightly into place.

The shell may now be taken to the working face. An electric post drill readily drills a hole in the coal sufficiently large to receive the shell. As the shell is slipped, discharge end foremost, into this hole, a terminal plug, with firing cable attached, is inserted in its outer end. Thenceforward the shell is treated exactly as if it were a charge of explosive. It is shoved to the back of the hole and tamped in place. The lead cables are connected to the firing cable; the operative retires to the nearest break-through, connects the firing cable to the terminals of a blasting machine, shouts a warning such as "fire!" or "fire in the hole!" to other workmen who may be in the vicinity, and, after a slight pause, gives the machine handle a vigorous twist.

The current from the blasting machine ignites the match-head which in turn starts the reaction between the chemicals of the heater. By this means in approximately 1/85 of a second as nearly as it can be measured, the liquid carbon dioxide within the shell is vaporized and the pressure jumps from the loading pressure of 900 pounds per square inch, to several thousand pounds per square inch, the exact pressure depending on the thickness and shearing strength of the disk. In any case this pressure exceeds the resistance of the disk and its central section first bulges and then shears against the hardened steel shear ring that supports it. This central portion or slug is caught and retained within the discharge cap while the gas that is liberated by the disk's failure escapes through the vent holes against the coal, which is broken and heaved down by the expansive force of the liberated gas.

Inasmuch as carbon dioxide is a colorless, odorless, tasteless, and inert gas, its presence in the atmosphere at a coal face is not perceptible to the senses except through its temperature. Thus the air in a place that has just been brought down by this means frequently is perceptibly cooler than before the "shots" were fired.

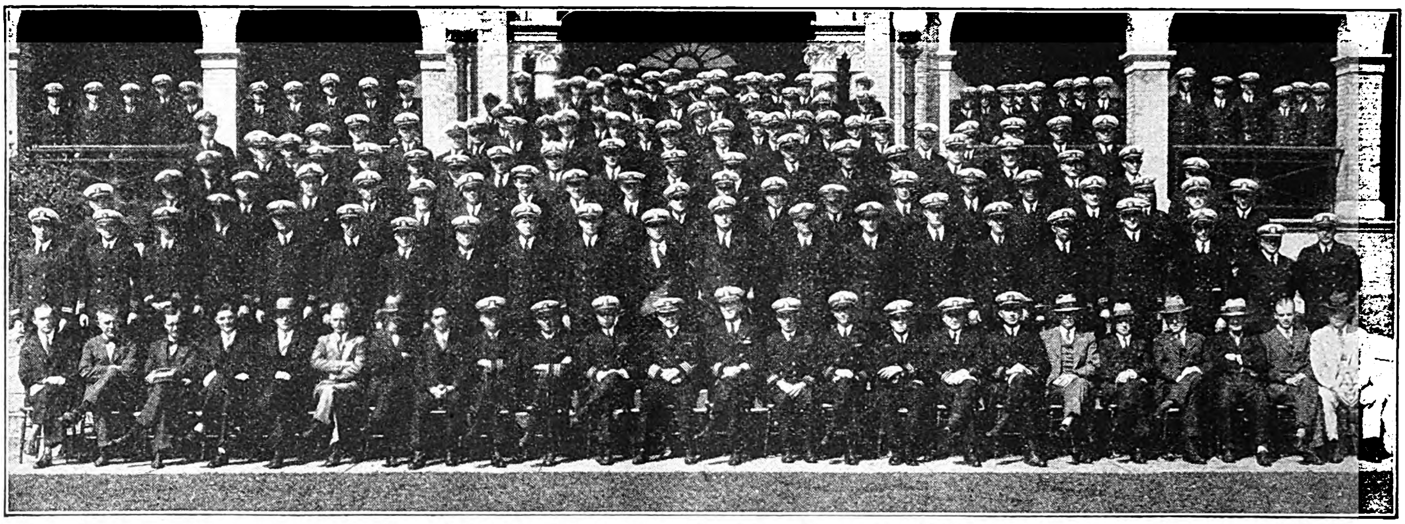
Since carbon dioxide is inert chemically, it can be breathed in small quantity without injury. The only ill effect of its presence in the air is its dilution of the normal oxygen content. Analyses of samples of the air at the working face taken as quickly as possible after a Cardox shot or series of shots had been fired have never shown more than 2.6 percent of carbon dioxide. The amount of dilution ordinarily encountered seldom exceeds .5 percent. Either of these percentages is negligible so far as respiration and ill effects on the human body are concerned.

INSERTING CABLE TERMINAL

The cable is large so that shell may be pulled out of the fallen coal by its aid

AS has been stated, the release pressure of this gas varies with the thickness of the disk, ranging from 10,000 to 20,000 pounds as against the 50,000 to 55,000-pound explosion pressure of black powder and the 100,000 to 150,000-pound pressure for permissible explosive. The initial shock that is dealt the coal is thus far less with Cardox than with even the slowest of explosives and the shattering effect and amount of fine coal produced is proportionately less, so that more lump and less slack is produced. Not only this, but the shock and jar imposed on the roof strata is less violent and less timbering is needed.

Another and, in some cases the most important advantage possessed by this means for bringing down coal, is its safety in the presence of explosive mixtures of air and fire damp, or methane. After test by the United States Bureau of Mines, Approval Number 1 was issued covering this cartridge as a permissible blasting device. It is thus not even classed as an explosive. Important as this safety feature may be, however, there are many coal mines in the United States and elsewhere in which methane is seldom, if ever, found. To these, the improvement in quality of the product that its employment effects will be the important factor governing its adoption. To many mines this quality improvement is sufficient to spell all of the difference between an operating profit and a loss.



THE POST-GRADUATE SCHOOL, CLASS OF 1930

The Cultured Naval Officer

Few People Realize the Broadness and Completeness, Technically and Culturally, of Our Naval Education System

By CAPTAIN W. D. PULESTON, U. S. N.*

IN our naval service tradition has played a larger part in forming the character of the personnel, commissioned and non-commissioned, than is generally realized. Paul Jones' defiant "I have just commenced to fight"; Decatur's toast "My country, may she ever be right, but right or wrong, my country"; Craven's debonair bow to death, trapped in the conning tower, with his "After you, pilot"; and Farragut's inspiring "Damn the torpedoes, go ahead"; built up and continue to sustain the morale of the Navy, without which professional skill would avail little.

Accounts of these incidents, and of numerous others less known to the public but familiar to the naval service, originally were passed along by word of mouth from one naval generation to the next until they have gradually become enshrined in the mind of the service and serve to incite a laudable ambition among their younger hearers. But commissioned naval officers must also have thorough technical knowledge of their ships and weapons else their pride and daring will only bring them more quickly to defeat and expose their country to ruin; and unfortunately, inspiring tales of the exploits of previous leaders will not bestow their abilities upon their professional descendants.

The commissioned officers of our Navy in the Revolution came mainly from the masters and mates of the colonial merchant marine and during the almost continuous maritime wars of our colonial days many of them became more or less acquainted with the customs and discipline of the British Navy. They knew enough of gunnery to fight with the guns that were a part of the equipment of almost all merchant vessels of that day and they were bold and skillful seamen and navigators. Most officers of this type were inclined to underestimate the need of systematic education and training, although Paul Jones, from the beginning, asserted that a naval officer, in addition to being a "capable mariner," should be "a gentleman of liberal education, refined manner, and punctilious courtesy, with the nicest sense of duty."

A FEW other of our earlier officers appreciated the necessity of proper education for naval officers, and commencing with the Honorable William Jones in 1814, nearly all our Secretaries of the Navy advocated the establishment of a naval school ashore where systematic instruction could be given midshipmen. Although most of the senior officers were opposed to the education of midshipmen ashore, they nearly all took pains to instruct their midshipmen in such professional subjects as seamanship and navigation, and instilled in them at an early age the strict code of the sea.

In the decade prior to 1845 there was much agitation in the public press about conditions in the Navy. Various groups of midshipmen from time to time memorialized Congress about their grievances, and the mutiny planned on the *Somers* and the subsequent hanging of Midshipman Spenser attracted the attention of the country to the unsatisfactory conditions surrounding the midshipmen afloat. The Navy in 1839 received its first appropriation for building steam vessels and even the crustiest old sea-dog was obliged to admit that a knowledge of steam could not be acquired at sea on a sailing ship. Forward-looking officers immediately realized that the advent of steam gave an additional reason for the establishment of a naval school ashore. But even these developments would not have established a naval school except for the support of Secretary Bancroft, who overcame the opposition in the Navy, borrowed a fort from the Army at Annapolis for its first home, ran it for a term under the general authority of the Secretary of the Navy, and in 1846 persuaded Congress to confirm his action and make the first annual appropriation for the Naval Academy. George Bancroft, scholar, historian, and statesman, gave to the Navy the Naval Academy, and to his country since its formation, a continuous supply of carefully trained junior naval officers.

The first course at the Naval School included English grammar and composition, arithmetic, geography, history, navigation and the use of steam, the Spanish and French languages; provision was made for its future improvement by the clause "and such other branches desirable to the accomplishment of a naval officer as circumstances may render practicable." Between 1845 and the Civil War the Naval Academy gradually enlarged and improved its curriculum. Throughout this period the Naval Academy was considered sufficient to satisfy the educational needs of the Navy.

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* See "Among Our Contributors," page 341

During our Civil War the capture of Charleston was greatly desired by Lincoln for military and political reasons, but the Navy alone was unable to reduce it. Among the young naval officers who witnessed the Navy's futile efforts to capture Charleston was Lieutenant Commander Stephen B. Luce, who, later, in command of a small gunboat, covered the passage of Sherman's Army across the Savannah River.

After the Civil War, Luce, while on duty as Commandant of Midshipmen at the Naval Academy, was one of the founder members of the United States Naval Institute, the object of which is "the advancement of professional, literary, and scientific knowledge in the Navy." In a broad sense the Naval Institute was the first post-graduate educational institution in the Navy. It met a real want and it continues to flourish to the present day.

THE success of the Naval Institute inspired Luce to additional efforts, and in 1877 he wrote the Secretary of the Navy advocating the establishment of a post-graduate school where officers could be given instruction in the art of war. In 1884, Secretary Chandler established the Naval War College and appointed Luce as president.

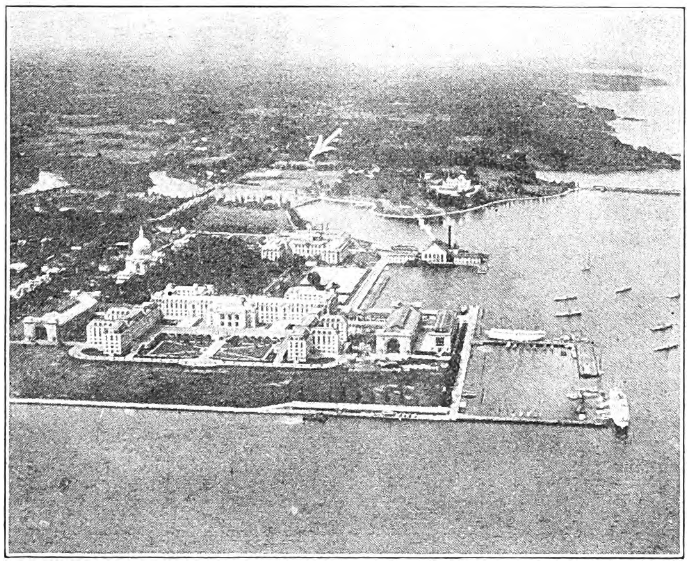
About 1873 the automobile torpedo was invented and shortly afterwards the Navy Department established a torpedo class at Goat Island, Newport, Rhode Island, to study and develop the new weapon. The War College and the Torpedo School were the first strictly post-graduate schools of the Navy. The Naval War College was also the first institution primarily devoted to the study of naval warfare in the world although Germany and other European countries had their Army War Colleges.

Thus the Naval War College, which is the apex of the present naval educational system, was the second educational institution in point of time to be established. Later other post-graduate schools began to appear, for the period of naval reconnaissance was at hand; and although there continued to be some opposition in the service to additional schools, it was gradually overcome.

After the World War, the Department detailed a Junior Class to the War College to be trained for duty on the staffs of high commanders and for command of small units. This new course provides junior officers trained in staff duties, and directs the attention of a large body of junior officers to the study of war at a comparatively early age when their minds are fresher and they can readily comprehend new subjects.

The Corps of Naval Constructors were next to realize the need of special post-graduate work, and in 1881 Rear Admiral Capps, then a junior officer, was sent to Greenwich, England, to study naval architecture and kindred subjects. Later prospective naval constructors were sent to Glasgow, Scotland, and this custom persisted until 1901, when candidates for the Construction Corps were sent to the Massachusetts Institute of Technology. This procedure still obtains, and yearly a quota of prospective naval constructors enters Massachusetts Institute of Technology. Some years later the Corps of Civil Engineers selected Rensselaer Polytechnic Institute for the post-graduate education of candidates for its corps, and today both these institutions can be regarded as an integral part of the naval post-graduate system.

AS early as 1893, the Bureau of Medicine and Surgery began a post-graduate course for medical officers at the United States Naval Laboratory, Brooklyn, New York. This subsequently developed into the Naval Medical School affiliated with the Naval Hospital at Washington. In addition, this Bureau has, since 1920, sent officers to civilian institutions, medical centers, and hospitals for special post-graduate courses.



UNITED STATES NAVAL ACADEMY

An air view of the Naval Academy showing the United States Naval Post-graduate School in center background, under the arrow

About 1900, interest in post-graduate education began to quicken throughout the Navy because the great improvements in ship design, marine engineering, electricity, ordnance material, and naval accessories, and the increase in educational standards throughout the United States made it plainly evident that four years at the Naval Academy was not sufficient to give officers the technical knowledge necessary to carry on the various duties to which they might be assigned. The Department responded to this service reaction by establishing in 1909 a "School of Marine Engineering" at Annapolis, with a technical curriculum and a staff of instructors about half of whom were civilians, eminent in their own specialties. In 1912 the curriculum was extended to include courses in ordnance and gunnery, electrical engineering, wireless telegraphy, naval construction, and civil engineering.

The World War caused a temporary suspension of this school, which reopened in 1919, with a more comprehensive curriculum based upon:

(a) A one-year basic course taken by all students at the Post-graduate School in Annapolis during which they refresh their knowledge of mathematics, physics, thermo-dynamics, and perhaps languages.

(b) Specialized courses of one or two years given at the following universities, where students concentate their energies on their particular subjects: Columbia University gives three of these courses—mechanical engineering, electrical engineering, ordnance optics. Massachusetts Institute of Technology furnishes to naval students courses in aeronautical engineering, ordnance design, ordnance torpedoes, and aerology, of one year each, and naval construction of two years. Both Harvard and Yale provide courses in communication engineering which include instruction in telegraphy and wireless telegraphy. Rensselaer Polytechnic Institute gives a two-year course in civil engineering to the Ensigns who desire to join the Civil Engineer Corps.

ORDNANCE, in addition to the course in torpedoes and ordnance design given at Massachusette Institute of Technology and ordnance optics at Columbia, requires a course of ordnance ballistics at the University of Chicago, ordnance explosives at the University of Michigan, and ordnance metallurgy at Carnegie Institute of Technology.

By this comprehensive system of post-graduate instruction, the Navy can be sure that its commissioned personnel will contain a sufficient proportion of technical experts who are acquainted with the latest developments in all material of a modern fleet. But the Navy Department gains a great deal more by this program of post-graduate education than a group of officers highly skilled in certain technical activities; it is brought at once in contact with the numerous educational institutions of our country; it must acquaint itself with their many activities in order to insure that the Navy is fully utilizing their services. This contact broadens the whole outlook of the Navy, for, in attending these various universities, naval students learn more than the content of their particular course—they learn the latest methods of instruction and the newest systems of research; and they return to the service bringing this new mental contribution with them which they gradually diffuse to the whole body of naval officers throughout the service.

ENSIGNS STUDY PARACHUTES

A class of Ensigns receiving post-graduate instruction in the use of parachutes

These technical specialists should insure us that our ships and their armor, guns, powder, shell, machinery, and boilers are the best that American science and industry can produce, and that the Navy will receive the care necessary to its efficient maintenance. This is an essential factor but it is not enough; the junior officers of the Navy will in due time succeed to higher command and they must early prepare themselves for this duty. To assist them in their preparation for their executive and operating duties, a "School of the Line," which was recommended in 1919, was established in 1927, as soon as the number of officers available permitted. This course embraces navigation, tactics (elementary), ordnance, mechanical engineering, electricity, logic, economics, diplomatic history and foreign relations of the United States, communications, radio, and aviation theory—a truly formidable list of subjects.

BUT it must be remembered that the young officers taking this course come from the fleet and have some knowledge of all these subjects and are likely to be thoroughly familiar with at least one of them. This course enables young officers to even up their progress in the various branches of naval science, while it requires them all to take such subjects as logic, economics, and diplomatic history, that will enlarge their mental horizon.

This School of the Line is an intermediate course between the Junior War College Course and the Naval Academy; and when practicable, graduates of this school, which lasts one year, proceed to the War College and, after taking the Junior Course there, are returned to the Fleet. This school, which the Navy established in 1927, completes the last link in the chain between the Naval Academy and the Naval War College. Junior officers fortunate enough to be assigned there, begin the study of the art of command which they will continue many years later—after much practical experience in active service at sea—by taking the Senior War College Course.

Aviation has become an integral and essential part of the Navy, and the Naval Academy curriculum has been widened to include many of its phases in the undergraduate work of the midshipmen. The Departments of Engineering and of Seamanship carry out most of the undergraduate work; and so important has it become that the junior class at Annapolis does not take the summer practice cruise but remains at the Naval Academy where it takes a three-months' course in naval aviation which includes aeronautical engineering, indoctrinal flights, and ground school work. Midshipmen usually average an hour's flight every second working day during this course.

In addition, the department maintains elementary aviation schools at Hampton Roads and San Diego for post-graduate work, where graduates may review their work of the Naval Academy, or if they graduated before the course was established, can get an indoctrinal flight course and some ground school work.

The real Post-graduate Aviation School is at Pensacola, where naval aviators who are going to devote their major time to aviation receive either a primary or advanced course that requires two years.

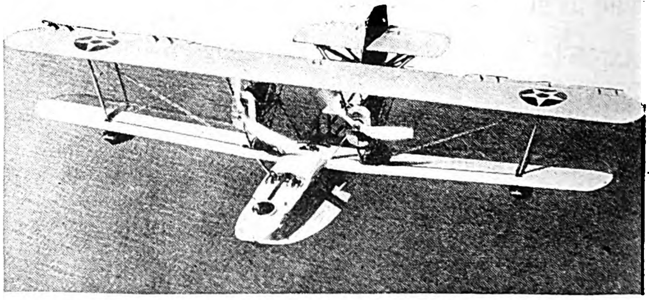
No less important than the Aviation School is the Submarine School at New London, Connecticut, where officers and men destined for the submarine service are given a six-months' course in the operation and care of submarines.

The Department also sends officers to the Chemical Warfare School of the Army at Edgewood, New Jersey, provides special courses in naval communications and torpedoes and gives refresher courses in languages to officers about to go to foreign shore duty.

The office of the Judge Advocate General in 1911 commenced sending officers detailed to duty there to the Georgetown School of Law after their regular office hours, and this practice continues.

THE predominating characteristic of the whole scheme of naval education is the preparation of officers for particular tasks, beginning at the Naval Academy where all available time and the energies of the officers and instructors are concentrated on preparing the midshipmen for their duties as junior officers of the Navy. The next step in the school system prepares line and staff officers for duty as heads of departments or command of small units, and in the third step, the Senior Class at the Naval War College, officers are prepared for high command after much practical experience.

The Naval Academy has a definite task to perform within a limited period of time, and although it gets splendid young material to develop, it must limit its effort and its course to the practicable, and must first make a midshipman a "capable mariner" and then add the "liberal education." The graduate of the Academy, no matter whether he goes into the Line or Staff, has only commenced his education. During his career he will probably learn more from the counsel, admonition, and criticism of his seniors, and from his own experience, than from text-books and formal courses. In training enlisted men, the young officer will begin really to educate himself, and as he matures he will find already in operation available for his use the comprehensive school system herein described. And what is more important, he will find in the service an appreciation of the necessity of post-graduate education that did not always exist. But the Navy properly and justly retains a healthy distrust of impractical theorists, and the final test of all officers will be their ability to carry on their work in the Fleet.

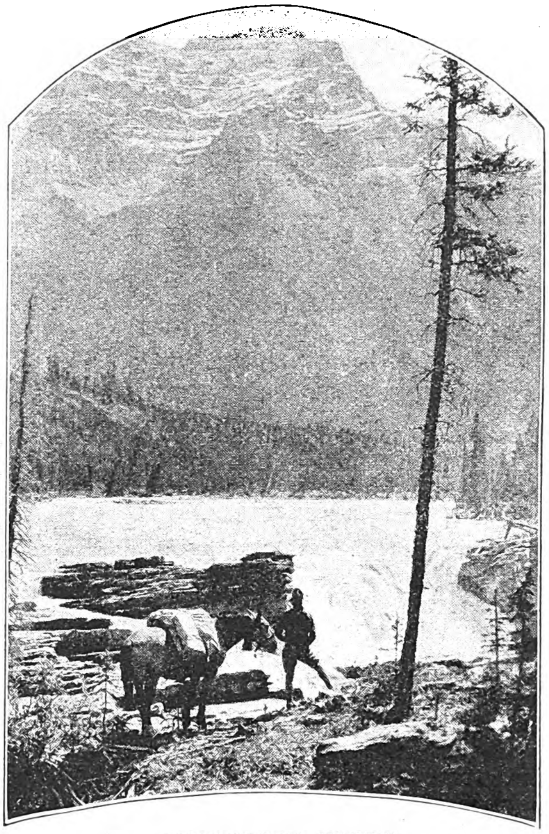


MIDSHIPMEN ALOFT

The Naval Academy keeps step with the development of naval aviation material

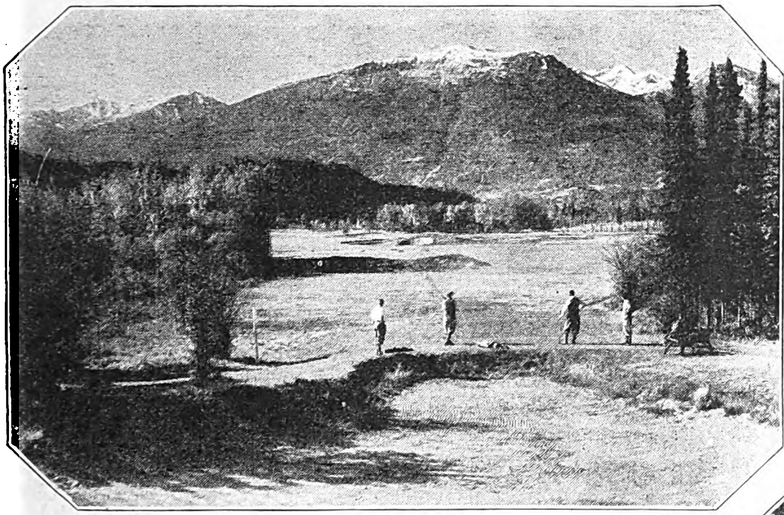
Canada's Peerless Playground

OUR own national parks are exploited to such an extent that we are apt to forget that our neighbor over the border also has the beauty of nature. Therefore we shall both illustrate and briefly describe the finest of Canada's natural possessions—Jasper Park. The avowed purpose of national parks is to make "the wild places of the land sacred." Civilization spells death to beauty; the primeval forest falls never to rise again. Waterfalls are denuded of their water so that wheels may turn and we can have cheap light and power. All these things are desirable, but the price is frightful. With the building of the transcontinental railways across the Yellowhead Pass a new door was opened to the Canadian Rockies; a new and wonderful alpine district was visioned to all lovers of the beauties of nature. Jasper National Park comprises 5380 square miles—a region larger than some European kingdoms, and more than half the total area set aside in Canada's national reserves. One of the chief characteristics of the park is the variety and beauty of its mountain lakes. Outstanding, too, are the number and depth of the canyons, each with its turbulent stream and often a fine waterfall thrown in for good measure.



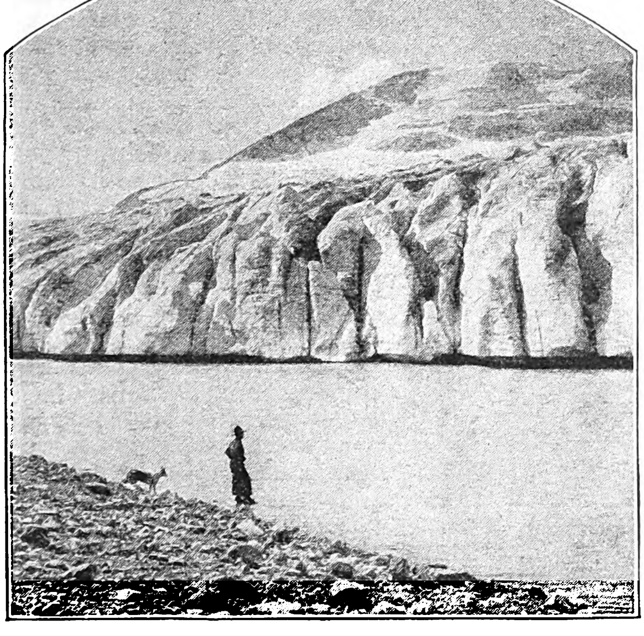
ATHABASKA FALLS

The mountain in the distance is Mount Kerkeslin, 9900 feet in height. The water is milky with silt from many of the glaciers. Delicate touches of vegetation here and there save the rugged scene from apparent harshness



JASPER PARK GOLF COURSE

This golf course is interesting owing to the rocky character of the site. Hundreds of cars of earth were brought in from the prairies to provide the soil for the fairways and greens



↑ LAC BEAUVERT

Mount Edith Cavell is in the distance. A fine hotel has been built on the pine-girt shores of Lac Beauvert, one of the most beautiful lakes in Jasper National Park. The lake and the mountains form a surpassingly beautiful picture never to be forgotten by the tourist

← GLACIER LAKE

From this vast ice sea issue streams which take their way finally to three oceans and carry life and fertility to thousands of miles of valley and plain. The attractions of Jasper National Park are so very diversified that it may be visited at any or all seasons of the year

The Successful Airplane Diesel

First Detailed Description to be Published of the Design of This Revolutionary Engine

THE PACKARD DIESEL ENGINE

In one of the test planes. In appearance, it does not differ radically from the conventional gasoline engine

FOR several years much experiment and research has been carried out in the effort to adapt the Diesel engine to airplane use. About a year ago the Packard Automobile Company, of Detroit, announced that it had been successful in designing and building such an engine but the construction details of this engine have been a carefully guarded secret. In the meantime a very extensive testing program has been carried out, a close estimate showing that the total of experimental ground and flight testing of this engine has amounted to an equivalent of approximately 330,000 horsepower-hours which represents a sufficient output for an average plane to fly a distance of a quarter of a million miles. It has passed an Army 50-hour acceptance test, and for it the United States Department of Commerce has issued an approved type certificate. Its advantages have been covered in some detail in past issues of SCIENTIFIC AMERICAN*. In this discussion, therefore, we shall limit ourselves to a description of the most important constructional details, condensed from a description by the designer, Captain L. M. Woolson.

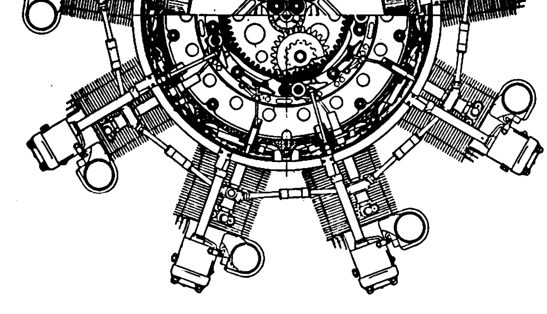
THE Packard Diesel aircraft engine is of the radial air-cooled type having nine cylinders with a bore of 4 13/16 inches and a stroke of 6 inches, giving a displacement of approximately 980 cubic inches. It is rated at 225 horsepower at 1900 revolutions per minute and weighs 510 pounds, or 2.26 pounds per rated horsepower. The engine's outside diameter is slightly over 45 inches and it is attached to the mounting ring with eight 3/8-inch bolts. So far as its general characteristics are concerned, with relation to size, weight, and general arrangement, the engine does not differ radically from conventional gasoline aircraft engines of a similar type. However, the engine incorporates many constructional features never before employed in aircraft engines.

A casual inspection reveals a radical departure from current practice in that each cylinder is supplied with only one valve which serves as both inlet and exhaust; and the single rocker-arm box which is slanted in the direction of the spiral of the slipstream contributes much to the clean external appearance of the engine and, what is more important, to its low parasitic drag.

The real point of departure between the system used by the gasoline aircraft engine and the Diesel engine are the ignition systems involved. The gasoline engine requires a complicated electrical ignition system in order to fire the combustible mixture whereas the Diesel engine generates its own heat to start combustion by means of highly compressed air. The temperature of the air in the cylinder at the end of the compression stroke of a Diesel engine operating with a compression ratio of about 16 to 1 is approximately 1000 degrees, Fahrenheit, which is far above the spontaneous ignition temperature of the fuel used.

One important advance, in the Packard Diesel, over previous Diesel practice, is the ability to extend the range of engine speeds possible with the Diesel cycle. Stationary and marine Diesels have heretofore been rated at 100 to 300 revolutions per minute and even so-called high-speed Diesels have been limited to about 1200 revolutions per minute. The speed of the Packard Diesel, however, has been increased to over 2000 revolutions per minute. This has been accomplished by an engine design that produces exceptional fuel turbulence. This and the highly efficient, quick-acting fuel pumps are the means that produce the accelerated mingling of the fuel and air which bring about the greatly increased speed. The engine structure has been designed to withstand the resulting maximum cylinder pressures which are considerably in excess of 1200 pounds per square inch.

HERETOFORE Diesel engines, even of the lightweight type, have weighed about 25 pounds per horsepower; the Packard engine weighs but one tenth as much. A review of the design will show that important weight economies have been secured by the elimination of carbureters and magnetos and by an intense simplification of design. Evidences of the latter are found in the one-piece crankcase construction of extremely light weight and the single valve arrangement which automatically halves the number of parts ordinarily required for valve operation.



IN PARTIAL CROSS-SECTION

Valves, cams, fuel system, and other parts described in the text are clearly shown

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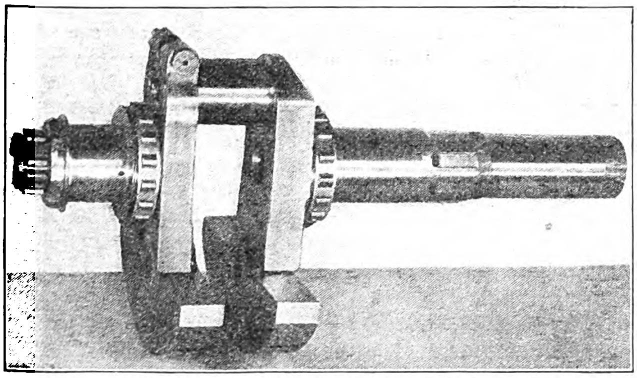
*See page 73, January, 1929; page 356, April, 1929; page 222, October, 1929; page 36, January, 1930; and page 310, April, 1930.

The crankcase, which weighs only 34 pounds, is unique not only because it is of one piece and thus dispenses with heavy flanges and bolts, but also in respect to the novel fashion in which the cylinders are fastened to the crankcase. Two circular hoops of alloy steel encircle the cylinder flanges in contact with the crankcase at the front and rear of the engine and these hoops are contracted by means of sturdy turnbuckles. Thus an initial stress which exceeds by a wide margin the operating stress resulting from the cylinder explosions, is set up in these hoops. Under this system the crankcase is subjected to an initial compression which it is well adapted to resist. When the engine is running, however, these stresses are materially reduced and at no time is it possible to transfer any tension loads from the cylinder to the crankcase.

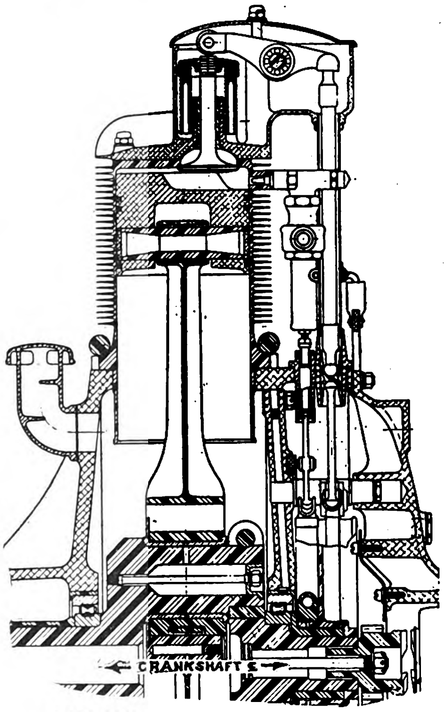
OF no less importance are the arrangements whereby the crankshaft and propeller are protected from excessively high stresses. In the Packard Diesel the maximum cylinder pressures are over 10 times as great as the average cylinder pressures during the working stroke. This would necessitate the pistons, connecting rods, crankshaft and propeller being approximately 10 times as strong as they would have to be to resist the average pressure, were it not for the fact that effective measures have been taken to cushion these major parts of the engine from the shock loading. Advantage is taken of the fact that the peak explosion pressures exist for a very short time in each cycle. The crankshaft counterweights and the propeller are both flexibly mounted on the crankshaft so that the stresses in the crankshaft are greatly reduced.

The counterweights, instead of being rigidly bolted to the cheeks, are pivoted on them and are located between powerful compression springs. When the crankshaft is suddenly accelerated, the counterweights lag behind slightly so that the peak cylinder pressure is expended before the counterweights are again solidly driven by the crankshaft. In a similar fashion the propeller hub is allowed to float on an extension of the crankshaft driving end, and specially designed propeller-blade clamp rings, provided with integral driving lugs, receive the driving effort from a two-arm driving member splined to the crankshaft. On the extremity of each of these two arms a pair of rubber blocks are compressed, between which the propeller clamp ring driving lug is secured. The inherent damping or hysteresis of the rubber blocks, supplemented by the surface friction in the counterweight mounting, quickly and entirely smooths out the shaft rotation.


SHOCK-ABSORBING CRANKSHAFT

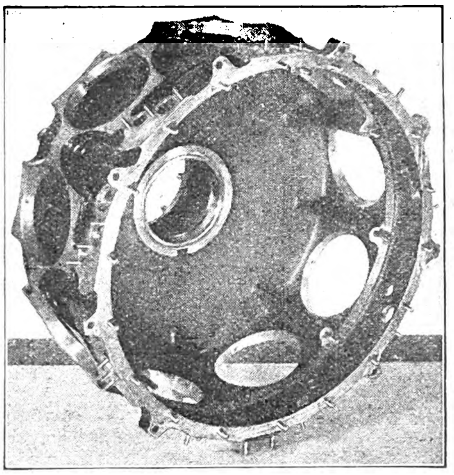
Here will be seen the method of mounting the counterweights on pivots between springs to cushion the shock of explosion

Each cylinder weighs only 11¾ pounds. It was recognized that the cooling problem of a Diesel cylinder was considerably simpler than that of a corresponding gasoline engine cylinder since the increased thermal efficiency of the Diesel is reflected in far lower heat losses to the cylinder walls. This fact justified a simple form of closed-end cylinder design in which the cylinder head proper is formed integral with the cylinder barrel, a construction which is not considered satisfactory for gasoline engines.



CYLINDER CROSS-SECTION

Side view, showing mechanism of one cylinder, left side, and the two cams


THE 34-POUND CRANKCASE

This is unique because of its construction and method of attaching cylinders

The fact that only pure air is drawn into the cylinder on the intake stroke of the Diesel permits the use of a single valve for both inlet and exhaust purposes. This arrangement makes for simplicity, weight saving, and reliability; and, furthermore, the available time for opening and closing the valve is lengthened appreciably so that lower rates of acceleration thereof can be utilized, thus saving wear and tear on the whole mechanism.

In this Diesel the turbulence necessary to insure a homogeneous mixture of fuel and air is accomplished by giving the incoming air an extremely rapid whirling motion. This high velocity spiral motion of the air is brought about by shaping the inlet port as a flattened Venturi arranged tangentially to the cylinder bore. By this method of air injection and the finely atomized injection of the fuel, accurately controlled and timed, complete combustion is assured.

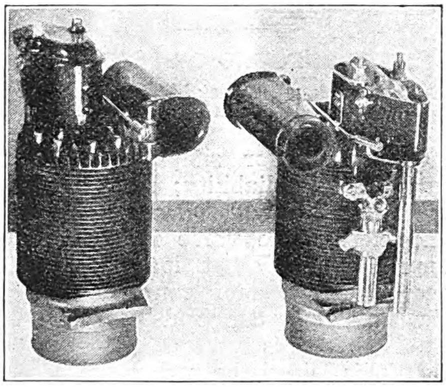
THE feature which probably contributes most to this phase of operation is the combination fuel pump and nozzle unit. Heretofore the majority of solid fuel injection Diesels of the high-speed type have been characterized by a multiple pump unit mounted somewhere on the engine remote from the cylinder heads in which the nozzles are located, and connected to them by comparatively long capillary tubing. The many difficulties arising from this kind of system have been overcome in the Packard Diesel since the pump and nozzle are practically one unit with extremely short connecting passages between them.

The crankcase is a one piece magnesium alloy casting of rather large diameter, this casting supporting through the medium of a forged steel container a deep-groove ball bearing at the front end adapted to take both propeller thrusts and radial load at this point. A roller bearing is mounted immediately ahead of the front crankshaft cheek, this bearing arrangement being quite orthodox.

The crankshaft is of the commonly used split type, the rear half being attached to the front half by means of a clamp bolt and key engaging the crankpin. The rear crankshaft bearing is also of the roller bearing type and is supported in a removable wall in the crankcase, termed the diaphragm. The diaphragm also carries the major working parts concerned with the operation of the valves and fuel pumps.

The connecting rod assembly follows standard practice in practically every respect, a master connecting rod being used in conjunction with eight link connecting rods.

The valve and fuel-pump push rods, of which there are nine each, are radially arranged at the rear of the engine and are, in turn, operated by two cams which are formed integrally and each of which is provided with four lobes. These cams are driven at one-eighth engine speed in the direction opposite to the crankshaft rotation, a large internal gear being formed integrally with the cams and a compound idler gear meshing with the cam and crankshaft gears respectively. Both the single valve and fuel pump of each cylinder are operated through the medium of rocker arms which contact with the respective cams and are supported on a common shaft which is anchored in the diaphragm and which also obtains a steady bearing in suitable bosses formed in the cover casting.



LIGHT-WEIGHT CYLINDER

At left: front of cylinder with air intake.
At right: rear, air valve and fuel pump

WHEREAS the inner end of the air-valve push rod seats in a spherical receptacle formed in the rocker arm referred to, the inner end of the fuel-pump operating push rod fits in a specially formed groove or channel provided in the fuel rocker arm. Furthermore, these fuel-pump push rods are connected by linkage near their inner ends to a circular control ring mounted in a groove on the diaphragm, the movement of which ring is controlled by an externally mounted lever connected to the pilot's control and *offering the sole means of regulating the speed of the engine.* The linkage referred to moves the inner end of the pump push rods, this movement altering the effective stroke of the fuel-pump plunger and thus varying the amount of fuel injected into the cylinders in accordance with requirements.

The cylinder-head caps (see drawings) are light aluminum alloy castings which serve merely to support the overhead valve mechanism and valve stem guide and incorporate the inlet and exhaust ports. This casting is secured to the top of the cylinder by means of ten studs which insure good thermal contact for heat transfer from the upper surface of the cylinder to the radiating fins on the caps.

The aluminum alloy piston used is characterized by a peculiarly shaped head provided with an eccentrically located pocket which is designed to promote, in conjunction with the inlet port and valve arrangement, the high degree of turbulence which is so largely responsible for the efficient operation of this engine at high speed.

The fuel pump and nozzle assembly constitutes a radial detachable and interchangeable unit which is bolted to a flange on the rear of each cylinder. Among the advantages favoring this construction are the elimination of all high-pressure tubing between pump and nozzle and the avoidance of the resultant troubles, such as air pockets, after dripping, and variations in timing due to the compressibility of the liquid in the piping and the elasticity of the pipe itself under pressures as high as 6000 pounds per square inch.

ONE of the major problems in connection with the development of this Diesel airplane engine has been the matter of starting. The special requirements in aircraft service are that the engine must start promptly in all conceivable operating temperatures, and also that the starting mechanism must be light in weight and simple to operate. A great deal of experimentation was carried on with various types of starters, such as the cartridge type using 12-gage shotgun shells, the compressed air type, and various forms of field starters not carried in the plane. It was finally concluded that the conventional type of inertia starter, used so extensively with gasoline aircraft engines, offered the best solution. It was also found necessary to develop an incandescent heating element, or glow plug, to give the required heat for starting at below-zero temperatures. These glow plugs offer no handicap to the ordinary operation of the Diesel. With them instantaneous starts are possible at any temperature at which it is possible to turn the engine over at all.

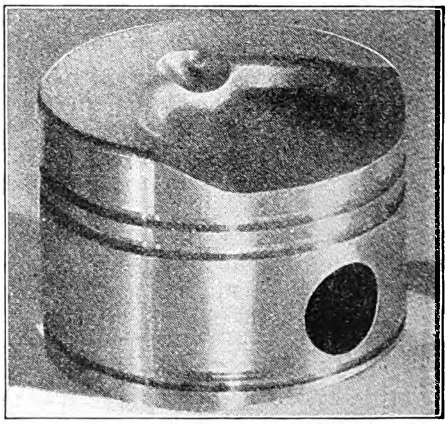
The starter incorporates a small flywheel which is rotated through a system of gearing at very high speed by means of either a hand crank or an electric motor. When sufficient energy has been imparted to the flywheel, a dog-type clutch is manually engaged with the crankshaft, resulting in the rapid cranking of the engine during the few seconds necessary to dissipate the energy stored up in the flywheel. The engine starts immediately on its regular supply of fuel oil, no special fuel or preparatory heating being necessary. At very low temperatures, however, it is essential to use the glow plugs.

In stopping the engine it is merely necessary to close the throttle completely against a spring stop, this extra motion of the throttle mechanism serving to restrict the stroke of the fuel pumps so that no fuel is forced into the nozzle. The engine can be stopped instantly no matter how hot it may be, without danger of kicking backwards.

SUMMING up: the engine is started with the throttle wide open, and then is easily stopped by closing the throttle completely. There are no other controls used except those of the inertia starter. The engine automatically adjusts itself to burn efficiently whatever fuel is being injected.

A very intensive testing program was carried out in the development of the Packard Diesel. This testing has comprised dynamometer, torque stand, and flight testing in two different types of planes: a Stinson Detroiter, six-place cabin plane, and a Waco three-place open cockpit plane. Ground testing on individual engines has been carried up to 500 hours on the dynamometer. This program has covered a period of two and a half years of test work.

As a result of this development, simplification and further economies in the operation of transport planes may be prophesied. Large transport, mail, and freight planes may be driven either by a single Diesel engine of large power or possibly by two smaller engines mounted on the wings so as to remove the source of noise from the passenger compartment. In this fashion it is believed that a high degree of safety and low cost of operation will be arrived at, thus greatly stimulating the growth of commercial aviation.



ALUMINUM ALLOY PISTON

With two compression rings and one oil ring. The pocket helps promote turbulence

Advice to Students of Aviation*

By DR. H. J. COOPER

Medical Section, Aeronautics Branch, Department of Commeree

ALL persons desiring to become licensed pilots should bear in mind that while they may pass the physical requirements for student and private pilot licenses, that is no guarantee they will not have difficulty with the physical examinations for limited commercial or transport licenses.

Many former students have been physically disqualified when they applied for limited commercial or transport licenses, and, as a result, considerable misunderstanding and disappointment have arisen. Therefore, the medical section of the Aeronautics Branch desires at this time to disseminate as much information on the subject as possible.

THE medical section approves or disapproves a medical examination upon the basis of the grade of license applied for. If a student examination shows that the applicant just barely meets the physical requirements for that grade, he will be qualified for it. However, the medical section can not write the applicant that while he has been approved as a student pilot, and will be approved later for the grade of private pilot, his examination is unsatisfactory for either limited commercial or transport pilot and therefore he will not be able to reach either of these grades of license as long as his present defects exist.

The reason the medical section can not do this is because it has no way of knowing, out of the total number of student applications received, what students plan to become limited commercial or transport pilots.

There are two fundamental principles that a student should keep in mind when he starts in training.

1. If his sole desire is to become a private pilot for the purpose of flying his own plane when and where he pleases, and if he has no desire to operate commercially, he should take the student physical examination. If satisfactory, this examination will also qualify him for the grade of private pilot when he becomes eligible for the flight test and the written examination for that grade.

2. If a student's sole purpose in applying for a student permit is to become later a limited commercial or transport pilot, he should take the transport physical examination at the start. In this way he will know before he starts his training whether he has any defects which will bar him from qualifying for that grade of license he ultimately desires.

The student who desires to become a limited commercial or transport pilot will not be put to any more expense for medical examinations by following this advice, because, although he pays $15 for the transport examination, this examination includes tests that will not have to be made again no matter how long the interval may be between the date of the examination and the time at which he becomes eligible for the limited commercial or transport license. If he takes the student examination for $10, he will later pay $5 for that portion of the examination not made originally.

The attention of student applicants also is directed to the following:

1. The Department of Commerce maintains two types of physical examination, one for student and private pilot and one for limited commercial and transport pilot. The requirements for student and private pilot are, of course, very much more lenient than those for limited commercial or transport pilot.

2. Any applicant who has been physically qualified for student pilot on the basis of a satisfactory student examination will be physically acceptable for private pilot at a later date, provided, of course, that his physical condition has not changed adversely in the meantime.

3. Any applicant who has been physically qualified for student pilot on the basis of his having taken and passed a transport physical examination, will be physically acceptable for any grade of license applied for at a later date, again provided that his physical condition has not fallen below standard in the meantime.

4. When a student applicant takes the transport physical examination and finds that while he qualifies for student and private pilot, he does not qualify for limited commercial and transport pilot, he should write the Medical Section, Aeronautics Branch, Department of Commerce, Washington, for an official opinion on his defects. The Medical Section will inform him what the possibilities are of his receiving medical approval for the higher grades of license by a waiver.

5. If any applicant is physically disqualified for student pilot, he is at liberty to inquire of the Department the nature of his defects, and if the medical section believes there is anything in the way of treatment that will reasonably improve the defect, the applicant will be so advised.

6. When a student applicant has been physically disqualified by a medical examiner, he should await action on his examination by the Department. He should not visit other examiners in an effort to qualify, for even if an examination made by another medical examiner is satisfactory, it will not be accepted. Under such circumstances the Medical Section will require that the applicant return to the original medical examiner in order to demonstrate to that examiner that the disqualifying features are no longer present.

7. Prospective applicants who know they have certain physical defects are invited to communicate with the Medical Section and state the nature of the defects. The Medical Section will inform the prospective applicant whether or not the defects are disqualifying.

8. The student permit of any student will be suspended in case of an accident in which he sustains personal injuries such as to interfere materially with bodily functions. The suspension of the student permit will be maintained until the student is able to submit to a physical examination, made by an authorized medical examiner, showing that the student has recovered from his injury. In case of partial recovery, the medical section will determine whether or not the recovery is sufficient to warrant removal of the suspension.

9. In order to make the visual requirements clear, special attention is directed to this paragraph. The lowest vision acceptable for student pilot is 20/50 in either or both eyes, without correcting lenses. Judgment of distance must be within the normal specified limits, without correcting lenses. If the student just meets the foregoing minimum requirements, he is required to wear correcting lenses in his goggles, bringing his vision approximately to normal. His judgment of distance must be within qualifying limits while wearing this correction. Failure to meet any of the foregoing requirements will result in disqualification.

10. When it is necessary for the student to wear corrective lenses in his goggles, the correction should be ground into the goggle lenses. Small corrective lenses fastened on the inside of the ordinary goggle should not be purchased. Students should be very particular in these matters, for incorrect lenses often result in harm to the vision.

11. Student applicants who do not meet at least the minimum physical requirements will not be recommended for license. Waivers will not be recommended for students.

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Stunting for Safety

Training in Plane Acrobatics Instills Confidence and May Help the Pilot Out of Tight Places

By LIEUTENANT (j.g.) H. B. MILLER, U. S. N.

STUNT flying has been the direct cause of perhaps more peacetime air crashes than any other one thing. As a result of this fact and the consequent adverse publicity freely dispensed by many periodicals and newspapers, the prejudice of the public against stunting has been so encouraged that it is now almost insurmountable. The ability to stunt, however, is at times an invaluable aid to safety; it may even mean the difference between life and death for the pilot and his passengers. Lieutenant Miller explains in no uncertain terms why and when this is so.

—*The Editor.*

IN A SWEEPING DIVE

A Boeing Navy fighter in a dive. It is imperative that all military aviators have much stunt flying training

THE reaction of the public against stunt flying has definitely begun. Denunciations of stunting and acrobatic flying are becoming more and more frequent. No doubt there has been sufficient flagrant display of this type of flying to warrant public censure, but on the other hand, it is more likely that the whole truth of these cases has not been known.

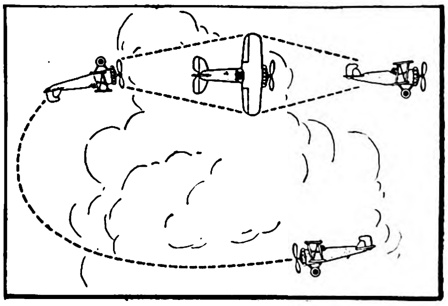
Only recently a pilot lost control of his plane while performing a loop. Both the pilot and passengers were killed. Moreover, people on the ground were endangered, because the plane fell into the heart of the residential section of the city. On the face of the matter, stunt flying would automatically be condemned.

UNFORTUNATE as is this case, it is positive proof of the definite need of thorough acrobatic training for all flyers. This particular pilot had just obtained his private license, after the necessary 15 hours of solo flying and 10 hours of dual instruction, which permitted no time to devote to advanced flying. The pilot's stunt training was obtained on the ground at a round-table discussion. In addition, the flyer violated all air traffic rules when he stunted over an inhabited district. It is amazing to think that two people could be found who had sufficient confidence in such a novice pilot as to take a joy hop with him.

Had the pilot qualified after a thorough training course, he would not have lost control of his ship. Also had he been thoroughly indoctrinated, he would have observed the Air Commerce Regulations and private property would not have been endangered.

For safety's sake, then, why not prohibit all forms of stunting by all pilots? The answer is a paradox. For safety's sake, regulated acrobatic flying should be encouraged.

The expression "stunt flying" is used generally to cover the abnormal maneuvers which can be done with an airplane. In addition, this expression should include such things as diving at hangars, flying low over cities, and other forms of "dizzy flying." Moreover, all unnecessarily hazardous flying such as the Dole Flight are covered by the term "stunt flying."



IMMELMAN TURN

From a half-completed loop, a roll over and flight in the opposite direction

Such stunt flying as changing from one plane to another while in flight, and long over-water flights in landplanes after insufficient preparation, add nothing to the progress of aviation. Failures resulting from such attempts discourage the enthusiasm of the public for aviation.

Our military services will not assist in the dedication of an airport, when the program tolerates such flying as wing-walking. This type of stunting is discouraged officially.

The expression "acrobatic flying" is accurately applied to those intentional maneuvers of a plane flying in any positions other than a straight line. When done at a dangerously low altitude, acrobatic flying becomes stunt flying.

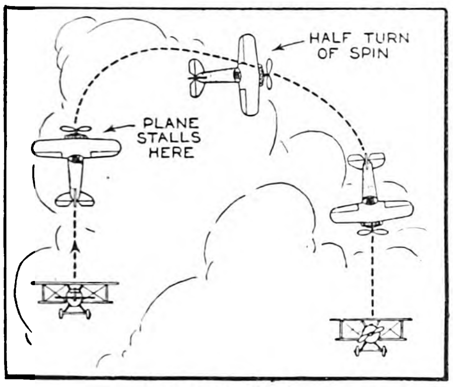
Acrobatics can be indulged in safely only with suitable equipment. Training ships and sport planes capable of being stunted are now available. Strength sufficient for violent flying is built into these ships and the manufacturer of a plane will state the maneuvers for which his ship is designed. The pilot who stunts a plane which is not designed for that purpose will sooner or later come to grief. Too often have the wings deserted an old broken-down plane during some violent maneuver. The flyer who recognizes the limitations of his ship will probably enjoy a long career in aviation.

All photographs are Navy Official

THE HIGH-HAT SQUADRON

Executing difficult maneuvers and formation flying with planes lashed together with ropes, at the National Air Races

Acrobatics can be performed with various degrees of gentleness. Some pilots can bring a plane down after a stunt hop with the ship in perfect condition. Others will perform exactly the same maneuvers and land the plane with slack in the brace-wires. Few ships have ever been built that cannot be broken up in the air if the pilot so desires. Even military fighting planes, which possess a safety factor of 12, can be flown to pieces. Just because a commercial plane will withstand active evolutions, that feature should not be abused. Material failures are especially apt to result when pulling out of prolonged and fast dives.



SPLIT "S"

Useful for turning in a limited space. The pilot climbs steeply, stalls, and turns

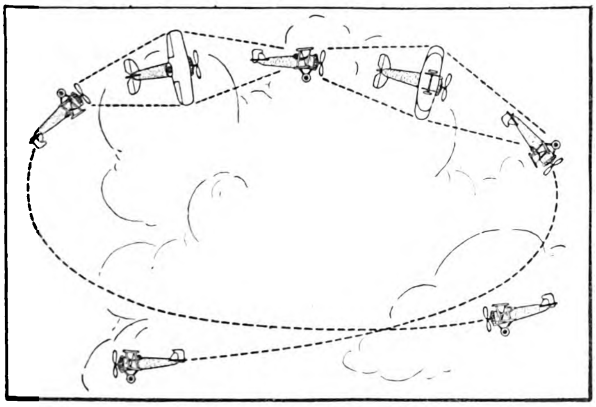
Confidence can be instilled in a student flyer in no better way than by giving him acrobatic training. This should come after the student has had 15 or 20 hours of solo flying. A person learning to swim progresses slowly until he is thoroughly at home in the water. Moreover, he lacks faith in himself at first. The same is true of the student aviator.

Handling a plane under unusual conditions and attitudes gives the young flyer complete confidence in his flying ability. If he should ever find himself thrown into some unusual maneuver, it will not be strange to him. He will instinctively manipulate his controls as in acrobatic flying in order to return the plane to its normal attitude.

One case on record shows that a flyer became lost in a low-hanging fog. In endeavoring to continue his flight to a landing field, he followed a blind canyon. Suddenly the pilot found himself hemmed in by the canyon walls. In front was a spur of the mountain which was too high for him to climb by flying straight ahead. Nosing the plane down momentarily to gain speed, the pilot pulled back sharply on his control stick. At the top of the loop, he half-rolled his ship into an Immelman turn. Saved; one life!

Instructions in acrobatics are quite simple. The various stunts are discussed in detail on the ground. The instructor then takes the student up and goes through each maneuver a number of times. With the instructor still in the plane, the student goes through the evolutions until he has learned to perform them with a fair degree of skill. The novice then must put in many long hours of solo acrobatic flying for mastery of stunts is had only by long and arduous practice. Finesse and perfection are a result of hard work.

EXCLUDING the various forms of inverted flight, which is extremely advanced, there are only a comparatively few acrobatics. By ingenious combinations, a skilled pilot can appear to do a multitude of distinct maneuvers, but the bases of practically all of them are the loop and the spin. Nearly all other maneuvers are merely variations of the spin. Among these are the barrel-roll, which is a horizontal spin; the falling leaf, which is a series of partial spins, alternating to right and left; and a split "S" which is a half-spin reversing the direction of flight.



A DIFFICULT LOOP

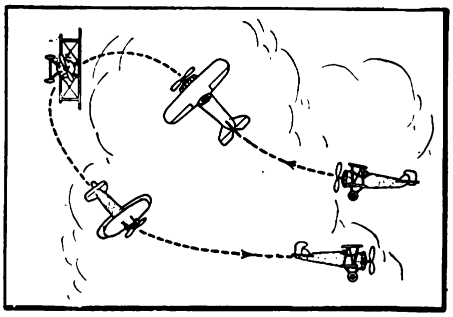
The pilot begins the loop, makes a full roll at the top of it, completes the loop, then continues original flight

A combination of loop and spin produces a roll on top of a loop. The Immelman turn is merely a half-roll executed at the top of the loop. This reverses the direction of flight and at the same time gains altitude. The roll can be extended into a double-roll and even a triple-roll. A recently devised maneuver has proven popular. This is called the "slow roll." In this the pilot rolls his ship horizontally by use of the ailerons alone. An appreciable length of time is required for this maneuver, as compared to the snap-roll which is merely a stall.

LOOPING IN FORMATION

An experienced pilot can follow another through any maneuver. Here three Navy planes are on top of a loop

The flipper turn and the wing-over are not classified as stunts. The former is merely a steep turn of a greater bank than 45 degrees. Here the action of the elevators and rudders reverse in their relation to the horizon. Picture the tail surfaces inclined over 45 degrees from their normal position. The rudder then becomes the elevator, and vice versa. The wing-over is merely a 180-degree turn with a sharp climb at the moment of greatest bank.



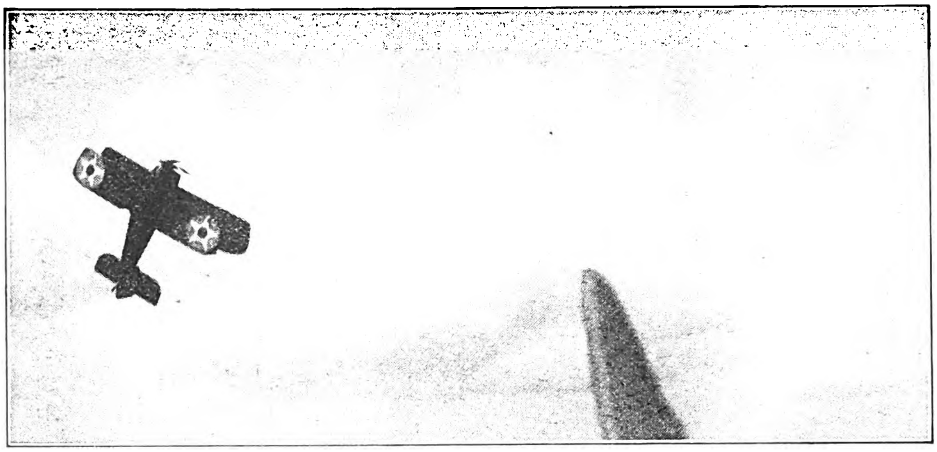
WING-OVER

A climb, a steep banking turn, and the plane has reversed, but has lost altitude

This maneuver begins with what is practically a stall and, when it is completed, the plane is flying in the opposite direction with less altitude.

Acrobatic flying is used by the military services almost exclusively for training purposes. A good stunt pilot is generally a smooth flyer. Always, is he master of his plane, but he rarely, if ever, indulges in acrobatic flying without good reason.

Contrary to popular belief, stunts are



DOING A BARREL ROLL

A Navy fighting plane doing a barrel roll, photographed past the rudder of another plane. This maneuver is the same as the ordinary spin, except that the plane's movement is horizontal

seldom indulged in during aerial combat. This is because most of them are based on a spin which is a result of a stall, and a stall means, of course, loss of speed and altitude—two factors which cannot be sacrificed during combat. It is an acknowledged fact in pursuit work that the simplest maneuvers will lead to a conservation of altitude and consequently to the most advantageous positions. An experienced pilot will follow his enemy through a loop or Immelman turn with no difficulty whatsoever. And if the enemy goes through maneuvers that result in loss of altitude, the following plane holds a distinct advantage.

"THREE SEA HAWKS"

From left to right, Lieutenants Davis, Tomlinson, and Storrs, three Navy fliers

The commercial flyer has no need for stunts in his everyday work. If he has mastered acrobatics, however, he will be a better flyer in every way. Safety in the air is augmented by the experience and skill of the pilot. The passengers he carries will be safer because of his ability to handle a plane in any emergency or abnormal attitude.

Except in a very few special cases, acrobatic flying should be indulged in only under the air-traffic rules of the Department of Commerce. The basis of these regulations is safety—for the performing plane, for other planes in the air, and for people on the ground. These rules provide that no acrobatic flying shall be done over a congested area, over an open-air assembly of people, or within 1000 feet horizontally from an airport or airway. These are very necessary rules.

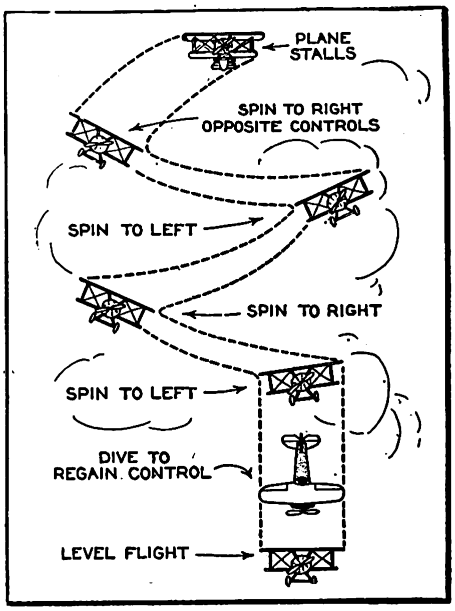
Further, all such maneuvers shall be completed at an altitude of not less than 1500 feet. This is a wise provision. The student, especially, needs plenty of altitude in order to recover from possible spins. High aloft, mistakes can be corrected, and in case of engine failure a bountiful supply of altitude is most comforting.

Exceptions to the Air Commerce Regulations are granted in special cases. For instance, at the National Air Races, acknowledged masters of acrobatics are permitted to perform at lower altitudes. As a crowd producer, there is no equal to such spectacular performances.

Who, having seen them, can forget the "Three Sea Hawks," and the "Three Musketeers" at the races held in Los Angeles in 1928? The tremendous crowds saw probably the most perfect flying of all time.

As the Sea Hawks rolled over and flew across the field on their backs in perfect formation, one man who was watching the performance was overheard to say, "I don't believe it. There is a trick in it somewhere." The trick was in the many hours of hard work these men had devoted to the attainment of perfection. They knew every trick of the air and of the planes they were piloting.

No one who saw Lieut. Al Williams' inverted stunt flying at the Air Races in Cleveland last October could fail to realize that here was a master of the airplane. His uncanny skill is a direct result of the many arduous hours spent in practicing acrobatic flying.

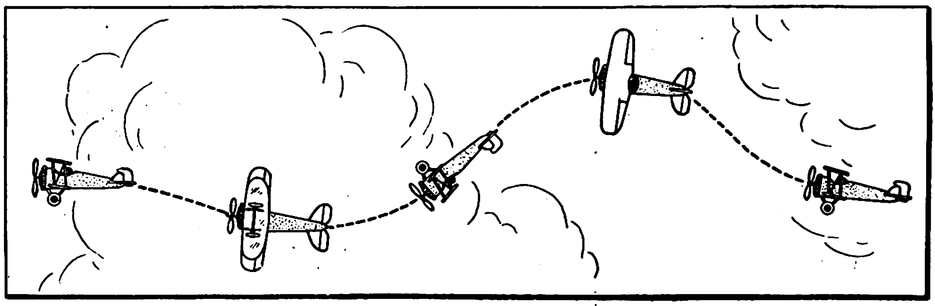


FALLING LEAF

After a stall, the plane settles like a leaf until the pilot dives to regain control

Fortunately, the Department of Commerce prohibits stunting with pay passengers. But there are thrill-seeking people who would tempt a pilot with money to attempt maneuvers unsafe with his type of plane. Accidents would multiply overnight if this restriction were removed. Few pilots can afford to fly a person on a stunt hop just for friendship's sake. It is an expensive gesture and, in addition, there is always the possibility of a resulting liability lawsuit if the passenger should be injured, friendship or no friendship.

Acrobatic flying is merely hard work which prepares a pilot to fill a position of responsibility and trust. It is therefore of the greatest importance that the syllabus of every aviation school should include thorough training in acrobatic flying.



BARREL ROLL

This maneuver might just as well be called "the corkscrew" for the plane, in executing it, moves forward in a horizontal spiral, slightly changing its altitude in the manner shown

Midget Marine Motors

The Rise of the Outboards Has Been Rapid, But Even Greater Developments May Be in Store

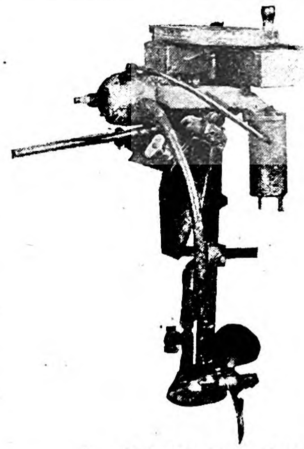
By THOMAS W. FARNSWORTH

THE desire to transform the row boat into a motor boat was no doubt the *raison d'etre* of the outboard motor. The first attempts were simply small editions of larger inboard motors, with clutches, shafting, foundations, stuffing boxes, and struts. It was, of course, difficult to shift these from one boat to another, and even when this was done, the chances were that the new boat had to be made over before it would take the motor. The solution of this problem was a portable, detachable motor which could be clamped to the stern of the small boat. Thus we have the so-called "outboard motor."

ONE man's meat, as has been said, is another man's caviar. And how well we see this demonstrated in the world of outboard motors! The little motor which saves hours of labor for the fisherman or hunter who "putt-putts" to his day's sport in the early dawn, is the same motor which gives hours of joy to the children at the seashore or on the lake, while the more powerful motors provide the last word in thrills for those who get their fun in racing or stunting on the water.

Formerly automobiles put a damper on pleasure boating, but now it would seem that they are helping to revive it. As automobiles increased in numbers and popularity, the demand decreased for power boats for recreational purposes. Boats, the usefulness of which was limited in most American climates, to approximately six months of the year, could not compete with the year-round automobiles, offered in about the same price range. But now that the highway congestion is becoming so tremendous, people in greater numbers each year are seeking recreation on the water. In many instances the automobiles are used simply to get to the boats, or perhaps to carry the boats to the water.

Once the boating public made up its mind that it must have a portable motor—and hence one that was light and free from a multiplicity of parts—it was logical that the fundamental working principle should be that of the two-cycle system.

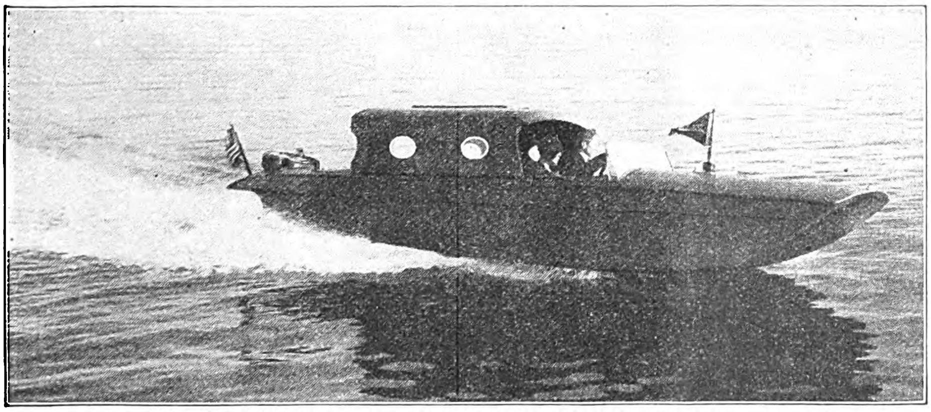


AN OLD TIMER

One of the first Evinrude motors ever produced. Compare with the new models

Briefly, a two-cycle motor consists of crankcase, crank, connecting rod, piston, and cylinder. It gets its name from the fact that in one revolution of the crank the two strokes of the piston complete the cycle. There is an explosion every time the piston reaches the top of the stroke, as against every other time in the four cycle.

THE AUTHOR AFLOAT



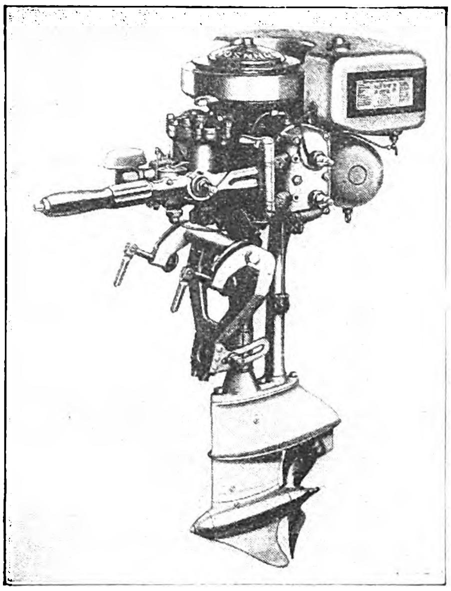
AN OUTBOARD MOTORED CABIN CRUISER

Motors can now be obtained that are adaptable to almost all kinds of craft, from tiny rowboats to such luxurious cruisers as the Sea Sled illustrated in the above photograph

The first outboard motor in the United States (which country now leads the world in outboard motor production) was built by C. D. Waterman in Detroit, Michigan, in 1904. There is record of the Waterman Marine Motor Company's advertising outboard motors as long ago as 1908. The Waterman motors were produced by the Caille Motor Company. The first motor had a single cylinder, held vertical. The crank, which was horizontal, drove a vertical shaft through a set of bevel gears. This shaft followed down to below the water line where it drove the propeller through another set of bevel gears. Most of the working parts of this motor were exposed. The whole unit pivoted for steering. A long tiller handle extended into the boat and on this was attached a fuel tank.

ABOUT 1910, Ole Evinrude came into the field with an engine similar in form to the one which is in present use. This engine had its cylinder placed horizontally and the crank drove the shaft direct, thus eliminating a set of bevel gears. An attempt to eliminate the lower set of bevel gears was made by driving a shaft direct with a propeller on the end of it and supporting the whole unit at an angle on the transom of the boat. By 1914 there were no less than ten manufacturers in the outboard field.

Before 1920 outboard motors were composed largely of cast iron, malleable iron, and bronze. With the introduction of the Elto light twin in 1921, aluminum made its appearance, while shortly thereafter an aluminum alloy called Lynite, having approximately twice the strength of aluminum, was used extensively in the construction of outboard motors. Thus, today we have at one extreme a twin-cylinder motor weighing but 29 pounds and developing 2¾ horsepower, while at the other extreme is a 4-cylinder motor



"SEA HORSE 32"

A Johnson four-cylinder outboard, typical of design advances that have been made

weighing 120 pounds and developing 35 horsepower. This low weight per horsepower is due directly to the extensive use of alloys.

Before 1921 no attempt was made to streamline under-water parts. In 1921 and up to the present date, streamlining of the lower unit and gear housing has been a most important factor in the construction of the outboard motor. The airplane industry has contributed some valuable data in this connection.

In 1921 Ole Evinrude, now president of the Outboard Motors Corporation, and the Johnson Motor Company brought out motors with twin cylinders opposed. In 1924, outboard motor boats were raced. An Elto twin averaged nine miles per hour. The next meet produced an Evinrude motor which made 12 miles per hour. From that time progress has been made by leaps and bounds until at the present time outboards on specially designed boats are approximating 50 miles an hour.

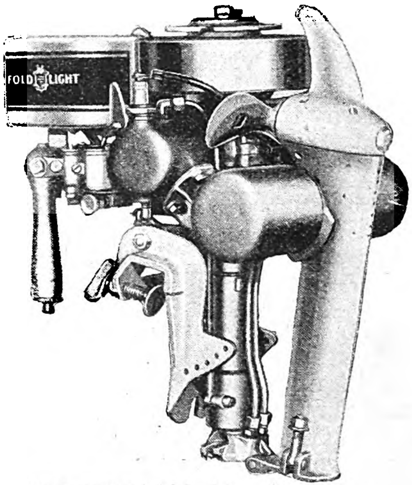
In 1928 the Elto Outboard Motor Company brought out the first four-cylinder outboard motor, and the Johnson Motor Company put an additional valve on their motor called a "release charger." This valve releases the compression in the inactive cylinder and diverts the entire charge of fresh gas to the active cylinder, making the motor much easier to start.

Here then we have motors which have not increased in weight in anything like the proportion of their increase in power. The refinements which have gone into the improvement of these motors are very interesting. The power curve, which began to drop off at 2600 r.p.m. had to keep going up to 5000 r.p.m. This necessitated handling the gas mixture faster, cutting down the resistance and balancing and lightening the moving parts. The new features, designs, and mechanical refinements which have been added to outboard motors have had to do largely with increased revolutions per minute. As most of us know, horsepower is in direct proportion to revolutions per minute. So if the 2000 r.p.m. motor of yesterday was four horsepower, the same motor at 3000 r.p.m. would be about six horsepower and at 4500 r.p.m. would be about nine horsepower—as we find it today.

The friction and retardation of the gas being sucked into the crankcase, compressed, expanded into the cylinder, compressed, exploded, expended, and ejected by the fresh charge, had to be overcome. One way in which it was found that this could be done was to increase the number of ports, and last season saw two-port, three-port, and four-port motors. One motor came out with a combination of two and four ports, using a mechanically operated rotary valve to admit the gas mixture to the crankcase. This rotary valve not only permitted a large opening to the crankcase, but because of its mechanical operation kept this opening effective for the full length of the suction stroke. The same result is accomplished with a valve acting against a spring installed in the intake manifold leading to the crankcase. In this way, instead of the gas mixture being shot into the crankcase during the brief opening of the ports, it is sucked in continuously during the outward travel of the pistons. Larger openings, admitting gas for a longer time, mean a greater volume, higher compression, more revolutions per minute, and hence more power.

Compression has been increased by reducing the crankcase dimensions and when the limit was reached, the crank itself was increased in size to take up more room. Cylinder compression was increased in proportion by reducing the compression chamber. In the early racing days, motors were "pepped up" by filling in under the pistons with cork or Plastic Wood and brazing metal to the piston head.

Having satisfied in part the public's demand for speed, the manufacturers of outboard motors have been turning their attention to improvements and refinements. These include ease of starting, under-water exhaust, balanced reciprocating parts, ball- and roller-bearings, streamlined under-water parts, lighter and stronger materials, oiling and cooling systems, and so on.

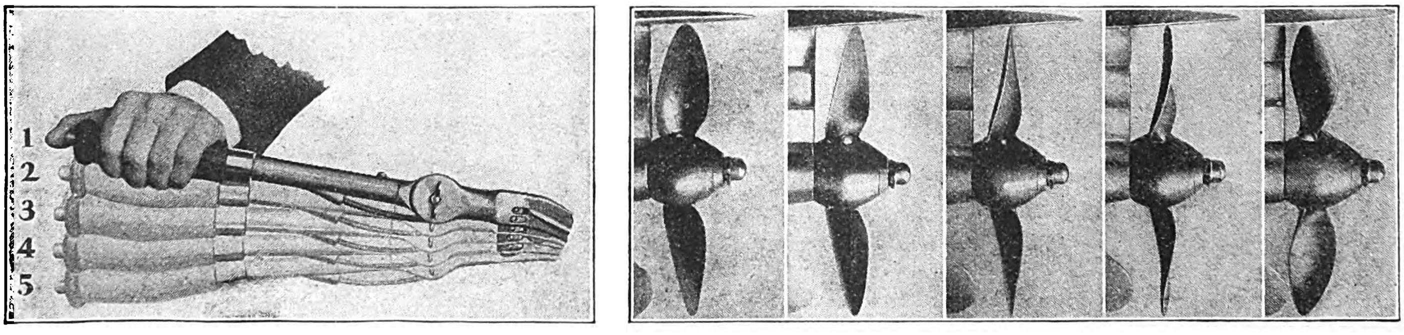


Courtesy Outboard Motors Corporation

THE "FOLD-LIGHT" TWIN

An Elto motor especially designed for carrying in a motor car or otherwise where extreme light weight and compactness is desirable. Note two mufflers

A recent addition to the outboard motor field is a product of the Indian Motor Cycle Company. This firm has had 27 years' experience in the building of small motors. Their



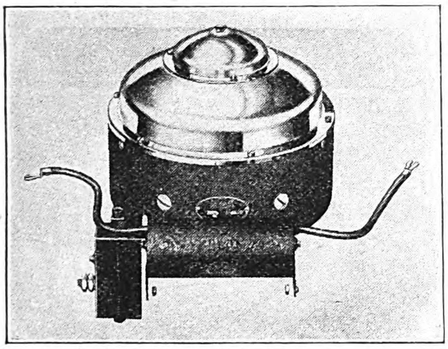
THE CAILLE "MULTI-FLEXIBLE" CONTROL

By moving the tiller arm up and down as at the left, the pitch of the propeller and consequently the speed of the boat may be varied. Also, as at the extreme right, the propeller blades are in "reverse" when handle is in position 5. Neutral position is obtained at 4

heavily finned one-piece muffler and under-water exhaust, one-piece crankcase, and new cylinder construction of hot-head type are outstanding features.

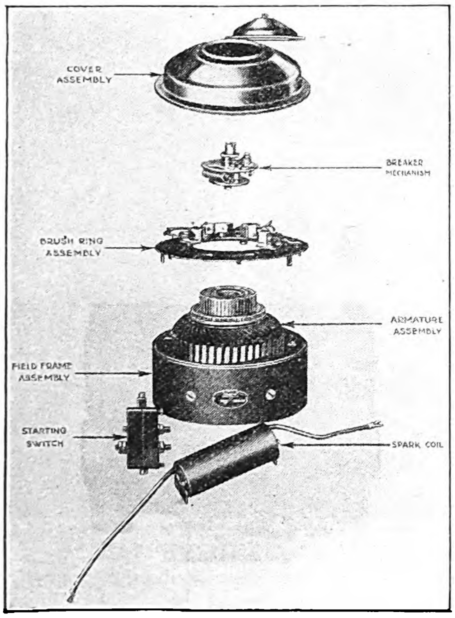
Because the two-cycle motor has simplicity, cheapness, compactness, inherent light weight, ability to run at any angle, ease of lubrication to a degree, lack of moving parts, and steady running, the disadvantages have been overlooked, even though these are rather numerous. We might list, for instance: hard starting, lack of low-speed control, temperamental control and operation, lack of thorough lubrication, concentration of heat about the exhaust ports, enormous fuel and oil consumption, uneven piston heat temperatures, spark plug difficulties, poor carburation because of low depression in the Venturi and bad fuel caused by oil being mixed with the gas.

When we consider this rather formidable-looking list there would seem to be little wonder that a four-cycle outboard motor is being attempted which does away with most of these disadvantages and contributes many additional advantages. The Cross radial five-cylinder motor, built by the Cross Gear and Engine Company of Detroit, is the outstanding example of efforts along this line. This motor is said to develop 50 horsepower at 4000 r.p.m.



ELECTRIC STARTER

Above: The starter-generator assembled. *Below:* The unit taken apart to show the components. See description in text



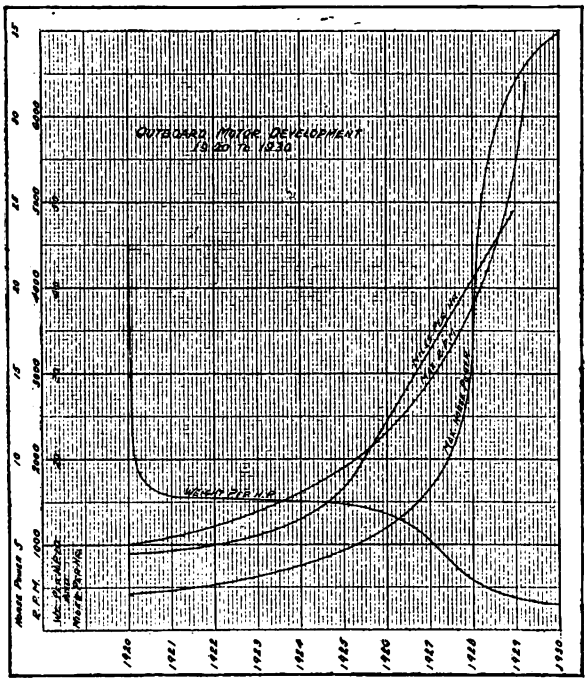
Probably the greatest development, and one which may be due to revolutionize the outboard motor industry, is the new electric self-starter and generator for outboard installation. The Type KB starter-generator, built by the Owen-Dyneto Corporation, is a six-pole, compound-wound, single-unit machine equipped with battery-charge regulator. It is made in two designs, one for use in a six-volt circuit, the other for use in a 12-volt circuit, and is composed of four main sub-assemblies, field frame assembly: armature assembly, brush ring assembly and cover assembly.

The field frame assembly is mounted on top of the engine crankcase and consists of a field frame made from a single steel stamping, six removable laminated pole pieces, and two field windings—a series and a shunt—both containing six coils connected in series.

THE armature assembly is of conventional mechanical construction, and is of large diameter with thin stack to accomplish flywheel effect, for it is keyed direct to the engine crankshaft, and serves as the flywheel for the outboard motor. It is of the two-circuit series type, and weighs approximately 16 pounds.

The brush ring assembly is a steel stamping formed for rigidity and is centered in the field frame by six small tongues. The ring mounts the Dyneto battery-charge regulator and three brush holders: two for the main brushes and one for the control brush. The main brush holders are securely riveted to the ring, but the control brush holder is movable, to allow setting of the charging rate by movement of the control brush. The battery-charge regulator automatically regulates the charging rate as the voltage condition of the battery warrants.

When the starting switch is turned to the "on" position, the starter-generator first operates as a motor and spins the engine at from 400 to 450 r.p.m. After the engine begins to run under its own power, at speeds above approximately 1000 r.p.m. with the six-volt unit, and above approximately 1500 r.p.m. with the 12-volt unit, the machine automatically operates as a generator and charges the battery; at lower speeds it operates as a motor. The power available from the starter motor increases as the speed is diminished and absolutely prevents the motor from stalling.



The curves on the accompaning chart indicate what have been the influencing factors in the outboard motor industry in the last ten years, and may serve as a basis for prediction.

It would appear that weight-per-horsepower reduction could not continue to drop off at its present rate. Revolutions will probably continue to mount higher and higher and this, of course, will mean more horsepower, and consequently greater speed.

The obvious advantages of the four-cycle engine will help in the development of this type of outboard but the question may be raised as to whether the more delicate mechanism, with its multiplicity of parts, will stand the abuse the public is now giving the two-cycle outboard motor. The question also arises as to whether the boating public will be willing to pay for the much more expensive four-cycle type of motor, even with the great saving in operating cost.

IT seems reasonable to predict that outboard motors will be developed with an increased number of cylinders. It is possible that something will be done along the line of the German Junkers opposed-piston two-cycle Diesel engine.

Just what is in the future it is hard to say. But one thing is certain: the outboard motor is here to stay. It is filling an increasingly large place in the outdoor life of America and, like the "flivver" or the motorcycle, may develop from a hobby to a necessity.

The outboard motor will soon be made so fool-proof that anyone will be able to drive it. And, just as the automobile is today, it will be operated by many a man, woman, and youth who knows little or nothing about what makes the wheels go round.

Michelson

An Appreciation of America's Foremost Optical Physicist[*]

By PROFESSOR WILLIAM H. CREW[†]
Physicist, United States Naval Research Laboratory

IT is my purpose to sketch briefly the scientific achievements of the man whose first researches were carried out at the United States Naval Academy over 50 years ago and who now, at the age of 76, has set for himself three tasks which to others, even in his own field, seem almost Herculean. And furthermore, it will be interesting to note the far-reaching significance and influence on contemporary thought in physics that may be attributed to these major researches of Professor Michelson.

More than three quarters of a century have passed since Albert Abraham Michelson was born in a small village, Strelno, just 40 miles from the birthplace of Copernicus and then, in 1852, a part of Germany, but now within the borders of Poland. But during practically all of that time he has lived in America as a citizen of the United States.

AT the age of 16 he was appointed by President Grant as a midshipman at the United States Naval Academy and was graduated four years later in the class of 1873, or as then designated, "Date of '69." One reads with interest Admiral Fiske's account[1] of his boxing tilt with Michelson when they were schoolmates at the Naval Academy, a fight from which Fiske emerged in rather the worse condition. However, upon the admiral's own admission, his admiration of Michelson the "pugilist" is surpassed by his admiration of Michelson the physicist. We also learn from Admiral Fiske that an innate interest in physical experiment and evidence of unusual ingenuity were observed in Michelson during his years as midshipman; although Admiral Worden,[2] so it is alleged, was a bit concerned for the future of one who devoted so much of his time to extra-curricular experiments. Humanity may be thankful for the influence that then permitted the individual to follow his true bent undeviated by the rigid restraints of a military régime.

Not very long after graduating, Michelson was detailed to the Naval Academy (1875-1879) as an instructor in mathematics and physics, and at that time he outlined in a simple, characteristic half page in *Nature*[3] an improved method of determining the velocity of light.

Before the Navy had established a post-graduate school, certain officers were selected and sent abroad for graduate study, and in this line of duty Michelson spent the years 1880 to 1882 in Berlin, Heidelberg, and Paris; and in the following year he resigned from the Navy to enter upon an academic career. It is interesting to note that 36 years later (1918) he was again on the Navy Register, enrolled in the United States Naval Reserve Force as a specialist. I recall with pleasure making a visit during the War to the roof of his laboratory at the University of Chicago where he was developing an optical range finder for use by Navy vessels.

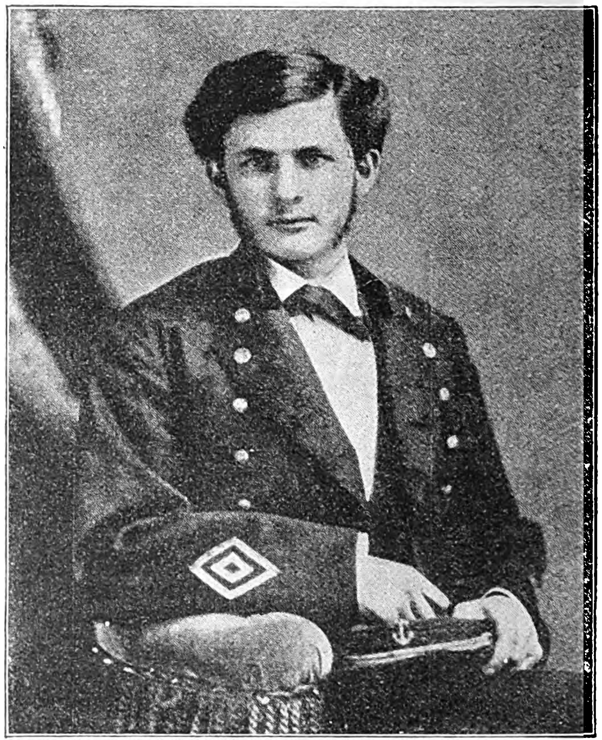
FOLLOWING his early Navy career, Michelson became a professor of physics first at the Case School of Applied Science at Cleveland and later at Clark University at Worcester and finally, since 1892, at the University of Chicago, to which he was called as head of the Department of Physics.

The recognition of Professor Michelson as a scholar and an investigator of the highest order is borne out by the many honors, both foreign and domestic, of which he has been the recipient. His awards, such as the Rumford Medal, the Copley Medal, and so on, are too numerous to mention here, but one cannot resist pointing particularly to the fact that Professor Michelson was the first American physicist to receive the Nobel Prize Award.

Although for nearly 40 years Professor Michelson has made his home in Chicago, much of his time has been recently spent in California where, even during the past summers, he has been repeating the ether-drift and velocity-of-light experiments, always with new and improved technique, increased precision, and with convincing results. It is thus that we learn of Michelson, at 77, outlining three new tasks which are in brief: the re-determination of the velocity of light; a refinement of the measurement of the diameters of stars; and another search for a possible ether-drift.

It may be of interest to review very briefly the principle researches of Professor Michelson; and then to consider their bearing and influence on current physical thought.

PROBABLY the first serious effort to find out whether or not the velocity of light is finite was made by Galileo; but the crudeness of his experiments left him with no evidence that the passage of light from one point to another was not instantaneous. In 1676 the Danish astronomer, Römer, pointed out that inequalities of the time intervals between eclipses of Jupiter by one of its satellites may be accounted for by the varying distance of the earth from that planet due to the periodic motion of the earth about the sun and at the same time assuming a finite velocity of light of about 192,000 miles per second. Subsequently, short-range determinations of this velocity were made, and noteworthy were the toothed-wheel experiments of Fizeau (1849) and Cornu (1874), and at the same time the revolving-mirror experiment of Foucault.



Courtesy *Journal of the Optical Society of America* and *Review of Scientific Instruments.*

MICHELSON AS A MIDSHIPMAN

His first determination of the velocity of light (*Scientific American Supplement*, Sept. 13, 1879) was made about five years later when he was a young teacher

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[*] Reprinted by courtesy of *United States Naval Institute Proceedings.*

[†] See "Among Our Contributors," page 341.

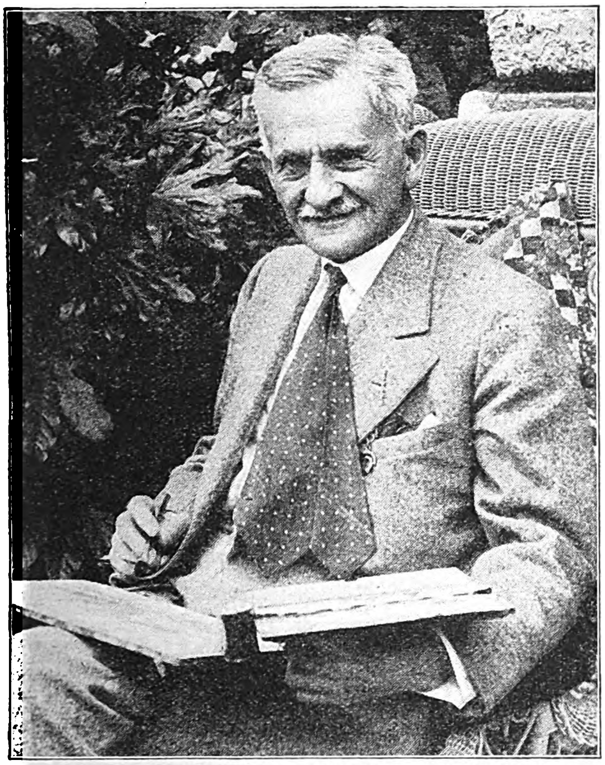
[1] Fiske, "*From Midshipman to Rear Admiral,*" page 15.

[2] Admiral Worden was then superintendent of the United States Naval Academy, and formerly was commanding officer of the ironclad *Monitor.*

[3] *Nature,* 18, 195 (1878).

The method of determination of the velocity of light as proposed by Michelson in 1878 was that of the revolving mirror, driven by an air blast and calibrated against a tuning fork of accurately known frequency. The apparatus for this experiment was set up along the sea wall of the Naval Academy at Annapolis, a position which is now occupied by the tennis courts. Here an unobstructed path of 500 feet between mirrors was obtainable. The results of this experiment were published in the *Proceedings of the American Association for Advancement of Science*[4] in 1878, and the best value obtained, 186,508 miles per second, was a mean of ten independent observations "made under difficulties, and with apparatus adapted from material found in the laboratory of the Naval School."

In the years subsequent to 1878, improvements in the measurements of the two fundamental factors in this experiment, the *distance* interval and the *time* interval of the passage of the light beam, have been made under the direction of Professor Michelson. The distance between mirrors in the 1924 determination[5] was about 22 miles, accurately measured for the purpose by the United States Coast and Geodetic Survey, between Mount Wilson and Mount San Antonio in California. The rotating mirror in this case was in the form of an octagonal prism, each face being an optical flat, and it functioned also as a timer by virtue of its calibration with a standardized tuning fork. This experiment has given what is by all odds the most trustworthy value of the velocity of light, namely, 186,359 miles per second in air.



PROF. MICHELSON MAKING A SKETCH

Water color sketching is his recreation. So also is the refinement of accuracy in the determination of "*v*"

In the early eighties, when in Germany, Professor Michelson's interests were first directed to the "Aberration Question," which in short was this: "Does the medium, usually called 'ether,' in which light waves are propagated through empty space, remain fixed with respect to the stellar universe while the earth moves freely through it; or does the earth drag the ether with it, as a rapidly moving vehicle carries a quantity of air with it into its motion?"

A study of this question, both experimental and theoretical, has led the way to a vastly greater comprehension of the universe in which we live than has, perhaps, ever been realized before. In particular, the results of the now famous "Michelson and Morley Ether-Drift Experiment," carried out at Cleveland in 1887, gave the initial impetus to the theory of relativity. Let us consider this far-reaching experiment.

As early as 1880, Professor Michelson conceived the idea of making a direct test for ether-drift by sending simultaneously two beams of light waves out from a point in two mutually perpendicular directions, and by means of mirrors reflecting each back along its own path to the starting point. If during such an experiment there is no drift of the ether, the two beams of light waves will arrive together in step; but, on the other hand, if there is a drift of the ether along the path of one of the light beams, then the two sets of waves will arrive somewhat out of step. To measure such a possible "out-of-stepness" Michelson invented (1882) a simple but tremendously ingenious interferometer, an instrument which has since found application in many and various types of optical measurements.

His first effort to detect ether-drift with an interferometer was in Helmholtz' laboratory in Berlin; but here the vibrations due to city traffic made the use of this instrument impossible, and accordingly the apparatus was moved to Potsdam. The results obtained there, however, were considered inaccurate and therefore of no significance, and were disregarded.

Upon returning to America, Professor Michelson, assisted by Professor Morley, built an interferometer on a large scale at the Case School of Applied Science; and there they made the surprising observation that the light waves reflected back along the two perpendicular paths of the interferometer met one another "in step." The immediate interpretation of this was that there was *no relative motion*, that is, no drift, between the earth and the ether. This experimental observation was repeated later, and with increased precision, by Morley and Miller at Cleveland, and by Michelson at the University of Chicago and in each instance the original Michelson-Morley experiment was substantiated.

This experimental result which indicated no ether-drift was in contradiction to the supposed facts deduced from observations of aberration; and as late as 1900 Lord Kelvin, at the International Congress of Physics held in Paris, averred that the "only cloud in the clear sky of the theory of the ether was the null result of the Michelson-Morley experiment." But at about that time Lorentz, in Holland, and Fitzgerald, in Ireland, proposed an hypothesis to make compatible the results of the Michelson-Morley experiment and the earlier aberration experiments; and it was this hypothesis, now usually referred to as the Lorentz-Fitzgerald contraction hypothesis, on which Einstein founded his theory of relativity in 1905. The influences of this theory are too numerous and too profound to mention here, but suffice it to say that they have introduced entirely new and extremely interesting speculations as to the structure of atoms and in general the nature of things.

In the years 1921 to 1925 very extensive ether-drift experiments were carried out by Professor Miller at the Mount Wilson Observatory in California. Physicists the world over were astounded when Professor Miller announced an observed motion of the ether of about ten kilometers per second; for such a result was apparently in disagreement with the Michelson-Morley experiment and with the theory of relativity. Professor Miller then carefully repeated the experiment and verified this former result, but the same experiment was done independently at Mount Wilson by Dr. Roy Kennedy; who found no evidence of an ether-drift. A few years later Professor Michelson went to California and there repeated his ether-drift experiment, and in November of 1928 at Washington he announced to a very eager and attentive audience at a meeting of the Optical Society of America the result of this last and most precise experiment—no observ-

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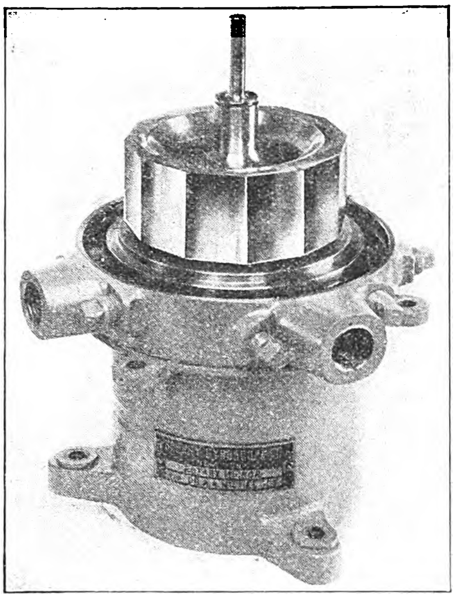
[4] This article has recently been republished in the *Scientific Monthly* for December, 1928.

[5] Michelson, *Astrophysical Journal* **60**, 260 (1924)



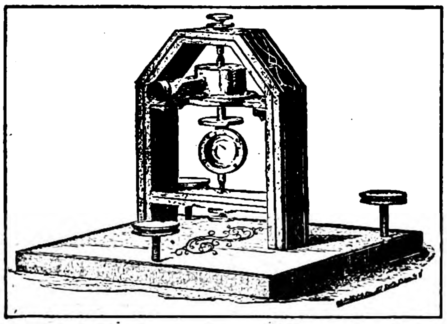
MODELS OF 1926 AND 1879

Above is the 12-sided mirror (made by the Sperry Gyroscope Co.) most recently used, and at right the simple mirror of the first determination, reproduced from the *Scientific American Supplement*, 1879

able ether-drift. The contrary results of Professor Miller's experiments, done under his keen supervision and skillful hand, still stand unexplained; but the situation, as recognized by the scientific world, is that relativity remains vindicated.

I wish to refer briefly to some of the other important achievements of Professor Michelson. I have mentioned the interferometer which was devised by him for the purpose of determining a possible ether-drift. This same instrument has found most remarkable applications in other fields of science, notably in the measurement of the distance between components of double stars and in the measurement of the diameter of the giant star Betelgeuse. In this latter instance an interferometer was mounted on the end of the 100-inch reflecting telescope at the Mount Wilson Observatory; the diameter of this great star, located in the constellation of Orion, was calculated to be 240,000,000 miles, a distance about equal to the diameter of the orbit of Mars.

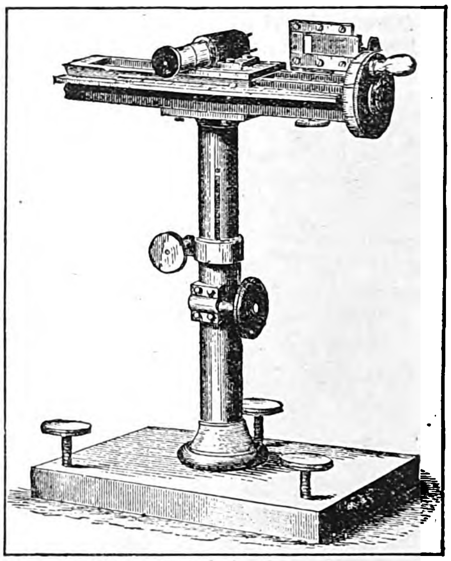
THE international standard of length is the distance between two scratches on a particular bar of platinum-iridium kept at Sèvres near Paris, and is known as the standard meter. In order to establish permanently this standard of length so that it might never be lost to mankind due to material destruction, Professor Michelson spent the first year of his appointment at the University of Chicago in Paris in determining this length in terms of the wavelength of a particular red line in the spectrum of cadmium. For this purpose again the interferometer was brought into use and a most accurate determination yielded the result that one meter is equivalent to 1,553,163.5 wavelengths of this particular red cadmium line. And now we may rest assured that even though the standard meter of Paris be destroyed by war, by vandalism, or by natural causes, it could be again reproduced to within an accuracy of at least one part in 3,000,000. It is a remarkable thing and a fortunate one that the wavelengths of the light in the spectrum of any element such as cadmium are identical the world over and probably throughout the entire universe.



From the brief résumé of Professor Michelson's achievements it may be concluded that their distinguishing feature is precision. The economic value of these experiments of precision can not be estimated in numbers but their use in promoting useful and properly directed thought is inestimable, and an interesting discussion of these uses has been given by Professor Millikan in *Science* for May 10, 1929. Certainly of greatest importance, in my mind, is the ether-drift experiment which triggered off the study of relativity, which in turn has promoted thought along the lines of atomic structure, has introduced the notion that energy is intimately related to mass, and has finally led to exceedingly interesting speculations as to the constitution of stars. Knowledge along this line certainly seems worth while in that, possibly, our future source of energy may be the stars, or, in particular, the sun.

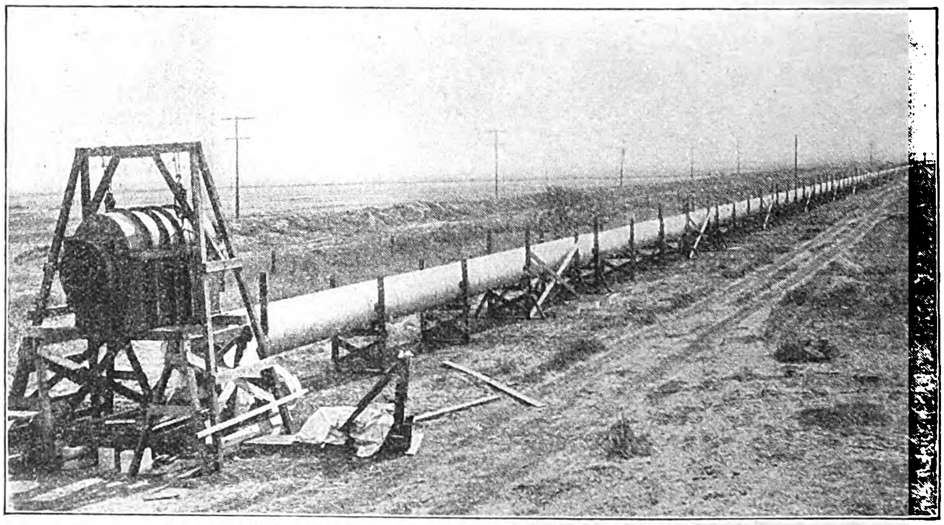
As the Copernican theory led mankind away from geocentric ideas, so has the theory of relativity led him away from egocentric ideas; that is to say, one can no longer honestly estimate velocities and accelerations with respect to himself but must also extend to other stars and even other universes the privilege of being the basis of reference. A most entertaining and illuminating discussion of this subject is to be found in Eddington's recent book, *The Nature of the Physical World.*

These valuable scientific researches in themselves stand as evidence to the skill and mental prowess of Professor A. A. Michelson as an investigator, and the United States Naval Academy may well be proud to count him as one of its graduates, but these researches are apparently not the last.



APPARATUS USED IN 1879

For measuring the deflection of the beam. Note screw head, divided circle, adjustable slit at the top, right, and eyepiece



PROFESSOR MICHELSON'S PRESENT EXPERIMENT

The 1926 determination was made on a 22-mile base line. Next an 82-mile base line was proposed but its atmospheric conditions were wrong. So Professor Michelson is now performing the experiment in a vacuum within this pipe line in Southern California

The Aerial Ferry Arrives

Operating at Frequent Intervals, Amphibions Carry Passengers on Regular Schedule

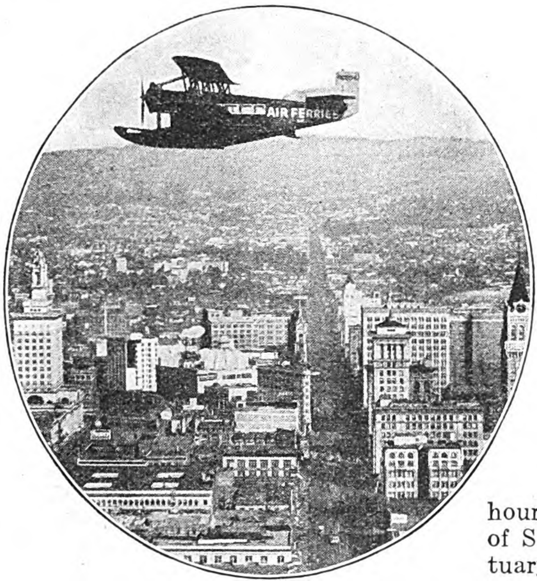
SHORT-HAUL air transportation has been tried out successfully in California between San Francisco and Oakland. The regular trip by boat and train ordinarily consumes 40 minutes, while the seven-passenger amphibion makes the trip in six minutes. The one-way fare is $1.50, but regular commuters may effect an economy by the use of scrip books. This is the shortest and most frequent air service in the world. In the first 19 days of operation the three Keystone-Loening amphibion air yachts carried 8330 passengers. Approximately 110,000 persons cross the bay daily and therefore there will always be potential patrons for the air-ferry service.

What made short-haul air service practical, however, was that Air Ferries, Ltd., brought its airplanes to the centers of business and transportation. The quick accessibility of the waterfront terminals and the amphibion equipment made it possible to turn to advantage the waters of San Francisco Bay—the same medium which has been the chief obstacle to transportation between the communities which lie inside the Golden Gate.

THE air ferries operate across the bay on a more frequent schedule than even the ferryboats, the long established means of transportation. The ferry steamers leave every 20 minutes. They debark passengers at Oakland mole, a trestle reaching far out into the bay, whence electric trains carry them through the East Bay district. By the use of air ferries, it is now possible to make the trip between the actual business centers of the two cities in approximately 18 minutes.

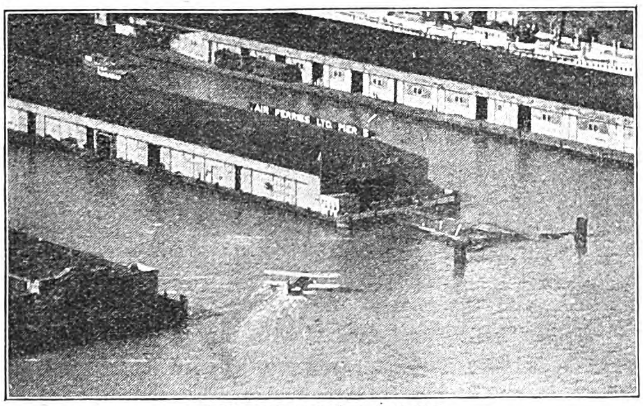
The 30,000-dollar Loening amphibions carry seven passengers and two pilots each, and cruise at a speed of 105 miles an hour. They take off from the waters of San Francisco Bay or Oakland estuary at a speed of 85 miles an hour, after an 18-second run, and have a landing speed of 55 miles an hour. They are powered with 525-horsepower Pratt and Whitney Hornets. Passengers step directly in and out of the planes, without having to travel in boats, climb ladders, or approach moving propellers. The air ferries are 34 feet 8 inches long, weigh 5900 pounds, have a wing span of 46 feet 8 inches, and can cruise 550 miles on a tankful of fuel. The gasoline consumption is about 26 gallons an hour.

Additional service will be provided soon to Vallejo, Sacramento, Stockton, and other points. The flying time to Sacramento—89 miles—will be 55 minutes. Night service is planned as soon as the necessary lighting equipment is installed.



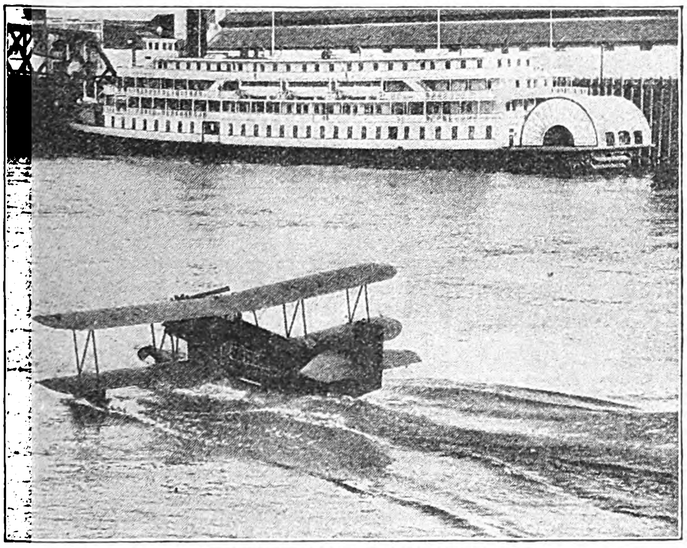
< ABOVE OAKLAND

The actual flying time between San Francisco and Oakland is six minutes



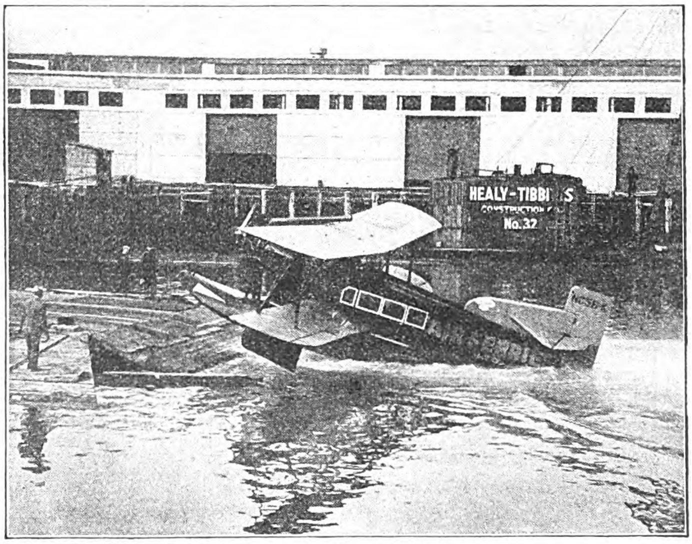
AIR VIEW OF DOCK

The amphibion is approaching the ramp where passengers will debark. The pier shed has been converted into a hangar



THE OLD AND THE NEW

In the foreground is one of the amphibion air ferrys. In the background is one of the stern-wheelers that are still in service



LIKE A DUCK

The amphibion air ferry lands on the water and taxies along the surface to a ramp up which it climbs under power of its engines

Our Air Analyzed

How Science Fights the Smoke and Dust Evils of Our Cities

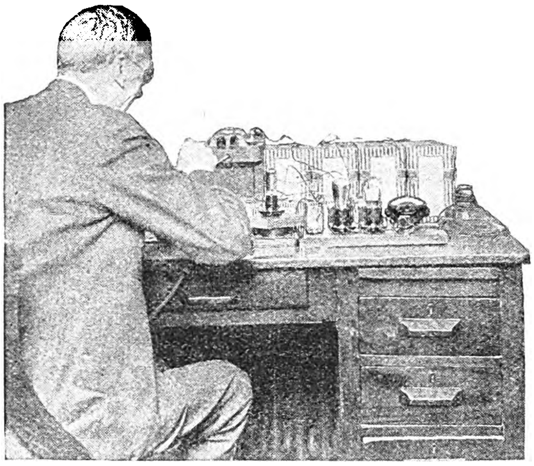


PHOTO-ELECTRIC CELL IN ACTION

Here we have H. B. Meller, head, Mellon Institute investigation, experimenting on the photo-electric cell for measuring atmospheric contamination

THE nuisance of smoke and dirt is present wherever fuel, particularly soft coal, is burned. Everyone detests smoke, but until comparatively recently not much constructive effort was made to get rid of it. Now, however, smoke abatement is a live subject in communities throughout the country. One hundred and twenty-five cities of more than 30,000 population have smoke ordinances of one form or another, more or less strictly enforced. Scientific research is being carried on in a few centers, but unfortunately the efforts as yet are not concerted and there is some unnecessary duplication.

At least one of the most outstanding organizations in the field of smoke abatement is Mellon Institute of Industrial Research in Pittsburgh, which in the past has made two surveys of conditions in Pittsburgh, and now is engaged in a third of broader scope.

The first survey was made in 1912 to 1914. Not only were determinations made of the amount of sootfall in different parts of the city, but conditions in plants making unnecessary smoke were investigated. The effects of smoke on health, on vegetation, on meteorological conditions, and on paints, building materials, and interior decorations were studied.

SAMPLES of precipitated matter collected monthly for twelve months were analyzed to determine the percentages of tar, combustible matter other than tar, and ash. The results showed that an average of about 1000 tons of solid matter was being precipitated per square mile per year in the city of Pittsburgh. Of this 10 tons was tar, about 300 tons combustible matter other than tar, and about 700 tons ash.

Following this survey, an anti-smoke ordinance was passed and has since been in effect. This ordinance prohibits dense smoke of two minutes or more duration in any period of 15 minutes, and dense smoke is considered to be equivalent to Number 3 of the Ringlemann chart. In a practical way, this may be said to be smoke of such density that it is not possible to see through the stream as it leaves the stack. This is the limit placed in the average ordinance, because with available equipment and under present operating conditions, a closer limit had not seemed feasible.

After ten years, or in 1923, it was desired to determine what results had been attained under the ordinance. Samples were collected and analyzed exactly as in the first instance. The marked difference was in the reduction of tarry matter by about two thirds. In other words, enforcement of the ordinance was successful in materially reducing prohibited dense smoke. On the other hand, the total weight of solid material deposited had increased by about 40 percent.

This brought up the question of whether the purpose behind the ordinance was being served; but since there is at present no feasible universal method of eliminating solids not visible to the naked eye and noxious gases that may accompany these solids, it did not seem advisable to suggest any changes in the law. The need for further study of the problem was indicated, however, and in 1928 Mellon Institute entered upon its third survey, this to cover many phases not previously considered.

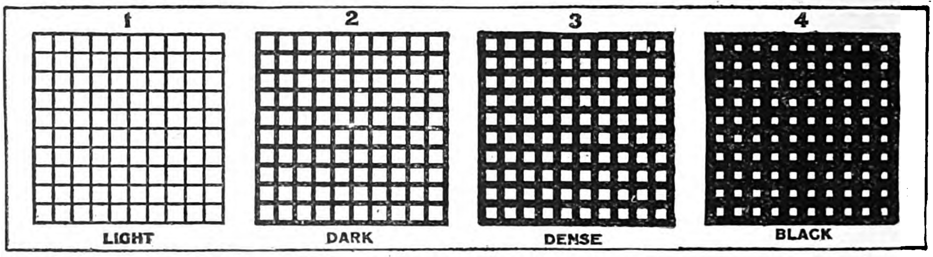
PHOTOGRAPHING DUST

Every specimen is mounted on a slide and photographed with high magnification

THE work now in progress may be grouped as follows: Determination of amounts and compositions of solid matter and gases at the sources; a study of the distribution and behavior of these solids and gases after they are introduced into the atmosphere and their effects, particularly in screening out sunshine; the possibility of developing methods to prevent such solid particles and objectionable gases from getting into the atmosphere.

In order to determine approximately the amount of contamination from stacks, it is necessary that tests be made of various kinds and sizes of boilers and furnaces, some hand-fired and some equipped with stokers, using the different kinds of fuel available in the district, with good draft and with poor draft, and with light load and heavy load; in other words, to make enough tests in a given case to say approximately what amount of pollution is being contributed. If it is desired to determine the approximate total for a city, it remains then to tabulate the plants in accordance with the grouping of the tests. These groupings may include stationary plants, locomotives, steamboats, and portable boilers such as steam shovels and hoists.

The automobile may be a greater source of contamination than is generally supposed. Aside from the products of incomplete combustion of fuel, which may enter the atmosphere



THE RINGLEMANN CHART USED IN PITTSBURGH

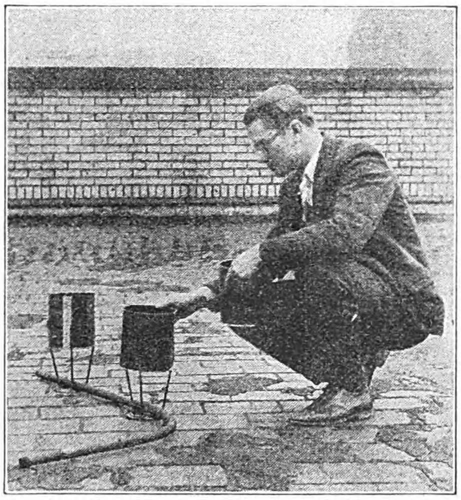
Place the chart on a line with a stack a sufficient distance from the eye to cause the lines to merge. Compare with the density of smoke under observation; if equal to or greater than 3, the smoke is a violation of the city ordinance and the operator is liable to penalty directly, there is the fact that they are emitted at a low level, and therefore are more of a nuisance and more damaging than if they entered the atmosphere at the level of the ordinary chimney. There is the added fact that the movement of the wheels and the force of the exhaust raise dirt from the street.

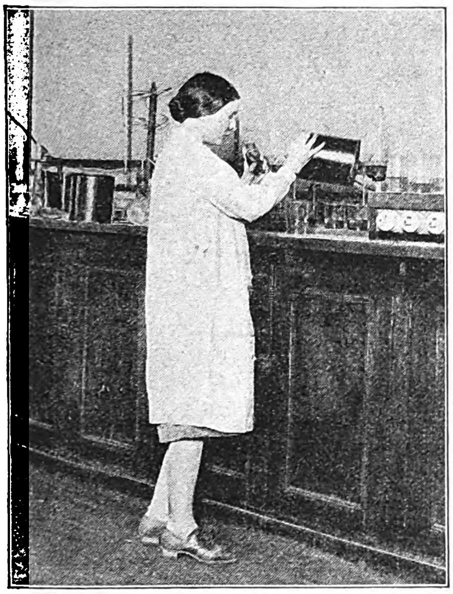
In any study of air pollution in a city, it is important to determine how much is being contributed from outside the city. Obviously, if it is desired to clean up, plants not within the city limits but close enough to add materially to the dirt must be considered.

After the solids and gases leave the stack, they are acted upon by the wind currents. Gases are diffused and the heavier solids dropped almost at once to the ground. Those of intermediate weight drift slowly downward and reach the ground at greater or lesser distances from the source. The lighter solids are retained in suspension and travel with the wind, and naturally some of the particles that drop at one wind velocity may be picked up and dropped repeatedly as that velocity varies. And, of course, the nearer to the ground, the greater the percentage of intermediate or heavier particles in suspension.

To determine the amount of material that may drop, and the amount that may be in suspension, the two following methods have been employed:

1. Containers are placed at different locations (20 stations being used at present in the city of Pittsburgh), and the amount of material that drops into the container is weighed and analyzed. In order that the effects of various weather conditions may be considered, there are two containers at each station, one being changed daily for the purpose of determining the sootfall in 24 hours, and for the additional purpose of comparison with weather conditions during that period, and the other changed each month so that there shall be enough material for accurate chemical analysis.

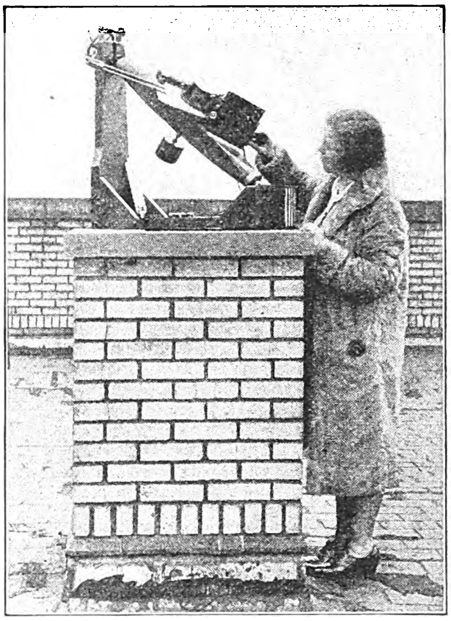




COLLECTING AND MEASURING

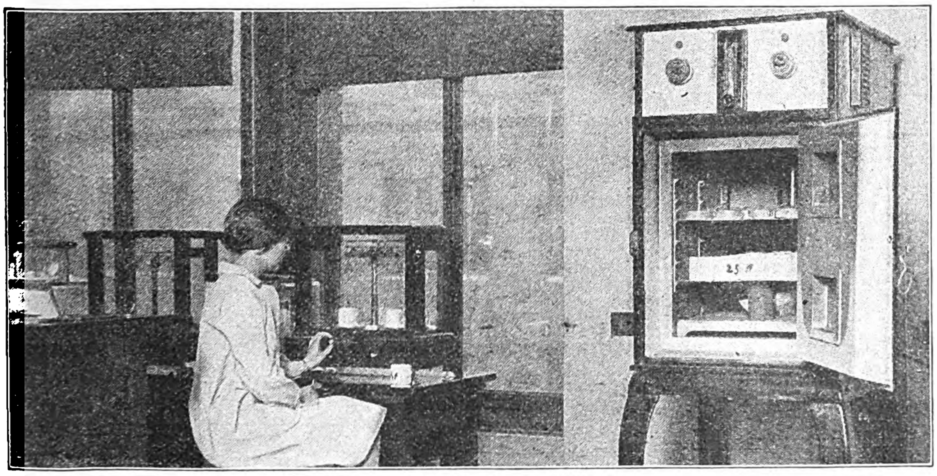
<<*Above:* At twenty stations dust is collected daily and monthly for weighing and chemical examination. *Left:* The assistant is transferring a sample from a collecting vessel to a glass beaker

2. The solid matter in suspension is sampled by means of the Owens Jet Dust Counter. The solid particles are precipitated on glass, and then this glass is mounted on a slide for study under the microscope. The number of particles is counted and the sizes are measured. Samples of this character are taken daily at strategic points, and these results also compared with the records obtained from the Weather Bureau.



THE SPECTROGRAPH

A spectrograph is used daily, if the weather permits, to measure solar radiation



WEIGHING THE DUST

After drying the samples of collected dust deposits, the weights of the latter are ascertained with accuracy. The experiments are carried on with care and the results are tabulated

While the effects of air pollution on vegetation, building materials, paints, and so forth, are fairly well understood and were studied carefully as a part of Mellon Institute's investigation of 1912 to 1914, what is considered one of the very important effects of atmospheric contamination is the reduction, through absorption and scattering by the solid particles, of the beneficial rays of the sun. To secure information concerning the extent of this screening, a quartz spectrograph is used as the basis for standardization of other instruments and other methods, and for taking, at stated intervals, photographs of the solar spectrum. Most of the work will use the photo-electric cell.

The behavior of various kinds of dusts is being studied in an air-tight dust chamber, so that it is possible to use samples having known quantities of definite kinds of solid material. The action of each of these is studied with the spectrograph and the photo-electric cell.

It is obvious that an investigation of this broad character, even assuming the possibility of securing all the data desired, would not be of maximum value unless methods were developed which would make possible the suppression of at least a considerable part of the evil. Consequently one phase of this research looks toward such development.

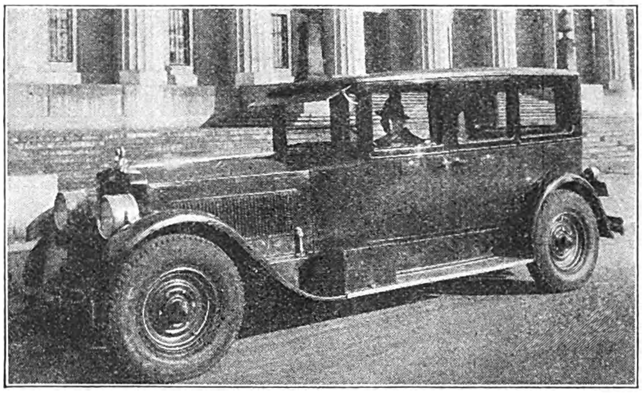
A Diesel Drives an Automobile

Stock Marine Diesel in 6000-pound Car Chassis Makes 2780 Miles on $7.72 Worth of Fuel Oil

By WILLIAM F. STURM

ONE of the most interesting engineering demonstrations of recent years, and one fraught with portent for the automotive industry, was a test trip made by a Diesel-engined automobile from Columbus, Indiana, to Indianapolis, New York, Detroit, and back to Columbus—which, for the benefit of those short on geography, is just 40 miles south of the Indiana state capital.

The trip of 2780 miles was important in that it marked the first time in America that a Diesel engine ever had been used to drive a regular automobile. The trip proved conclusively that the Diesel engine is flexible enough for automotive power plants and it opened the eyes of engineers to the possibilities of an engine that not only would perform satisfactorily in an automobile chassis but would do so on fuel oil which may be purchased at from eight to ten cents retail and which will drive a car at a speed of 55 miles an hour over all kinds of roads, hills, and detours.



THE DIESEL-ENGINED AUTOMOBILE

This car, the first in the country to be driven by a Diesel, was easily operated and its fuel economy was exceptional

THE engine used was of four cylinders, with a 4½-inch bore and a six-inch stroke, developing approximately 50 horsepower. The test trip engine was not one specially built for automobile use, but one taken from regular production for portable and marine use. The chassis was from a 1925 model of a well-known automobile, and the change was made simply by removing the automobile engine and replacing it with the Diesel. The heavy base of the Diesel was removed and fittings necessary to anchor it to the frame members of the automobile chasis were added. It was not necessary to change the hood or radiator alignment, nor to disturb the rest of the chassis in any way.

So well did the car perform, from the standpoint of flexibility, that no difference was discernible between it and the standard type of automobile. Mr. C. L. Cummins, president of the Cummins Engine Company, of Columbus, Indiana, drove the car into New York at the busiest hour of the day, between 4 and 5 P.M., and parked it at the Roosevelt Hotel. In all the larger cities he visited—New York, Philadelphia, Baltimore, Washington, Pittsburgh, and Detroit—he asked no odds of anyone in traffic. The greatest tribute to the engine performance is that until one came close enough to read the small sign, "Diesel Test Car—Cummins Engine Company," on the tire cover, he was not aware that it was not a conventional automobile.

No extensive experiments were made with the car prior to its long trip; in fact, the finishing touches were placed on the car at 9:30 in the morning and it left an hour and five minutes later for New York, making the trip in 25 hours driving time.

On the trip from Indianapolis to New York—792 miles—the fuel oil consumption was 30 gallons and the cost was $1.38. One must be honest, however, and say that this low cost was due to the fact that most of this oil was purchased at wholesale at the Cummins factory for 4 cents a gallon. But even had the top retail price of 10 cents a gallon been paid for the 30 gallons, the cost would have been only three dollars, as against 99 gallons of gasoline at a cost of $24.75 for the same chasis with a gasoline engine consuming a gallon of gas every eight miles. On the 2780-mile trip, 102 gallons of fuel were used. The cost of this was $7.72, as against a fuel cost of 86 dollars at 25 cents a gallon for a gasoline engine.

The actual average per gallon, with the car running wide open most of the time and no attempt made at fuel economy, was 27.2 miles, which includes distances between cities and mileage used within city limits in demonstrating the car. The full cost per mile was less that three mills, yet the car weighed 6000 pounds.

"We made the trip merely to demonstrate that the Diesel engine, as it is made today for marine and portable use, can be used successfully in an automobile," Mr. Cummins said. "I had listened so long to the statements that a Diesel is not flexible that I decided to demonstrate the falsity of the statement, at least so far as our product is concerned. The engine we used was not an automobile engine at all. But even without being especially adapted to automobile use, it met the occasion surprisingly well. We are certain that development can successfully meet the service conditions met with in trucks, buses, tractors, and similar services. It can be adapted to passenger car use—particularly for export—as easily as to trucks and buses.

"HOWEVER, the refinement of the motor, the path to passenger car use, lies through the truck field, simply because the matter of weight is not so vital in the truck and bus field as in the passenger-car field. I would like to make this plain—that the marine Diesel is entirely too heavy for even the ocntemplation of its use without refinements in the passenger car."

The matter of automotive adaptation is only one of engineering the engine to the problem at hand. When this is done, Mr. Cummins says that instead of 28 pounds per horsepower the weight can be reduced without injuring the life of the engine and its performance so that the automotive engine weight will not exceed 10 pounds per horsepower. This compares favorably with the average automobile engine of today.

The Diesel develops its power at low engine speeds, as evidenced by the engine used in the test trip. It was equipped with a governor which took the engine away from the driver at 1300 revolutions a minute, yet the car ran perfectly at a speed of 55 miles an hour. Further, one might expect the motor to vibrate considerably at low speeds, yet in the hundreds of miles the writer rode, he found its vibration no worse than any four-cylinder engine of its size. As the speed increased and 15 to 20 miles was reached, the engine smoothed out and ran as smoothly and as quietly as any gasoline engine. Its acceleration at 20 to 50 miles an hour was surprising, especially in view of the 2½ to 1 gear which was used in the car, instead of the 4.69 to 1 used with the original eight-cylinder engine.

The engine was started with a 12-volt motor-generator which, after starting the engine, becomes a generator to re-charge the battery. By a turn of a lever on the dash, the compression in the cylinders was released while the starter turned the engine over. After 10 or 12 revolutions of the motor to get up speed, the compression-release lever was turned to re-establish compression, and the momentum engendered started the engine instantly and as easily as the normal car starts. There are no carbureter and carburation problems on a Diesel. If the oil in the cylinder walls is loose enough to permit the motor to turn over, that is all that is asked. Whether the atmosphere is 40 degrees above zero or 40 degrees below makes no difference to a Diesel. The car was left out on a parking lot at Pittsburgh for two nights at zero weather and it responded instantly after standing 13 hours. On the compression stroke the air charge becomes heated to approximately 1000 degrees, Fahrenheit, and away she goes.

IT may interest the lay public to know that, with the exception of the firing by heat induced by compression, and injection of the fuel into the explosion chamber thus heated, the four cycles or strokes are exactly the same as in the standard type of automobile engine. The engine which was used has neither spark plugs nor any other type of spark ignition and no carbureter. In place of plugs, it depends on heat generated by compression of the air charge in the cylinder to ignite the fuel. In the gasoline engine the charge consists of gasoline vapor and air mixed; in the Cummins engine pure air only is drawn into the cylinders. On the compression stroke this air is compressed to 500 pounds per square inch, which generates a heat of approximately 1000 degrees, Fahrenheit. While the air is at its highest compression and temperature, the fuel (in a gaseous state) is injected into the explosion chamber by suitable mechanism. On contact with the heated air it ignites and burns progressively, instead of explosively, as in the gasoline engine, and creates the power stroke of the engine.

Mr. Cummins says his engine differs from the conventional type of Diesel because in the latter the solid fuel is injected at pressures varying from 3000 to 10,000 pounds, and as considerable time, comparatively, is required to gasify the cold, wet fuel, it is injected considerably ahead of the top center stroke of the piston, which results in heavy explosive pressures in the cylinder, making extremely heavy moving parts mandatory to withstand the strain.

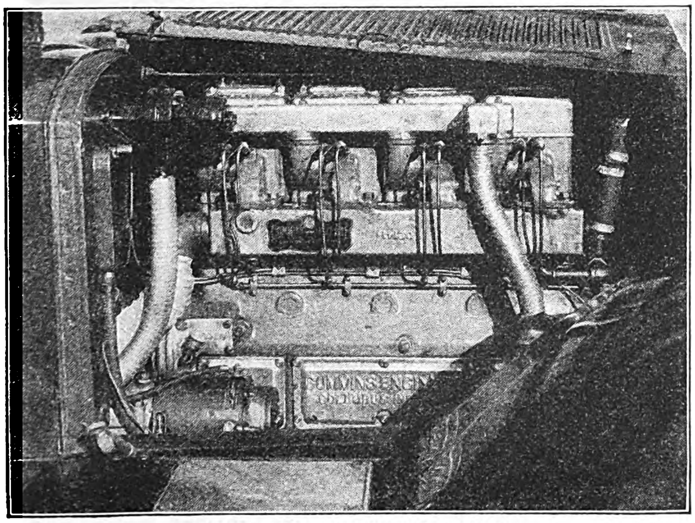
In the Cummins engine, the fuel is pre-heated by circulating it around through an annular space between two members of the injection plunger chamber. Fuel stands in this annular space through three cycles of the engine, namely, the compression stroke, the working stroke, and the exhaust stroke. At the beginning of the suction stroke, this pre-heated charge is forced out of the annular space into a small conical chamber, where it stands over the small distributing nozzles which lead out into the combustion chamber. A plunger operating in this chamber is slowly retracted at the time the fuel is delivered into the chamber, which prevents any of the fuel being forced out into the main combustion chamber. On the compression stroke, the final preparation of the fuel is completed. The highly compressed air charge from the main cylinder is forced through the nozzles up through this pool of previously heated fuel, thus cracking and gasifying the hot charge of wet fuel. When the piston is at approximately top center, the plunger is suddenly depressed, thus driving the rich gaseous charge of fuel out into the hot compressed air charge in the main cylinder, where ignition takes place and combustion follows.

Previous practice in Diesels has called for a plunger or valve for each cylinder, and it has been found impossible to keep these accurately adjusted to measure the proper amount of fuel under the extreme pressures under which the fuel is fed. In the Cummins engine, one plunger measures and delivers the fuel to all injectors, whether one or six, at a pressure of only 50 pounds. A distributor distributes this measured charge from the common plunger to the proper injector, thus eliminating any possibility of unequal distribution of fuel.

The entire fuel system may thus be divided into three divisions, the first of which covers the measuring of the fuel charge and delivering it to the injectors. The second covers the gasifying of the charge in the injectors and injection into the combustion chambers. The third division covers a means of obtaining the necessary turbulence or mixing of the combustion charge with the air in the cylinders.

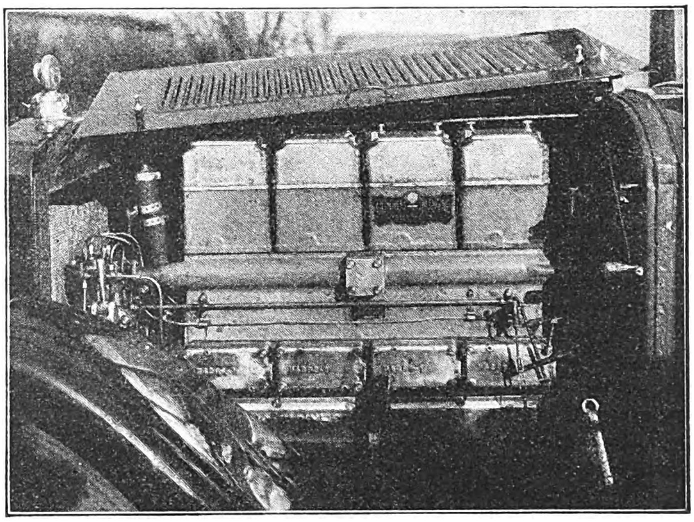
BECAUSE of this advanced preparation of fuel and the method of measuring, the Cummins engine will handle any kind of fuel from crankcase slop to gasoline.

The plan of the manufacturers is to adapt this engine to truck use first, by experiments under actual truck working conditions. Bus application will come next, with the passenger car last. This means that the engine should be perfected for trucks within a year or 18 months and that if the passenger car adaption comes, it will be a matter of four or five years before it is perfected.



FUEL OIL DISTRIBUTION

Right side of Diesel showing fuel lines. Right-hand lines carry oil to cylinders; left-hand lines carry excess oil back to reservoir



THE FOUR CYLINDERS

Left side of the Diesel showing the fuel distributing pump directly behind radiator. The rubber hose forward carries cooling water

Edison's Rubber

What Mr. Edison Is Doing in His Attempt to Develop an American Wartime, Emergency Rubber Industry in the South

By G. H. DACY

EDISON IN FLORIDA

The picture was snapped during Mr. Edison's inspection of his rubber garden

Mr. Edison Discloses

UNITED STATES Patent Number 1740079, December 17, 1929 (obtainable from Commissioner of Patents, Washington, D. C., ten cents), reveals Mr. Edison's method for extracting rubber from goldenrod and other plants. This method is described by the *India Rubber World* (New York, February 1) as "a modification of the process regularly employed for the extraction of rubber from guayule shrub." (See also page 332, April number, SCIENTIFIC AMERICAN.) In an article entitled "Guayule Rubber" Dr. D. T. MacDougal, Corresponding Editor of the SCIENTIFIC AMERICAN, outlined the guayule process. This was in our number for July, 1928.
—*The Editor.*

DOWN near the tip of our southernmost state where the climate is sub-tropical, Thomas A. Edison has dedicated his early octogenarian years to a problem which he says is of great significance and which may hatch out a successful future rubber-raising industry in the south. Mr. Edison seeks to discover an adaptable rubber plant which will grow prolifically in Florida and other warm-climate states and which may be produced on a commercial scale as a potential wartime necessity—and as a possible billion-dollar industry.

What Mr. Edison has sought from the start of his extensive experiments is plants that would prove suitable for rubber latex production as *emergency* materials. He has denied that he is seeking new sources of commercial rubber which would rival the trees of the tropics that now produce the world's supply of commercial rubber. Thomas Edison is, however, a genius at incubating apparent impossibilities into actuality.

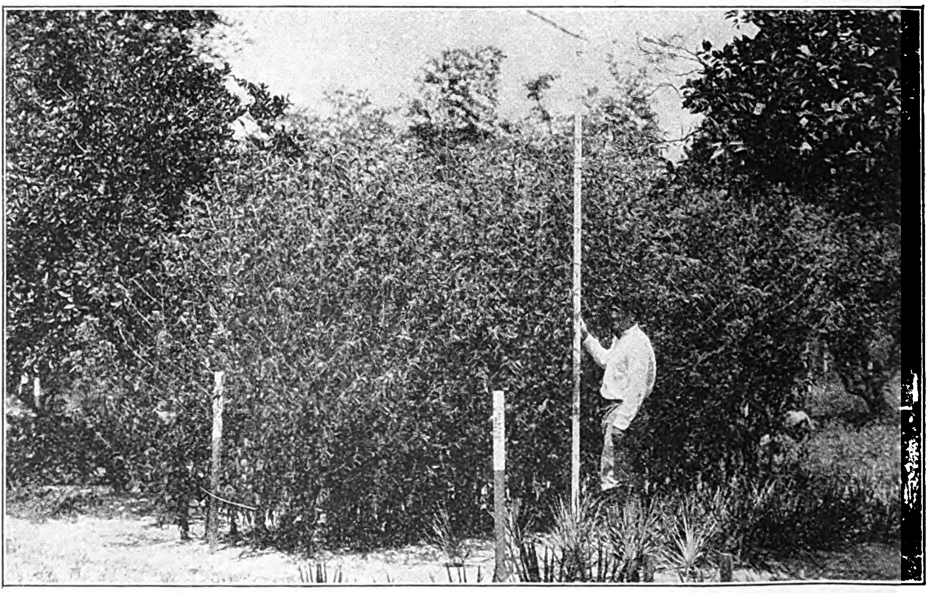
In Edison's ten-acre experimental garden directly opposite his winter home at Fort Myers, Florida, 4000 different varieties of tropical and semi-tropical plants are being grown under the careful culture of experts whom he employs to sift all secrets from American rubber raising. After several years of garden tests Mr. Edison has already demonstrated that at least 1200 of these plants which are able to thrive in Florida will yield good rubber latex.

Like the government botanists and agronomists at Washington who try out the possibilities of new plants imported from all corners of the world in the national quest for more foods for man and animals, Mr. Edison is adverse to publishing his rubber research data until he finds what he is after—or proves conclusively that such plants can not be grown in the United States. He reports that it will involve four more years of intensive technical investigation to ascertain all the answers to the riddle which now occupies his full attention.

AFTER two years of thorough tests, he has eliminated all foreign and imported plants from the research roster, including the notorious *Madagascarensis*. For several months, it looked as though *Madagascarensis* would solve the stubborn secret, but subsequent experiments proved it unworthy. The current experiments are centralized on 1200 plants which either grow wild or are cultivated for ornamental purpose in the south. Most of these are tender tropical plants which can be grown successfully only in such frost-free regions as southern Florida and southern California.

The Edison herbarium at Fort Myers is a rambling structure of concrete in which the experimental specimens of plant life are dried, mounted, identified scientifically, and filed away in spacious fireproof vaults. Propagating material taken from the most promising varieties are planted in three separate propagating gardens, one at Fort Myers, another at Oneco, Florida, and the third at Orange, New Jersey, where Mr. Edison carries on his personal rubber studies during the summer months.

Many of these plants are catalogued in technical nomenclature as weeds, but some of these "weeds" have produced remarkable yields of rubber latex which has proved durable and qualified for specialized uses when manufactured into test samples of rubber. This multiplicity of experimental plants is grown in carefully identified concrete-bordered plots, each of which is four by seven feet in size. The visitor who gains admission to the Florida gardens—and only a few people are admitted, because souvenir seekers have despoiled valuable material—may well imagine himself in some state or national proving grounds of plant research, for that is what the large garden



ONE OF THE PLANTS UNDER INVESTIGATION

Many common plants contain rubber latex, but the plant selected for culture must also meet practical and economical requirements. It must be suited to machine harvesting looks like. Accurate records are kept on the latex production during the plant growing period, and special cutting tests are made to ascertain the best seasons of harvest for the various plants.

The experimental plants are cut by hand and subsequently the harvested material, consisting of stems, leaves, and branches, are run through powerful presses in order to extract all the latex which they contain. Each specimen is analyzed and then is "manufactured" under laboratory conditions into small samples of research rubber. These rubber samples are subjected to a number of critical tests to determine their durability, quality, and suitability for the wide variety of uses to which the product would be put during times of war or peace.

The Florida laboratory, which is manned by a corps of eight scientists employed by Mr. Edison, is equipped with a battery of distillation retorts so that 36 distillation tests of latex specimens can be run simultaneously. The other equipment is complete for the rubber investigations now in progress. Mr. Edison's aides remain at Fort Myers throughout the year and during the summer carry on communication with their "chief" by correspondence, telegraph, and telephone.

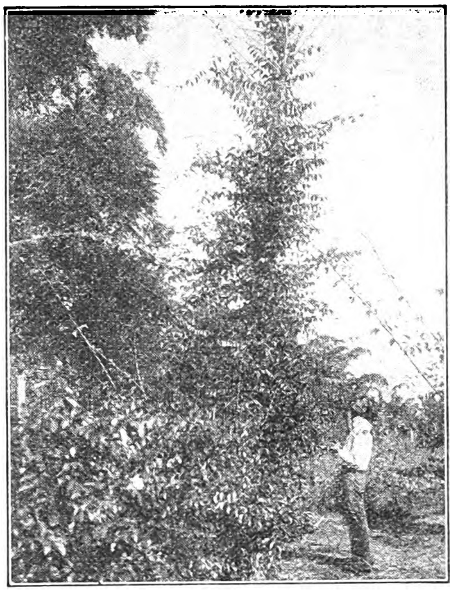
HENRY FORD, who owns and operates a 3200-acre plantation farther north near Savannah, Georgia, has offered the use of as much of this land as is required by his friend Mr. Edison for later field tests of those rubber producing plants which prove to have commercial possibilities and which can be grown that far north.* Mr. Ford has also volunteered the services of his mechanical experts and the use of his shops for the development of special harvesting and milling machinery for the transformation of the field crops into finished rubber products. Harvey S. Firestone, the tire manufacturer, is also co-operating with Mr. Edison in these rubber research investigations.

"I believe," said Mr. Edison in discussing the rubber experiments which now monopolize his waking hours, "that those states bordering the Gulf of Mexico can produce plant rubber with profit to the farmer in case of future war prices, and it may be possible potentially to grow rubber in those sections which will compete with the tropics even on a peacetime basis.

"The chemical development of synthetic rubber has no future whatever when plant rubber is quoted at about $.23 a pound," he continued. "I believe that the manufacture of rubber will be extended in the years to come to a point where it will be employed in the paving and repair of highways. Short sections of test roads made of rubber have now been in service in Scotland for five years with practical success.

"I HAVE found 1200 plants adaptable for culture in Florida which will produce rubber and in my advanced experiments I will cultivate 40 of these on a large scale. I hope to find a plant which may be cultivated successfully in southern Florida so that it will produce an emergency crop of rubber 12 months after planting."

The mechanical puzzles associated with the harvest of rubber plants and the extraction of their latex are not as complicated as they might appear to the layman. The shrub or bush which produces the milky latex will be cut with special tractor-operated mowers. The blades of these mowing machines will be adjustable for cutting the green growth of varying height and size. The arrangement will be such that the harvested twigs and branches will be delivered by special conveyor to wagons and motor trucks driven alongside the mower during the harvest operations. The harvested material will be hauled to powerful expressors which will extract all of the latex from the plant.

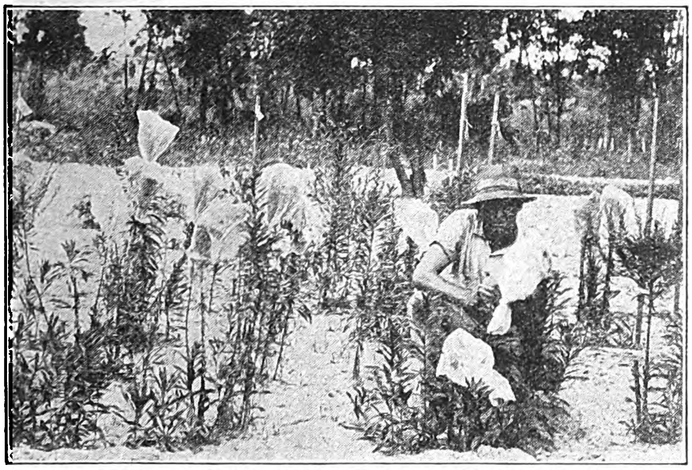


IT DID NOT MAKE GOOD

The wild plant from Madagascar which is not all it was "cracked up" to be

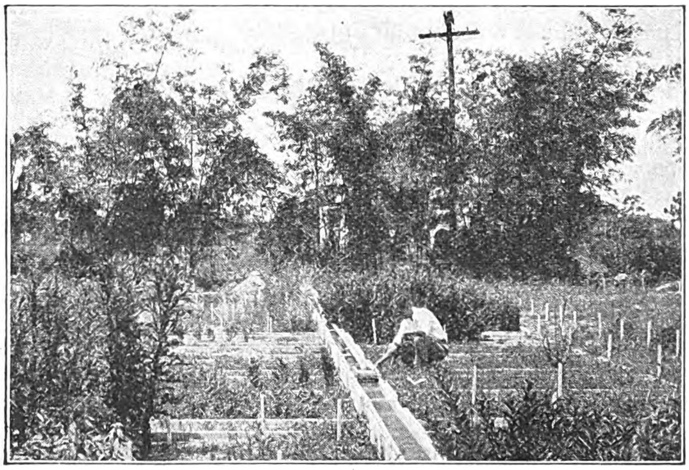
Mr. Edison has given a roving commission to five traveling botanists and plant hunters to scour the Gulf Coast States and procure specimens of all the rubber-producing plants of that area. This quintet of camp-car rovers has roamed highways and back roads searching for strange unidentified plants in half a dozen different states. They have traveled exclusively by motor car, carrying with them provisions, camp equipment, and miniature botanical laboratories on wheels. Their scouting trips through thousands of miles of Dixieland forests, jungles, and cultivated fields have yielded the wealth of experimental material which Mr. Edison is now utilizing intensively.

Mr. Edison has centralized his experiments in southern Florida because investigations carried on by the United States Department of Agriculture and the Department of Commerce demonstrate that region to be the best adapted for rubber production of any section in the United States.



BAGGING TO PREVENT CROSS POLLENIZATION

In plant breeding it is necessary, in order to prevent bees from cross pollenizing plants with other plants, thus depriving the test experiment of its value, to exclude the bees with netting



A FEW OF THE 1200 EDISON TEST PLOTS

When investigating the possibilities of rubber plants, Mr. Edison followed the old Edison technique: to try systematically everything under the sun, rather than sit and wait for inspiration

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* At the time of going to press, news reports state that Mr. Ford has prepared several hundred acres for planting, with the expectation of a harvest in the late summer.

"How Do They Know?"

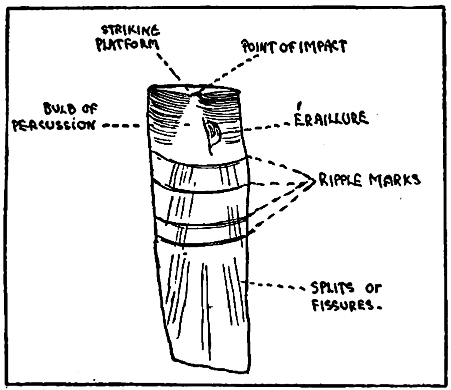
A Brief Glimpse of Some of the "Inside" Considerations Which Guide the Expert in Judging the Antiquity of Flint Implements

By J. REID MOIR

Fellow of the Royal Anthropological Institute; and Member of L' Institut International d'Anthropologie; President of the Ipswich Museum, England

IT is not so many years since the whole vast series of flint implements was divided up into two simple categories called Paleolithic and Neolithic, and prehistoric archeology was a more or less simple and straightforward subject. Now, not only has another and very important stage of ancient man's activities, the Eolithic, been added to the list, but in the case of the Paleolithic and the Neolithic phases these have been still further split up; and the process is not yet completed.

There are, however, still some archeologists of the older school who do not look with favor upon these modern methods of classification and who hold that though Paleolithic hand axes, for example, which are found in deposits of widely varying ages, must themselves be of a dissimilar antiquity, yet it is not possible to say that these implements differ from one another in the way they are made. Such critics would no doubt admit that the hand axes of early Paleolithic-Chellean times are more roughly flaked than are those of the later Acheulean period, but this admission would be qualified by the claim that while this difference exists it does not testify to any actual dissimilarity of technique in vogue in the two epochs mentioned.



All drawings by the author

FIGURE 1

A drawing of a humanly struck flake of flint, showing its various characteristics

This conclusion, however, is the outcome of neglect to make a close and enlightened study of the actual flake scars to be observed upon flint implements of different periods. When such an examination is carried out by anyone with the requisite knowledge based upon practical experience in flint flaking, it becomes at once obvious that the manner of production of flint implements differed at various epochs of the past as markedly and as certainly as did, for instance, the method of carving wood in later times. In fact, when those who are familiar with these matters are able to examine a representative series of implements of prehistoric industries the dissimilarity in technique of these is seen to be as well defined as is that between a carved oak chest of Tudor and of Stuart times.

There are, perhaps, few aspects of prehistoric archeology more fascinating that that which deals with the way in which flint implements were made, as it enables the modern investigator to realize precisely the manner in which the ancient artificer held and flaked his flint, and to understand how, usually with consummate skill, he produced the type of artifact needed.

THE importance of this recognition is further heightened when it is found that implements of the same prehistoric period, though found many hundreds of miles apart, exhibit an identical technique. But it is not possible to enter into the implications of this remarkable fact in the present article.

I am, however, anxious to bring home to readers of the SCIENTIFIC AMERICAN the reality of the dissimilarity to be observed in the method of manufacture of flint implements of different ages. It would be a matter of little difficulty to do this with the artifacts, for example, of the Chellean and the Magdalenian phases because these two industries—one belonging to the beginning and the other to the very end of Paleolithic times—differ from one another in the most obvious manner. I have, in fact, selected for examination two ovate hand axes, one of which is referable to the Chellean epoch, while the other belongs to the Acheulean which succeeded the former. Further, these two implements are very closely similar in size, form, and even in weight, for the Chellean specimen weighs 7 1/2 ounces, measures in greatest length 3 11/16 inches, and in greatest width 2 3/4 inches, while the Acheulean weighs 7 ounces, measures in greatest length 3 11/16 inches, and in greatest width 2 15/16 inches. Moreover, the Chellean example exhibits 42 flake scars while the Acheulean carries 57, and there can not, therefore, be any doubt that these two specimens are very similar to each other in several ways. Many people might regard it as impossible to demonstrate that the technique of each is different. Let us, however, examine these two implements still more closely and see what we can learn about them.

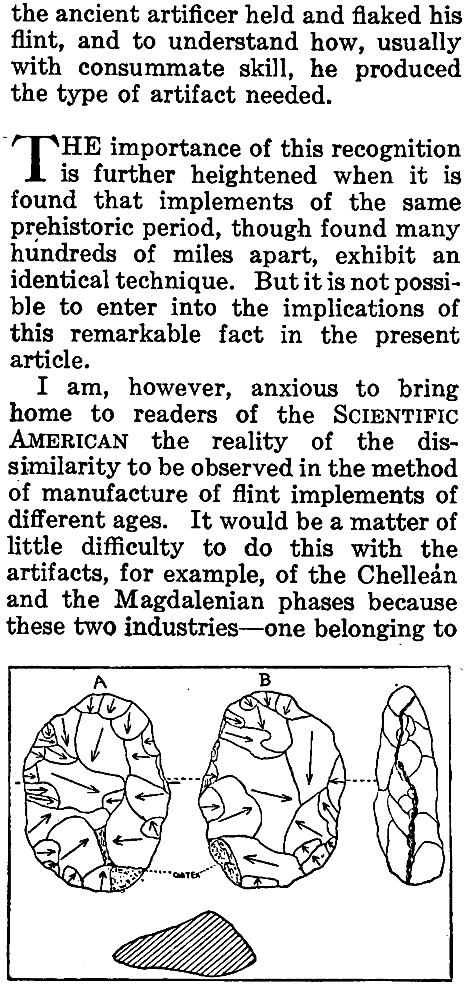


FIGURE 2, A and B

Two sides, edge, and horizontal section of a Chellean implement. Arrows show direction of the flake-removing blows

PERCUSSION FLAKING

Mr. Moir flaking an artifact, as photographed by a member of our editorial staff who visited his home in England

NOW, in order to do this it is necessary to prepare what are known as flaking diagrams of the specimens in which their general outline and that of the flake-scars is carefully drawn and arrows inserted to indicate the direction in which each flake-making blow was delivered. When a flake is struck off a flint by means of a blow, the fracture surface of the specimen usually exhibits several well-marked characteristics. For the purposes of this article it is only needful to draw attention, in Figure 1, to these characteristics, which are (a) the bulb of percussion; (b) ripple marks; and (c) the splits or fissures. The flake illustrated bears upon its fracture surface the "positive" bulb of percussion, while the flint from which it was removed exhibits a corresponding hollow known as the "negative" bulb of percussion. These hollows are often to be observed upon flint implements, while in nearly every case ripple marks and fissures are also present. As will be seen from Figure 1, the ripple marks have their concave side toward the point of impact where the flake-removing blow fell, while the fissures or splits also radiate from the same center. The recognition of these facts makes it easy, therefore, to ascertain from what direction each blow was delivered during the formation of a flint implement, and is the basis upon which the flaking diagrams accompanying this article were prepared.

If we now proceed to examine these diagrams it will be seen that the blows responsible for the formation of the Chellean ovate, Figure 2, A and B, were delivered somewhat less regularly around the periphery of the implement than is the case with the Acheulean specimen, Figure 3, A and B.

FURTHER, it is obvious that the forms of these flake scars differ in each implement, for the majority of these observable upon the Acheulean ovate tend to be long and narrow, while those exhibited by the Chellean specimen, no less definitely, tend to be short and broad. The reason for this difference is to be explained by the manner in which the ancient flint flakers held the flint while operating upon it with a hammer stone.

If it is desired to detach flakes which are long and narrow, it is necessary to hold the flint so that the fingers of the left hand are pressed against one side of the stone opposite to that upon which the blows are to fall. In Figure 4 the Acheulean ovate is held in the manner described, and the hammer stone would fall upon the flint just above the points of the fingers. The result of such manipulation will be that the detached flakes, for some reason, will run down under the fingers, and will more or less accord with their shape. Thus it is possible to say with a high degree of probability that the Acheulean man who made this particular implement actually held his flint in the manner shown in Figure 4, because the position and form of the flake scars on this specimen exactly resemble, both in form and position, those which can be produced today under the conditions described.

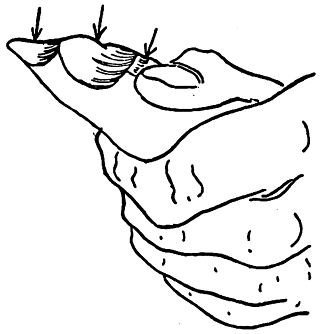


FIGURE 5

How Figure 2 was held. The arrows indicate where the blows of the hammer stone fell on the back face of the flint

When, however, it is needful to produce flake scars such as those exhibited by the Chellean ovate, an entirely different technique is adopted. In this case the flint is held firmly in the left hand, as shown in Figure 5, but the exact manner in which this is done does not matter. The hammer stone is directed first to one side of the edge and then to the other, and flakes are removed which, having no pressure of fingers or other support to influence their shape, assume a short and broad form.

The differences thus produced in the resulting implements do not, however, cease here. If the flake scars exhibited by the Chellean ovate are examined, it will be seen that while 12 of them are complete, no less than 30 are truncated or incomplete. On the other hand, in the case of the Acheulean ovate, the number of complete flake scars is 30, while 27 are truncated or incomplete. Thus it will be seen that the proportion of truncated or incomplete flake scars observable upon the Chellean ovate is very much greater than in the Acheulean example, and this is due almost entirely to the differing manners in which the two implements were made. A complete flake scar is one which has not been encroached upon by later flaking, while a truncated flake scar is one which has had its normal area reduced by the subsequent removal of other flakes.

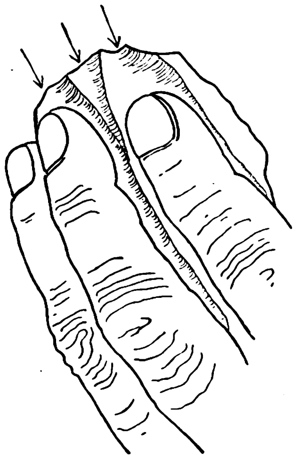


FIGURE 4

How the Acheulean flint was held. Blows fell on back side of flint, opposite the points indicated, producing long chips

Another clearly marked difference in the two implements under discussion is seen when their cutting edges are examined. In the case of the Chellean ovate, the edge is blunt and wavy, while in the Acheulean specimen, the edge is sharp and does not exhibit such a wavy outline. This dissimilarity is again traceable to the differing techniques adopted in the manufacture of the respective specimens.

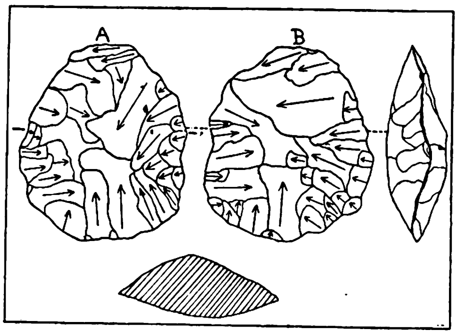


FIGURE 3, A and B

Flaking diagram of a typical implement of Acheulean age, one fourth of actual size. Arrows indicate where blows fell

It will thus be recognized that even in two implements closely resembling each other in weight, size, and the number of flake scars exhibited by each, there exist, nevertheless, fundamental differences in the specimens. These differences are the inevitable result of the manner in which the two artifacts were flaked and, being observable between most Chellean and Acheulean implements, serve to differentiate in a final manner the specimens of these two well-known prehistoric industries.

It is clear, also, that the two artifacts under examination have had different geological experiences in the past for, while the Chellean ovate is abraded and worn and exhibits upon its flake scars innumerable marks where other stones set in motion by rapidly running water have struck it, the Acheulean ovate shows few if any of such marks, and is very little abraded.

THIS difference in condition is generally to be seen between implements of Chellean and of Acheulean age from deposits of gravel both in England and as far away as Palestine. It points, unquestionably, to some drastic climatic conditions having occurred after the Chellean industrial phase, and through the researches carried out in East Anglia in England, it is now known that these conditions are to be associated with the second glacial epoch.

It is upon such lines as have been indicated in this article, that modern archeological research is moving, and in so doing is hastening the time when this study will take its place among the exact sciences. The method of examination of flint implements which I have here described is, however, but one of others which are being carried out at the present time, and these I hope to be able to describe on some future occasion.

¶ *We have on hand and expect soon to publish another of Dr. Paul R. Heyl's uniformly lucid articles, entitled "Is there an Ether?" The recent experiments of Dr. Dayton C. Miller have reopened this subject.*

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York City

A Mail Order Airplane

E. B. HEATH of Chicago has been building and flying airplanes since 1908, mostly of the low power or "flivver" variety. The opinion is often expressed that what aviation needs is a reliable, cheap airplane which can be purchased for a few hundred dollars. Perhaps the Heath *Parasol* is what is needed. At any rate, fully equipped and ready to fly, it costs less than 1000 dollars. All the parts, minus motor, can be bought for about 200 dollars. A small engine of under 30 horsepower can apparently be bought for about the same price. Blueprints can be purchased for a few dollars. The circular states that the *Parasol* can be constructed by the home-builder using a limited supply of tools!

We do not know whether it is advisable to have airplanes built at home, without Government license, even though they can be flown privately without a license. Nor does the circular from the company state whether the *Parasol* has a type certificate for the original model.

The *Parasol* has the following characteristics:

Span, 25 ft; chord, 4 ft. 6 in.; wing area 110 sq. ft.

Overall length, 16 ft. 9 in.; height overall, 5 ft. 10 in.

Weight empty, 260 lbs.; useful load, 300 lbs.

Gas capacity, 5 gallons.

High speed, 70 m. p. h.

Cruising radius, 200 miles.

Engine, Henderson converted motorcycle engine.

Our photographs give a very good idea of the trim little craft equipped as a seaplane, though otherwise not modified from its land conception. There is no reason why a good flier should not feel perfectly comfortable and happy in it. The short exhaust stacks should not be much of a handicap, in view of the low power involved. The little seaplane can be readily handled and launched by one man.

Glider Carnival Trophies

CONTINUING its traditional support of aviation, and to aid the spread of interest in one of the fundamental branches thereof, the SCIENTIFIC AMERICAN has offered a cup and second prize in Event Number Two, "Duration of Flight in the Primary Training Glider Event for Third Class Glider Pilots" to be competed for at the New York Glider Carnival in Bayside, Long Island, to be held April 25 and 26. Miss Amelia Earhart is chairman of the trophy committee and the women's events.

Considerable enthusiasm has already been aroused in this coming carnival and many prominent novices, as well as more experienced gliders will take part. The SCIENTIFIC AMERICAN will follow the developments and Professor Alexander Klemin, who is a member of the General Committee, and one of the Official Timers for the meet, will write a summary of the aeronautical advance and tell what deductions can be made therefrom.

While we would like to have more engineering information, we do think that this is a very interesting small plane which may do as much to foster aviation as the huge tri-motor at the other end of the scale.

Air Commerce in 1930

THERE is a depression in American aviation at this moment which is causing the industry much searching of heart. The article in the *Air Commerce Bulletin* which begins with the question "What is the outlook for commercial aeronautics in 1930?" is therefore very timely.

During the last three years, civil aviation has experienced tremendous growth. Air-transport planes fly on schedule almost 90,000 miles per day, yet these scheduled operations constitute only 15 percent of the total flown in the United States.

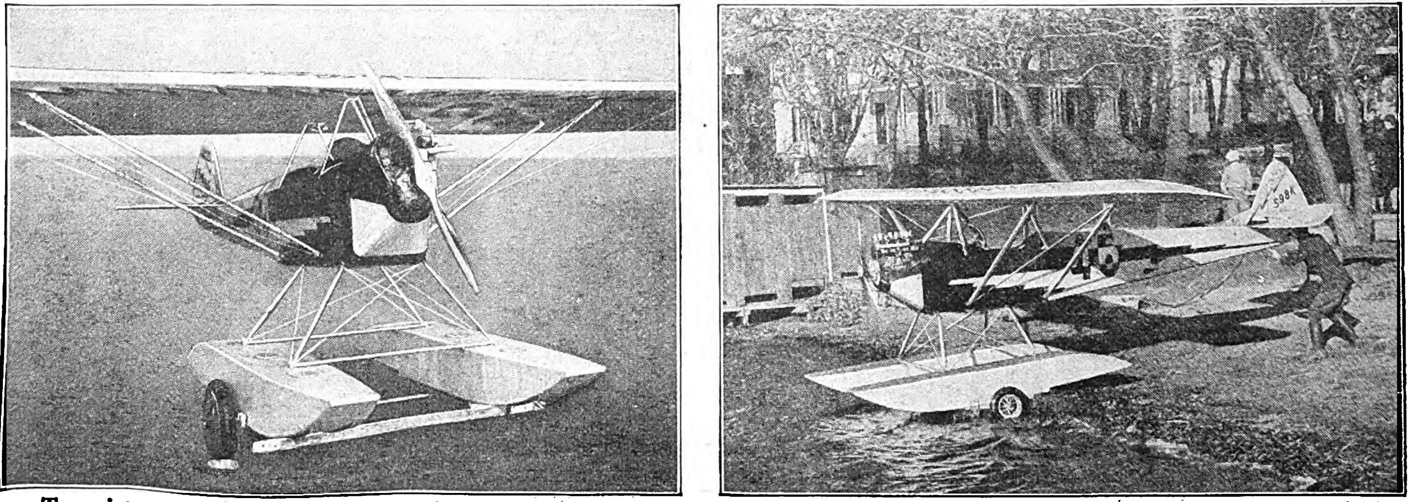
All phases of commercial aeronautics continue to grow at an average rate of 60 percent per annum. The expansion has been particularly marked during the last 18 months.

In this period of hasty development, a great number of new manufacturing facilities have been made available without reference to the consuming capacity of the market. Money has been forthcoming readily for financing, so readily in fact that marketing problems have been virtually forgotten. In air transport, on the other hand, the ample capital provided has on the whole been put wisely to work, and there is no excess. The operators have just enough money to meet the difficulties of getting passengers to fly, of perfecting their organizations, of securing safe operations, and so forth.

It is therefore mainly from the manufacturing point of view that depression has come upon us. It is to be expected that this depression will disappear in the course of a year or even less. Some of the weaker units will vanish via a receivership; others will merge; more powerful manufacturers will revise their production figures and gradually dispose of accumulated planes. While the manufacturers are retrenching at one end, the industry on the other hand will be constantly expanding and providing a larger market.

The *Air Commerce Bulletin* gives the following very encouraging statistics:

During 1929 approximately 16,000,000 miles were flown in scheduled operation as compared with 10,673,000 in 1928. Eighty

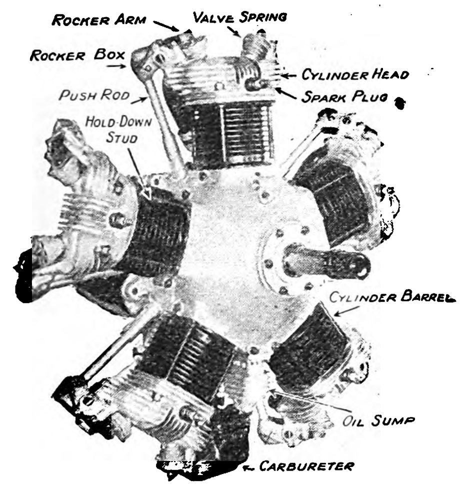


Two views of the tiny Heath *Parasol* monoplane, equipped with pontoons and powered with a small four-cylinder air-cooled motor. This plane is also available with a wheeled landing gear for land operation

five thousand passengers and 8,000,000 pounds of mail were transported in 1929, as compared with 49,000 passengers and 4,000,000 pounds mail in the previous year. Miscellaneous flying has shown at least an equal rate of growth. In 1926, miscellaneous flying totaled 18,000,000 miles; in 1927 it rose to 30,000,000 miles, and in 1929 we have the astounding figure of 125,000,000 miles.

Inside an Aircraft Engine

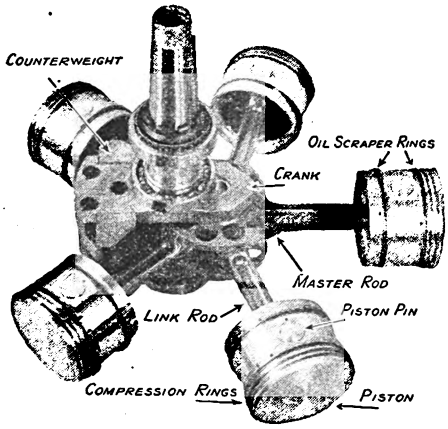
OUR photographs of the Lambert R-266 aircraft engine are quite instructive. This is a 90-horsepower, five-cylinder air-cooled motor with a speed of 2375 revolutions per minute, yet it weighs only 214 pounds, and is well adapted for a training plane or a sportsman's two-seater. It has rather a large bore (4.25 inches) and a short stroke (3.75 inches) which helps to make its frontal area compact.



Refer to the front view: The Y metal cylinder heads (which retain their strength at high temperatures) are seated on a nickel-steel cylinder barrel, with a copper-asbestos gasket between cylinder and barrel. Four long studs screwed into the crankcase hold the heads down. The barrels can be replaced separately. It is interesting to see how generous modern aircraft engine designers are of fin area. Cooling fins embrace the whole of the barrel and head. The valve rods and overhead valves and rocker arms are neatly enclosed. There are no accessories in front of the engine. This enables the plane designer to fit a smooth cowling over the engine.

Lightness is the keyword in aircraft practice; accordingly the crankcase is made of heat-treated magnesium alloy. It is split on a plane through the cylinder centers with valve lifters and intake passage in the rear.

The intake ring is inside the crank case, and leads the gas from a single carbureter to all five cylinders. Distribution of gas is helped by partial baffling inside the rim between two of the cylinders.



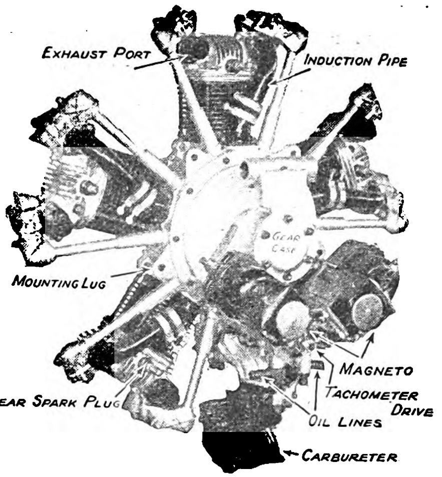
Upper right: **Rear view of the Lambert engine described in the text.** ***Above:*** **Piston, connecting rod, and crank assembly.** ***Left:*** **Front view of the same radial engine**

The gear case at the rear is also of magnesium alloy. A compact set of gears working from the main shaft drives the valve gear, two magnetos, and the lubrication pump.

A single master connecting rod works on the crankshaft, with other connecting rod ends working in the master.

A Flying Wing

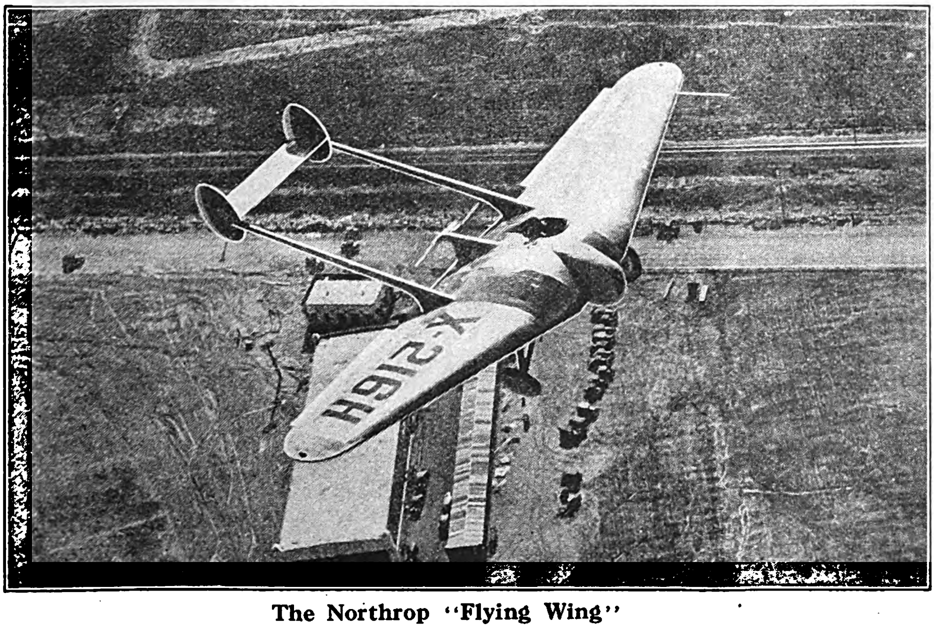
A NEW plane, secretly developed and flown by the Northrop Aircraft Corporation of Burbank, California, approaches closely to the ideal "flying wing" and with an engine of only 60 horsepower has flown at a speed of over 100 miles per hour.



The wing itself, 30 feet in span, is internally braced, with not a single exposed brace. It is quite thick at its center, thick enough, in fact, to contain a comfortable cockpit. There is no fuselage, the tail surfaces being supported by two long streamlined outriggers running from the wing. A four-cylinder inverted air-cooled engine, carefully cowled in, projects from the forward center of the wing. The "pusher" propeller is placed at the rear and is driven by a long shaft extending from the rear of the engine. Since it is not convenient to carry a tail skid or tail wheel on outriggers, a three wheel landing gear is placed under the wing, with the rear wheel steerable for taxying on the ground. The center rear wheel is somewhat nearer to the wing than the others, so that a suitable low-tail landing attitude can be readily assumed.

Besides the internal bracing of the wing, the two factors tending to increase efficiency are: one, the disappearance of the fuselage and the hiding of the pilot in the wing; two, the use of a "pusher" propeller, which interferes less with the flow over the wing, and the slipstream from which meets fewer parts, so that resistance here is reduced.

There is no doubt that the design constitutes a decided step forward in aerodynamic efficiency. It is creating much interest in aviation circles and its progress will be carefully watched.



The Northrop "Flying Wing"

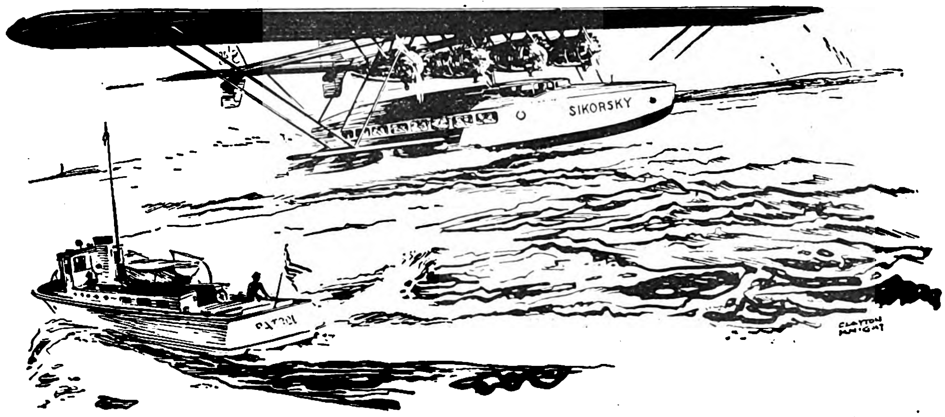
An Interesting Amphibion

A PROJECTED Sikorsky amphibion, the *S-40*, which follows on the heels of much service experience with the now famous Sikorsky *S-38* is shown in the accompanying artist's sketch. The design of the *S-40* has been carried out with care and has been thoroughly tested in the wind tunnel and the model basin.

If passengers are to make long journeys, such as from New York to Buenos Aires by air, they must be comfortable. Therefore the design provides for large passenger compartments, large windows with unobstructed vision, perfect ventilation, roomy toilets, washrooms, and kitchen and permanent quarters for the crew.

A flying boat must not only be satisfactory in the air; it must also incorporate the sound principles of surface vessels in the matter of marine equipment. The *S-40* can be towed from the bow; davits are provided in the front marine compartments; cleats for mooring a launch are available. A walk-way is provided along the lower structure to the pontoons. A hoisting sling allows the entire ship to be hoisted on a beam. To give seaworthiness, large excess buoyancy for the hull has been provided.

Power plant reliability is paramount for passenger service. The four engines insure reliability, because the plane can fly on full load with any one engine out of commission, as long as the fuel holds out. Also, storage space and hoisting arrangements are to be provided for carrying a spare engine. The fuel tanks, located in the wing to give gravity feed, have capacity for four hours' flight. The remainder of the fuel is carried in tanks located on top of the side floats. Cross feed valves will permit any engine to be supplied from any tank.



An artist's conception of the projected Sikorsky amphibion, *S-40*

In the construction of the hull, drainage has been provided from all parts. There are five water-tight compartments, any two of which will keep the ship afloat; the gas tanks provide emergency flotation.

In the positioning of the power plant, certain definite principles have been kept in view. Thus no part of the passenger or crew accommodations are in the plane of rotation of the propellers. The engine nacelles are so located with reference to the wing that there is a minimum of interference between them and the wing. The propeller clearance is 80 inches from the water, an important item when we consider the spray and rough water a flying boat has to encounter.

These large flying boats are to be built entirely of dural except for the fabric covering of the wings. Corrosion has to be taken into consideration. The high position of the wing above the water is a help. The use of the non-corrodible metal Alclad in covering the hull is an important feature.

The outriggers for carrying the tail surfaces run from the high wing, so that the tail surfaces are well above the waves. The structure follows the well tried Sikorsky principles.

The specifications of the new craft are to be as follows: Wing spread, 114 feet; chord, 192 inches; overall height, 22 feet 11 inches; over all length 72 feet 11 inches; wing area, 1980 square feet; power plant, four Pratt and Whitney Hornets, B, with a total horsepower of 2300; useful load, 11,250 pounds; high speed, 129 miles per hour; cruising speed, 108 miles per hour; climb, 675 feet per minute; stalling speed, 65 miles per hour.

A Mobile Weather Bureau

SIMULTANEOUSLY with advances in communication between airplane pilots and the ground, our large air transport companies are developing their weather services to the fullest extent. For example, the meteorologists of the Transcontinental Air Transport—Maddux Air Lines give the pilot, in advance of each flight, reports showing the location of storm areas, the direction and speed of their movement, regions of low ceiling and poor visibility, and areas of low pressure.

In addition to the regular meteorological equipment, new equipment has been added consisting of small rubber balloons, a special inflation device, and hydrogen tanks. These additions have been made in order that observers may gage accurately the height of low hanging clouds so prevalent in winter months, and the direction and velocity of winds at higher altitudes.

The Boeing Air Transport system is equally awake to the importance of weather service and has provided something of an innovation in the form of a "mobile" weather bureau. In addition to meteorological equipment the mobile bureau is equipped for radio transmission, with an aerial mast attached to the automobile.

A Minimum Altitude

TRANSPORT planes have heretofore been required to maintain a minimum altitude of 500 feet except when forced to fly lower by exigency of the weather. As a result of the T. A. T.—Maddux Air Lines crash, which led to the death of 16 passengers, the Department of Commerce has issued a new ruling. By this ruling, if a plane is forced to fly under 500 feet, under any circumstances, it must alight at the nearest possible landing place and do that as quickly as possible. This may effect a hardship on those operators wishing to maintain a schedule in conditions of low ceiling. Nevertheless, the rule should lead to safety, and safety is paramount.

Lindbergh Buys a Plane

IN spite of the fortune that he has undoubtedly accumulated, Colonel Charles A. Lindbergh remains as busily at work as ever, rendering consulting service to the most important air transport companies in the country. He has just purchased, paying over 17,000 dollars, the fastest two-seater sport plane ever built, the Lockheed *Sirius*, constructed by a subsidiary of the Detroit Aircraft Corporation.

In its coloring Lindbergh's new ship is distinctive. The entire fuselage is black and has a wide gold stripe along the mid section of each side. The wings, extending from the lower side of the fuselage, and the tail surfaces, are painted red.

The Lockheed engineers designed the new plane in consultation with Colonel Lindbergh. It has some very interesting characteristics.

To begin with, the plane is the last word in streamlining. The wings are internally braced, without the slightest exposed bracing. The fuselage is an almost perfect streamline and blends into the wings. The cowling, of the Venturi type, encloses the engine and reduces head resistance, yet allows perfect cooling. At the front there is a wide opening allowing plenty of air to impinge on the engine. But this air passes out through an opening at the rear which closely embraces the fuselage. Hence the air is not widely disturbed but follows the lines of the fuselage in streamline form. The wheels are almost entirely enclosed in special streamline housings, commonly termed "pants."

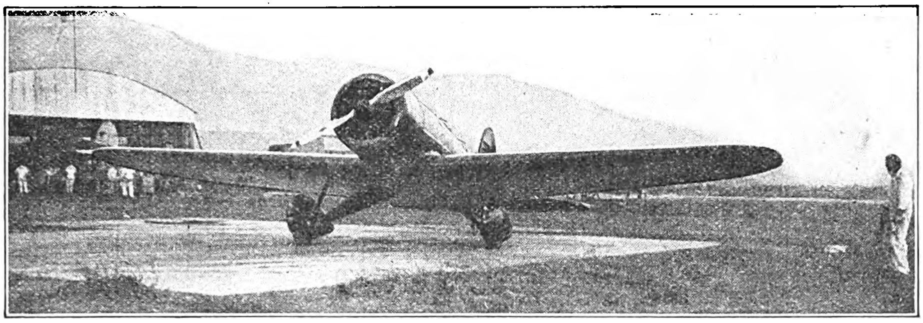
A Pratt and Whitney Wasp engine is employed, developing 425 horsepower at 2000 revolutions per minute.

The two cockpits, which Colonel and Mrs. Lindbergh will occupy so often, are located well to the rear of the fuselage so as to give maximum protection in a crash.

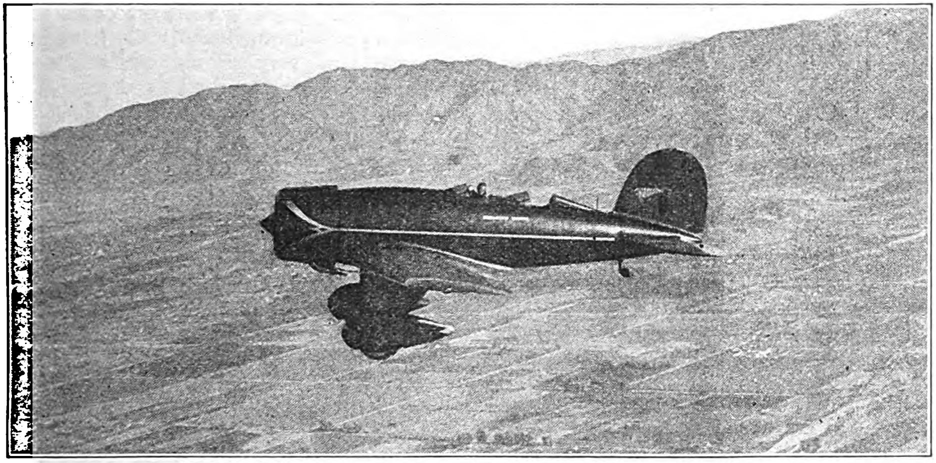
The wings of the plane have a span of 42 feet 10 inches, and their area is 265 square

The mobile weather bureau in operation in the field feet. Weight empty is 2950 pounds. For average use, the useful load is: 150 gallons of gas, 12 gallons of oil, pilot, passenger, parachutes, and baggage. The gross weight with this load is 4400 pounds.

Lindbergh desired a possible range of 3300 miles; therefore 320 gallons of gasoline may be carried in the fuselage, and 120 gallons in the wing. The plane will certainly be fast, even though performance data are not issued to date.



Above: Colonel Lingbergh's new plane with cowled air-cooled engine. *Below*: The *Sirius* in flight



Details of a French Catapult

MANY authorities believe that sooner or later airplane catapults will be used on all ocean liners carrying international mail, and that they may even be brought into service for launching heavily loaded land planes at airports of restricted size. We do not believe that the use of catapults in land operations will ever be found necessary, but see no reason why their use should not become general in liner service.

The United States Navy has developed catapults to as high a degree of efficiency an any other organization but the navy is somewhat chary, and rightly so, of disclosing full details of its apparatus. Details of the French system "Penhoöt," as employed on the *Ile de France,* and described in *L'Aeronautique*, are therefore of real interest, particularly as the Penhoöt system seems to be well worked out and reliable.

In Figure 1, the seaplane, 5, has its float or hull mounted on the chariot, 3. To the front end of the chariot is attached a cable, 12, which passes over a large pulley, 8, placed at the end of the runway. The cable then passes over a system of six pulleys. The pulleys to the right are movable and mounted on a rod which is rigidly attached to a piston in the compressed-air motor, 2. The motor is actuated by a great volume of compressed air contained in the cylinder, 1. There is, between the cylinder and the compressed-air motor, a valve, 9, which can have its air outlet regulated by the mechanism, 10. The value of this regulating valve is that it allows the chariot to be launched with constant acceleration and with a well defined final velocity—important factors for the efficiency of launching and the comfort and safety of the pilot.

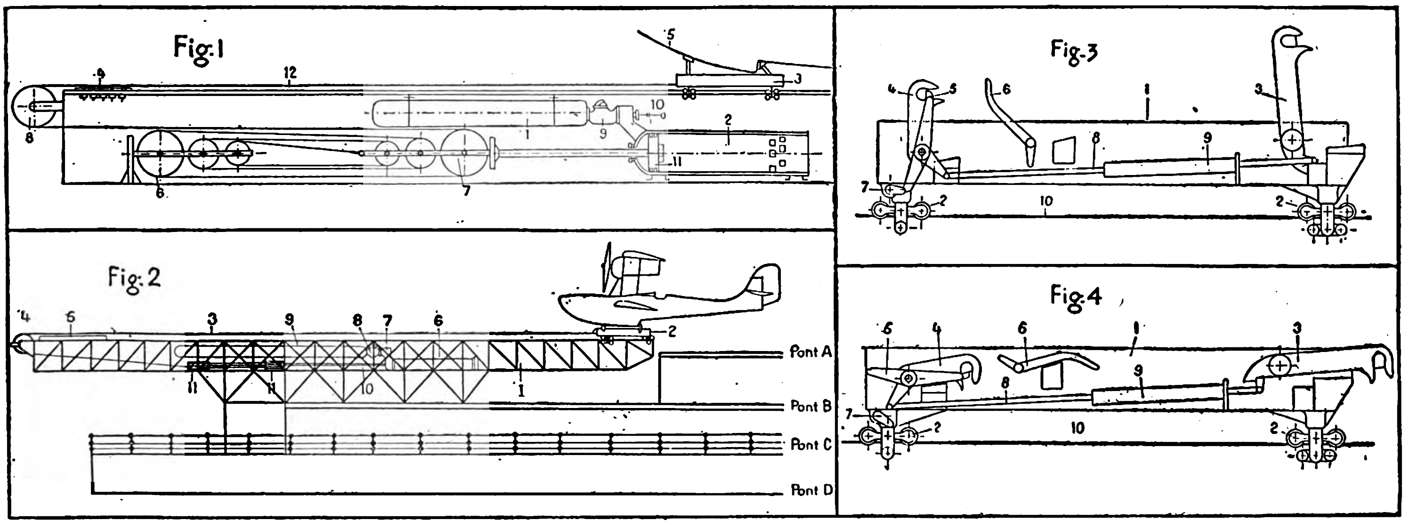
The chariot itself is a metal structure which must be very light so as to have the minimum inertia, and quite strong because of the large and peculiar forces involved.

Figure 2 shows the general arrangement of the system. The truss, 1, is a huge, solid structure mounted on the C and B decks of the *Ile de France*. The chariot, 2, is mounted on suitable rollers. The compressed air cylinder, the compressed air motor, the cable and the pulley system are all mounted within the truss, in a manner which is immediately intelligible from the diagram.

Figure 3 shows details of the chariot mounting when in process of being launched. Figure 4 shows the mechanism when the brakes are applied at the end of the run. The seaplane is held some four inches above the chariot, being suspended at the ends of the hooks, 3 and 4. At the end of the run, when the seaplane leaves the chariot by inertia effect, it actuates the trigger, 6. The trigger releases a spring, 9, which in turn brings down the hooks, and applies the brake, 7. The action of the brake is regulated also by compressed air. The deceleration of the chariot is about 15 to 20 times gravitational acceleration.

It would appear that in practice the pilot can stand an acceleration of some three times that of gravity. On the commercial steamship where space is not at such a premium as on a warship, the catapult can be 100 feet or more in length and the acceleration in launching can be less. The plane can be launched at an air speed a few miles higher than the minimum flying speed without any difficulty. For reasons of space, the *Ile de France* had its catapult mounted at the stern.

Theoretically the catapult should be mounted at the bow. The speed of the seaplane, relative to the air, is then equal to the speed of the ship plus the speed of the chariot and the acceleration relative to the ship and all the forces involved are much smaller. In the design of new ocean liners, naval architects will probably have these considerations in mind.



These diagrams of a French catapult are described in the text above

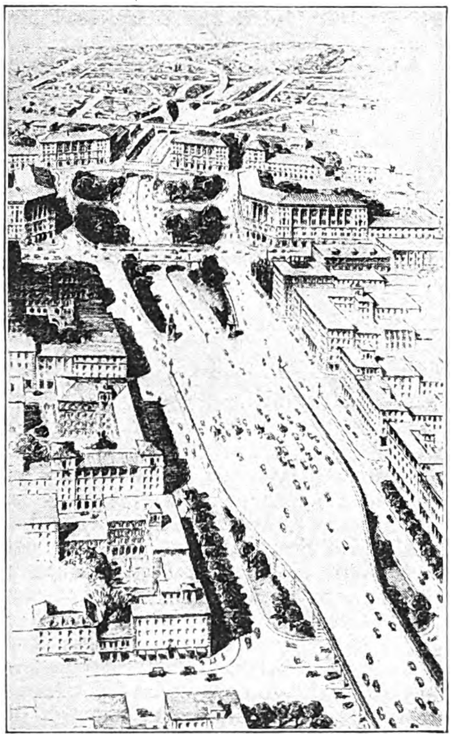
The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Hudson River Bridge Approach

TRAFFIC handling methods of an advanced nature have been introduced in the approach arrangements of the new Hudson River Bridge between Fort Lee, New Jersey, and West 179th Street, Manhattan.

No intersecting crossings at grade and no left-hand turns feature the scheme for expediting the movement of vehicles to and from the bridge. The plan of traffic distribution also seeks to accommodate motor travel without stops for lights or other signals. A handful of traffic men, it is declared, will be able to take care of the entire flow of traffic. The scheme is capable of handling the ultimate capacity of the bridge. Four lanes of traffic are contemplated initially.



Plan of the New Jersey approach to the new Hudson River Bridge

In discussing the approach innovation, Frank C. Ferguson, vice-chairman of the Port of New York Authority, commented: "The Port Authority has discarded the old circular plaza idea, which lent itself to civic planning but throttled motor vehicle performance. Such plazas, which then adequately served their purposes, are now a relic of the horsedrawn vehicle days with speeds of 10 miles an hour. American cities having circles or circular plazas today are either confronted by a traffic tangle, as exists at Du Pont Circle in Washington, or are discarding the circular movement of traffic as has been done at Columbus Circle, New York. Berlin has a similar problem at Belle Alliance Place. Traffic distribution must be as definite as the routing of railroad trains, with definite paths of travel in both directions."

The Fort Lee approach arrangement shows that direct access will be afforded to Hudson Terrace. The latter, which will be crossed by an overhead structure, is the first intersecting street in Fort Lee after one leaves the span itself. After passing over Hudson Terrace, the bridge approach will continue to rise until a broad, level traffic distributing point will be reached, from which northbound connections will be made with Lemoine Avenue.

Continuing, the bridge approach will pass under Lemoine Avenue and then distribute and collect southbound Lemoine Avenue traffic. Direct access also will be given to Center Avenue. The bridge approach will underpass Center, Linwood, and Fletcher Avenues. The Public Service Railway's right of way east of Center Avenue will be maintained without a grade crossing.

At Fletcher Avenue, a distributing basin is reached for State highway routes numbers 1, 4, and 6, the Bergen Boulevard, and County Road.

The entire bridge approach from Hudson Terrace to Fletcher Avenue will be flanked by marginal streets in order that local traffic may be accommodated without interference with bridge and through route traffic. The maximum grade will not exceed 4 percent, except on certain secondary connections where this rate will be somewhat higher, but well within motor operating conditions.

German Locomotive Has 1700-Pound Pressure

THERE had just been completed at the Berliner - Maschinenbau - A. G., formerly L. Schwartzkopff, a passenger express locomotive employing the unprecedented working pressure of 1700 pounds per square inch at 900 degrees, Fahrenheit. The new locomotive was manufactured by the aforementioned firm in closest co-operation with experts of the German railways. Its weight was kept within the limits prescribed for the standard locomotive. Test runs will be made in the near future and the locomotive will be exhibited at the World Power Conference in June.

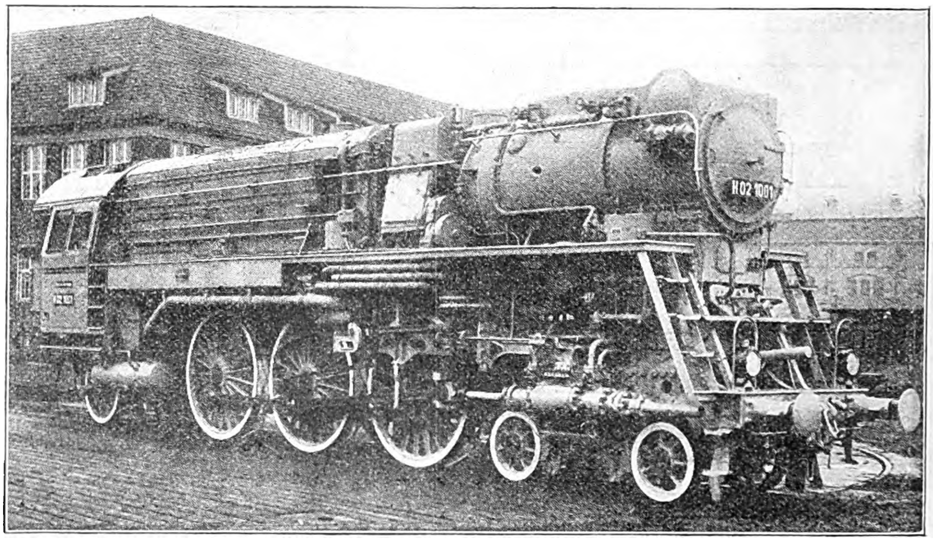
The new and unique method of generating high-pressure steam employed in this locomotive was developed by the late Prof. Dr. Löffler. It is claimed that it may prove especially successful in connection with locomotives because it overcomes the problem of the formation of "fur" within the boiler in a very simple manner, and its fuel economy is very high.

The characteristic feature of the method is that water is evaporated in a non-heated boiler drum. This drum receives heat indirectly from the grate by means of superheated steam. The high temperature of the heating vapor is transferred to a superheater, the heating surfaces of which are not subject to the formation of "fur." The locomotive factory in Wien-Floridsdorf proved the practicability of the method by applying it in a small stationary test arrangement, before the order for the locomotive was given.

World's Largest Underwater Tunnel

WORK is now going forward on a single-tube vehicular tunnel under the Mersey River to connect Liverpool and Birkenhead, England, which will have a total length of 2.16 miles and an interior diameter in the underwater section of 46 feet 3 inches. The tunnel will carry four lines of vehicles abreast, with ample space for ventilating air ducts. Although the tunnel cross-section shows a space beneath the roadway for street cars, these have not been definitely decided upon.

Plans for improving communication between the two boroughs have been under consideration for more than three quarters of a century. In 1922, a committee of three engineers was appointed to make a study of the problem and to report upon the feasibility of improving facilities for cross-river traffic by means of a bridge or a

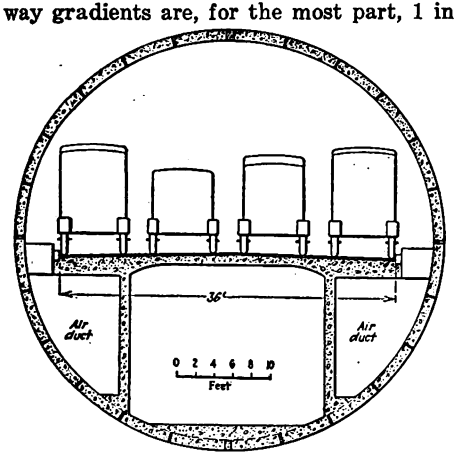


Courtesy German Tourist Information Office

The locomotive employing high pressure steam, which has just been completed in Germany. Note its very small cylinder and construction features

tunnel. After an exhaustive study, these engineers reached the unanimous conclusion that a tunnel would best meet traffic requirements. Accordingly, after approval of the plans had been secured from parliament in 1925, work was started in that year on the driving of a preliminary tunnel along the line of the future main tunnel to explore the ground. The two headings of the preliminary tunnel met beneath the middle of the river in April, 1928, and shortly thereafter a contract for the enlargement to full section of the underwater portion was awarded. The approaches in Liverpool and Birkenhead were awarded on separate contracts in November, 1928, and March, 1929.

Double approaches are provided on both sides of the river. The 36-foot roadway used in the underwater section is continued throughout the main approaches on each side and, in addition, branch approaches from sections near the riverfront are provided with roadway widths of 18 feet, accommodating two lines of traffic. Roadway gradients are, for the most part, 1 in 30, with a maximum of 1 in 29.4 on the Liverpool approach. The usual cast-iron lining is to be used, sealed with concrete grout and concrete on both exterior and interior.

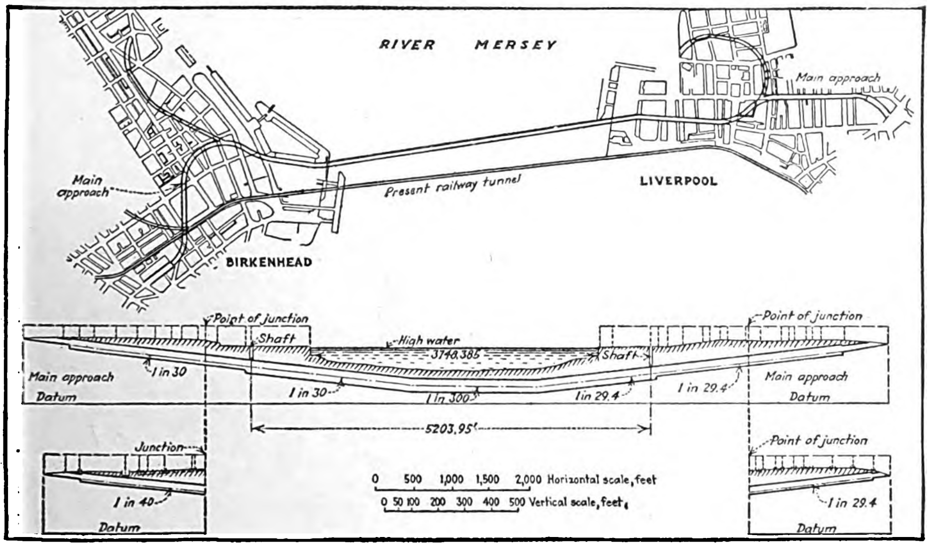


Courtesy Engineering News-Record

Cross-section of the Mersey River vehicular tunnel, showing space which may be used for street cars

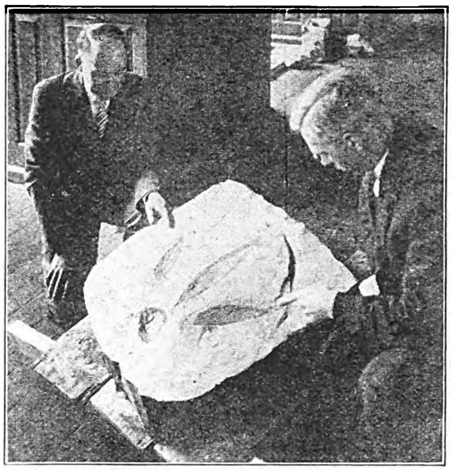
Ventilation will be taken care of by three plants on each side of the river which will supply a total of nearly 4,000,000 cubic feet of fresh air per minute. It is expected that the maximum proportion of carbon monoxide will not exceed 4 parts in 10,000. The system of ventilation to be used has not been definitely determined; studies are now being made of the relative advantages of transverse and longitudinal ventilation.

Present plans call for completion of the tunnel in June, 1932, at an estimated cost of approximately 25,000,000 dollars, of which the English government will contribute over 12,000,000 dollars. The balance of the cost will be met by loans, secured by toll charges to be maintained for a maximum periods of 25 years, and also by funds to be provided by the two cities.—*Engineering News-Record*



Courtesy Engineering News-Record

Plan and profile of the vehicular tunnel connecting Liverpool and Birkenhead, England. It will be larger in diameter than those in this country



In a clay pit at Woodbridge, New Jersey, footprints of dinosaurs were found in January and others have been found since then. The photograph shows scientists at Rutgers University examining one of the prints in a cut-out block of the clay

Glass Resists 15-Ton Pressure

A BIT of glass about a sixteenth of a square inch in area bearing a load of approximately 15 tons, is the simple new weapon of science developed by Professor Thomas C. Poulter of Iowa Wesleyan University.

It served as a tiny window looking into a pressure-chamber, where experiments are performed under the tremendous pressure of 30,000 atmospheres. The little glass window is ground perfectly flat and set against a ring of high-speed steel, also ground perfectly flat. There is no gasket; the pressure attends to the sealing of glass against metal.—*Science Service.*

Zinc Treatment Kills Weed Seeds Without Injuring Sprouting Trees

A METHOD of chemical weeding for seedling beds of evergreen trees has been worked out at the Northern Rocky Mountain Forest Experiment Station of Missoula, Montana. According to W. G. Wahlenberg, formerly of the United States Forest Service, who describes the work in detail in a new technical publication of the United States Department of Agriculture, this method saves 27 percent of the cost of producing two-year-old tree seedlings, besides saving many young trees that would be destroyed or damaged by the old laborious process of hand weeding.

The new method, as worked out during several years past at the Savenac nursery, consists in applying one and one eighth ounces of zinc sulfate dissolved in one quart of water to every four square feet of seedbed soil. This attacked and poisoned the roots of the weeds as they tried to leave the germinating seeds. The roots of the sprouting evergreens were more resistant and were not injured. The situation was roughly analogous to that in the blood of a malaria patient who takes quinine. The drug kills the germs but does not harm the body tissues.

During the experiments, other chemicals were tried, but zinc sulfate proved to be the most effective. Higher and lower concentrations of the zinc sulfate were also tried, but the higher concentrations sometimes injured the tree seedlings, and the lower ones were not so effective against the weeds. The concentration to be used for best effect must depend partly on the nature of the soil, Mr. Wahlenberg says. A finer-grained soil than the one at Savenac would require more of the sulfate, a coarser-grained soil less.

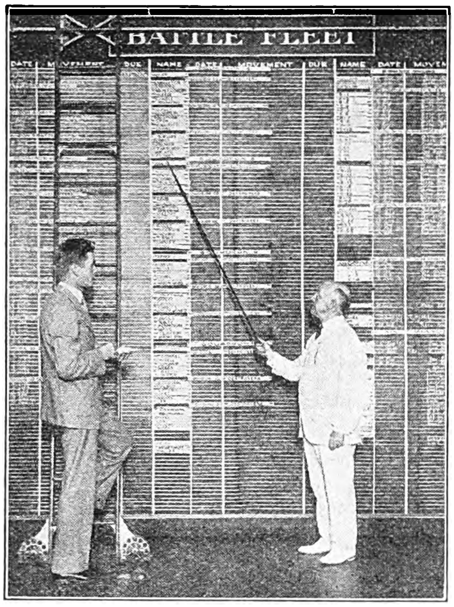
The method is not without its disadvantages, which must be guarded against. The sulfate tends to make the soil acid, and liming will be necessary in some localities to correct this. If the soil is stirred after applying the sulfate to the surface, the effect is lost; weeds sprout readily in spaded or plowed places after treatment. Fresh treatment of a seed bed is therefore necessary every time a new lot of tree seeds is planted.

One incidental advantage seems to come from the treatment. After the seedlings are taken up and the soil re-plowed, field peas are frequently planted as a green manure crop. The residual zinc in the soil does not injure the peas but rather increases their growth, apparently through encouraging the colonies of nitrogen-fixing bacteria on their roots.—*Science Service*

Huge Steel Balls to Carry Helium

SIX huge steel balls mounted on a flat car to appear on American railroads soon will not be globes consigned to a mammoth pawn shop, but efficient containers for precious helium to carry the gas from Texas oil fields to distant airship hangars.

When tested at Milwaukee recently, one of these six-foot spheres, made of steel an



A glance at this chart tells officials of the Navy the location of any vessel of the fleet. It is revised as ships are re-assigned or travel from port to port over the world

inch and a half thick and mounted on a flat car, was filled with helium at 1250 pounds per square inch pressure and run off a 25-foot bank. It was unharmed. It finally exploded under a pressure of 4500 pounds per square inch.

The odd-shaped container is used because it can carry twice as much gas as a cylinder of the same volume. That sounds contradictory, but because of its spherical shape, double the pressure in the cylinder is required in the sphere to stress the steel equally. Consequently at double pressure the sphere will hold double volume.—*Science Service.*

"Sub-Soiling" Deep Tillage

FOR unknown thousands of years man has scratched the surface of the ground before planting his seeds. The power for this work was the strength of his own back, the implements were a forked stick or a pointed heavy limb. Then the horse was domesticated and he did the work for ages. The farmer of today has the power of a tractor. How shall he make the most of that power? By deeper plowing? Possibly—but there is another way.

A new technique of soil tillage has been developed in the semi-arid areas of the Pacific Coast states. It has been found that the tractor may be put to profitable use for stirring and breaking the hard packed sub-strata of soil without turning them to the surface. This has been called "deep tillage," and "sub-soiling," but the word "subbing" is a short, descriptive phrase for this improvement in agricultural practice.

"Sub-soiling," done either by tractors with specially constructed implements called sub-soilers, or by blasting with dynamite, is an operation by which a hard stratum of a sediment, at many places of an almost rocky nature, is broken up and is made permeable to water. The latter, by its physical and chemical action, will disintegrate that stratum, so the roots of plants may penetrate it and obtain from it and also from the soil beneath it, the necessary plant food. A study of the results of experiments in subbing compels one to the belief that it is generally well worth the cost to rid field or orchard or vineyard of this stratum of impervious soil that limits the productive depth of the farm.

Subbing, as practiced in California, is usually associated with a complete system of tillage, particularly in orchard districts. The sub-soiler is used in the fall—when the soil is dry—after which the soil is prepared by cultivation for the green-manure crop. A leguminous cover-crop is raised in the winter or early spring.

Instead of turning under this cover-crop with the plow, so that the vegetation is buried under a heavy layer of earth, those who favor deep tillage employ a heavy duty tractor disk harrow of special type, to chop the cover-crop and mix it thoroughly with the surface soil.

In preparation for irrigation, a heavy duty "chisel" cultivator is employed to stir the soil to a considerable depth. To this are sometimes attached "crowders" or furrowers to make the irrigation ditches. No plowing is done.

A prominent western authority on tillage and soil management recently made the rather startling prediction that within a few years in many districts, the new system would make the plow obsolete.

The foundation of the deep tillage system is the "subber," or sub-soiler, a sturdy implement carrying one, three, or five standards, depending upon the depth to which it is desired to subsoil, and upon the power available for sub-soiling to that depth. These standards are composed of a stout metal shank to which is usually attached a renewable chisel-like tooth. This is sunk into the ground beneath the stratum of under-crust, and is customarily pulled by a stoutly-built tractor that is generously powered. It cuts to a depth of 12 to 30 inches, although special outfits may go as deep as 40 inches or more. The sub-soiler is pulled only when the ground is dry and more readily fractured, and the ground is thus shattered to a considerable distance on each side of the standard, the exact width of the effective work varying with the depth of the blade and the type of the soil.

Sub-soiler in operation in a vineyard. The sub-soil is loosened but the surface soil is hardly broken

The chisel cultivator is stoutly built. This stirs the soil without turning it up. To the frame are sometimes attached right and left moldboards. These may be used to form a furrow in which fertilizer can be placed, these moldboards being reversed on the second passage over the ground to cover the fertilizer.

The chisel cultivator is especially favored for field crops. Although it does not work as deep as the sub-soiler, it is effective in the destruction of plow-pan. This implement is now being used successfully by many grain growers in place of the plow. Users generally agree that this method is cheaper than plowing. Some farmers, however, state that the cost of the two methods is about the same. The heavier chisel-cultivators will work at a depth of 12 inches.

The disk harrow is a tool widely used by advocates of deep tillage—ordinarily being of heavy and sturdy construction. One of the larger, heavy-duty implements has 44 disks (20 or 22 inch) and weighs more than a ton.

The furrower is a light, V-shaped device attached to the shank of the chisel cultivator and sometimes is called a "crowder." The furrower makes an extremely deep furrow and a very narrow one. Measured from ground level, the furrow seems about 14 to 16 inches deep, to say nothing of the way the sides are built up by the soil thrown out, and only about a foot wide at the top. Therefore, when irrigation water is turned into a furrow like this it goes deep and leaves the surface of the ground dry. Loss from surface evaporation is reduced and the very harmful effect of hot sun shining

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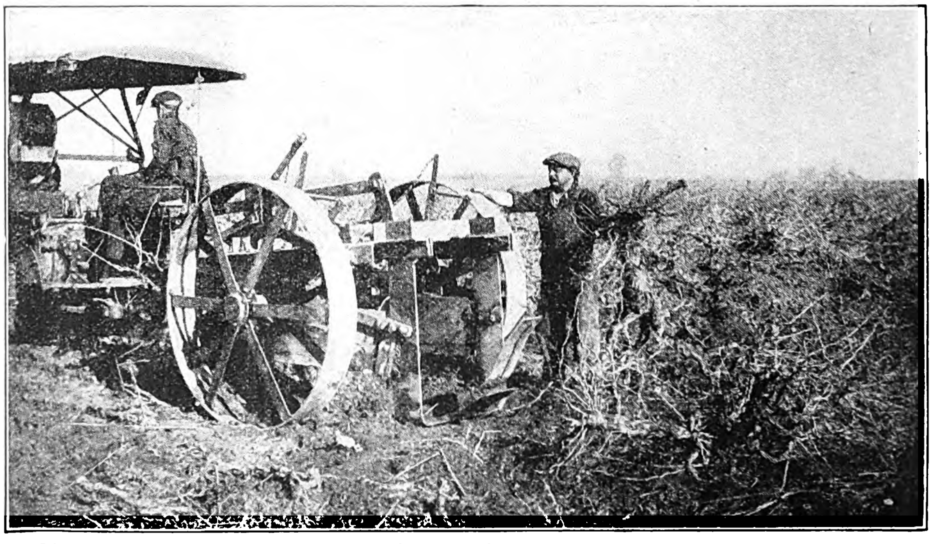


The sub-soiler equipment is useful also for uprooting the matted and gnarled roots of old worn-out vines when necessary to replace them with new ones

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

"Parrot Disease"

IN 1904, three cases of psittacosis or "parrot disease" were reported in Boston. Last fall an outbreak of this disease was reported in Buenos Aires and more outbreaks have recently been reported in the United States.

In Hamburg, Germany, 28 cases with five deaths occurred last fall. In the epidemic of psittacosis which occurred in Paris in 1892, there were 49 cases and 16 deaths and it was reported that the infection had been caused by parrots brought from South America.

The symptoms resemble those of other infectious diseases and one should be certain that the disease is actually psittacosis and not pneumonia or other infection of the lungs.

Obviously, the first step is to get the suspected parrot and to find out whether or not it contains the germs which are responsible. There is great doubt as to the exact organism that causes psittacosis. The most recent evidence seems to indicate that the germ is of the filtrable virus type. Experts are doubtful that the germs now commonly associated with the disease are the actual cause and they are more inclined to believe that it is probably a filtrable virus; that is to say, an organism that will pass through a mesh of clay filter and is too small to be seen in the ordinary microscope, but the presence of which can be determined by the fact that the disease can be produced on infection and by the reflection that it causes when specimens are looked at with the supra-ultra microscope.

The occurrence of such cases in the United States is new evidence of the fact that methods of transportation, exchange of products among various nations, and the complete abolition of boundary lines between peoples makes it impossible any longer for a nation to be isolated. The disease of one people will sooner or later appear among others.

Already cases of many of the tropical diseases have been found among the sick in the United States. It is probable that more and more cases are likely to appear in the future, notwithstanding the fact that the United States Public Health Service and all of the health organizations of various nations are concerning themselves with the prevention of such transmission.

Cancer

THROUGHOUT the world in hundreds of laboratories in research institutions efforts are being made to find the cause of cancer, to learn the nature of cancer, to aid in its early diagnosis, and to discover some specific cure. Recently, Dr. Charles F. Geschickter toured Europe and visited most of the cancer laboratories to find out what was being done in these various phases of cancer study.

It has been recognized for many years that workers with certain dyes, with tar and with pitch, were likely to develop cancer. Therefore, research workers use this method to produce cancers in mice and then study the cancer in the animal in a way that is not possible in the human being. Other workers were able to transplant cancer cells and have used this method in developing tumors in animals which are then studied by modern methods.

There are many workers who are convinced that cancer begins as a general systemic disease and that it represents in a way perhaps the natural end of man. However, this view has not been scientifically confirmed by experimentation.

Studies have been made of the chemistry of cancer, of the way in which the cancer cells use sugar as contrasted with the way normal tissues use sugar, and all of this has been of importance in learning about the nature of cancer, but has not led to immediate practical results.

It has been known for years that a cancer may arise from repeated irritation of certain cells in the body. Recent investigations tend to indicate that it is the cells of the body which are important in this connection, or the material that is used to bring about irritation, or perhaps even the irritation itself. Nevertheless, the irritation is a contributing factor, and for this reason repeated rubbing of dangerous spots should be avoided. This is particularly important as it relates to cancer in the mouth. Much can be done in prevention of cancer of the mouth by early attention to decaying teeth, rough edges, and similar sources of irritation.

Practically no serious worker in the field of cancer is willing to admit that there is an infectious origin or that the condition is in any way to be compared to infectious diseases. Many investigators are inclined to the view that no one cause, either inside or outside the body, is alone responsible for this disease, but that there may be several contributing factors. Cancer probably begins as a small lesion in one spot and then by a change in the nature of the tissue spreads throughout the body. Apparently the age of the patient has much to do with the manner of the spreading.

The search for a cancer cure is becoming widespread. Radium treatment has been receiving more and more attention, particularly as a means of treating cancers on the surface of the body. The lead treatment of which so much was heard five years ago is now practically discontinued throughout the world. Experiments are being conducted with it but it is not in any sense of the word a practically successful method.

Attempts have been made to suffocate tumors by putting around them an atmosphere deficient in oxygen. Other attempts have been made, notably by Sokoloff who made a small sensation with his method in the International Congress on Physiology, to eliminate the cancer by overbreathing. This work is of interest but in no sense of the word established.

Recently two investigators in the United States have noted interesting changes in cancer following the injection of extracts of glandular substances. The theory behind the use of this is complicated. Changes have been noticed in the tumors, but the evidence is not yet sufficient to warrant the belief that anything certain has been accomplished for the treatment of cancer by medical means.

Doctor Geschickter has established such criteria. He says: "A series of criteria for judging alleged cancer cures is easily formulated, although compliance with its requirements is difficult. We all know what we want or wish for any patient suffering from this disease. First, we want to face the facts and know for certain whether or not the patient actually has cancer. This implies biopsy. Secondly, we want to be able to cure cases in all stages, even in the face of recurrences and generalized metastases. Thirdly, we want the cure to be permanent. These three criteria, histologic diagnosis, cure of metastatic cases, and permanent cures established by follow-up examinations, extending over five year periods, should be applied to all alleged cancer cures.

"From this point of view immediate cures of local tumors in experimental animals, however intriguing, are false alarms. Serious and extensive clinical trial of any method by workers other than its advocate should await, first, the submission of the sections to substantiate the diagnosis in all cured cases; second, proof that the disease had progressed to dissemination at the time of treatment and, third, a five year follow-up to show the permanence of the cure."

Scarlet Fever

IN addition to treating scarlet fever by the use of specific antitoxin, it is possible to provide the sufferer with antitoxin through the blood of a person who has had the disease and who recovered. The health department in Detroit arranged to collect blood from people who had recently recovered and to keep it available for the use of those who might develop the disease. It was also used to protect people who had been exposed to scarlet fever against the disease.

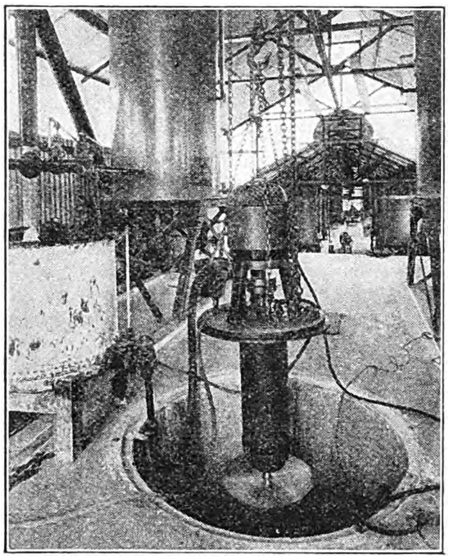
The quarantine period for scarlet fever is 28 days. It was found that the convalescent serum protected people for short periods, but apparently the immunity created did not last longer than three or four weeks. The chief value of the method seems to be that it prevents outbreaks of scarlet fever in hospitals and in other institutions after one or two cases have developed. The method is also particularly suitable to use in young people who may react unfavorably to injection of the special fever antitoxin.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Spray Drying of Latex Revolutionizes Rubber Manufacture

ONE of the most interesting developments in the rubber industry in recent years was the development, by Ernest Hopkinson of the United States Rubber Company, of a revolutionary new process for the preparation of crude rubber from the sap of the rubber tree, which is known as latex. The process, as carried out at the plantations in Sumatra, is described by Hendrik de Leeuw, in a recent issue of *Chemical and Metallurgical Engineering*.


A latex spray-drying unit in a plant on the eastern coast of Sumatra

"The method for spray-drying rubber consists of atomizing latex by pouring it upon a disk installed at the top of a drying chamber, rotating at a high speed. Air heated to 350 degrees, Fahrenheit, intermingles with the particles of latex, drying them without raising the temperature to a point which would be detrimental to the rubber. The falling dried material resembles snowflakes. The mass of rubber is removed at intervals and pressed.

"A spray unit consists of a tank holding several hundred gallons, the spraying apparatus, and the drying chamber. Latex is forced through a rubber hose from the tank to the top of the cone, where it is led to the spray rotor which atomizes it, the fineness of the atomization being controlled by the speed of the rotation of the electrically driven 18-inch disk. The spraying apparatus is shaped like an inverted truncated cone. It reaches a diameter of 30 feet and is covered with steel plates. The heated air is produced by an oil-burning furnace located near the unit. The hot air is forced to the top of the cone through insulated pipe.

"The drying chamber or lower compartment is a concrete-walled room, 30 feet square and 30 feet high. At the bottom there is a series of parallel floors mounted on rollers. These floors can be withdrawn one at a time so that the dried rubber which has accumulated on them can be removed.

"Rubber as it comes from the drying room is in a spongy mass. It is pressed into a more compact mass by hydraulic presses, baled in heavy burlap and shipped to Belawan, the seaport of Deli."

Roast Beef In a Salt Shaker

THERE has recently appeared on the American market an Oriental condiment, Ajinomoto, advertised as imparting a meat-like flavor to soups, gravy, sauces, or vegetables. Inquiries that have reached this department reveal an apparently general assumption that this condiment is a concentrated meat extract. As a matter of fact, it is really an entirely synthetic flavor, the chemical name of its active principle being monosodium glutamate. [See also page 159, February, 1930 SCIENTIFIC AMERICAN. Editor.] In recent years, this product has become so popular that it is freely used like salt and sugar in the average Chinese home. The Chinese alone used 1,130,000 dollars worth of it in 1928. In the tropics people live principally on vegetable diet, and they resort to monosodium glutamate to improve the flavor of their simple food.

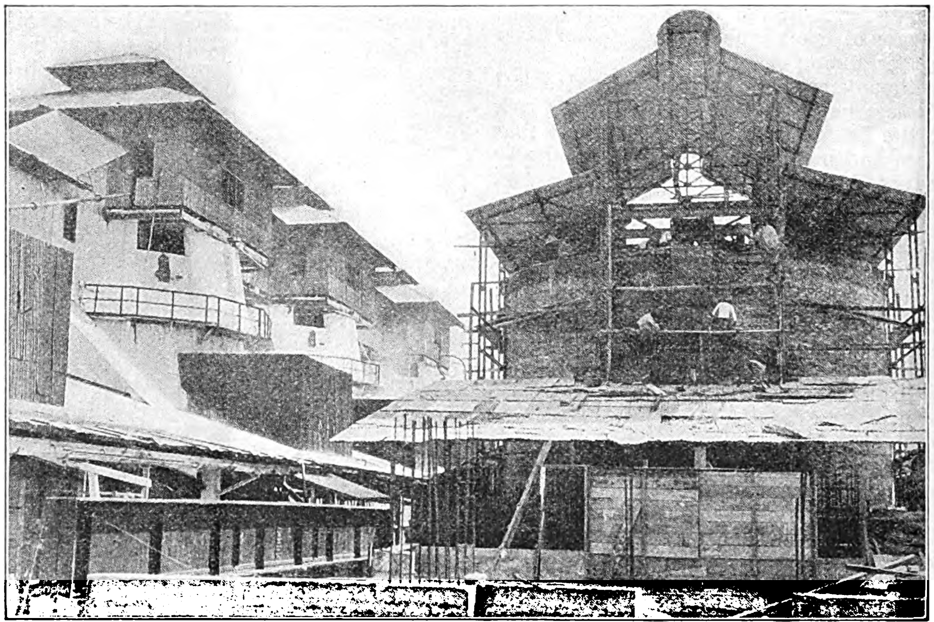
The Chinese process for the manufacturing monosodium glutamate is described by J. E. S. Han in a recent issue of *Industrial and Engineering Chemistry.* Gluten and concentrated hydrochloric acid are placed in a stoneware vessel provided with a reflux condenser, and heated over an oil bath at a moderate temperature until the protein in the gluten is dissolved. The temperature of the oil bath is then raised and the acid kept boiling until hydrolysis is complete. The product is filtered, the glutamic acid hydrochloride crystallized and purified, and finally neutralized with soda. The monosodium glutamate so obtained is crystallized, dried, and ground to a fine powder.

Coolies dusting and weighing the sponge rubber delivered from the drying chamber described in the text

How to Flame-Proof Fabric

A REPORT published in the British Fire Prevention Committee Red Books, outlines the method generally known as "non-flame" process which gives a good fire-retardant effect and has the further merit that this effect remains after the material has been subjected to washing or the weather. In tests made by the British Fire Prevention Committee, flannelettes were found to have been little changed after 20 washings. The process consists in steeping the cloth in a solution of three pounds of sodium stannate per gallon of water used (specific gravity 1.07). After wringing and drying it is rinsed several times in running water and finally dried.

A less permanent treatment can be made by subjecting the cloth to a solution consisting of two pounds of ammonium sulfate


Plant in Sumatra where crude rubber is produced by spray-drying latex

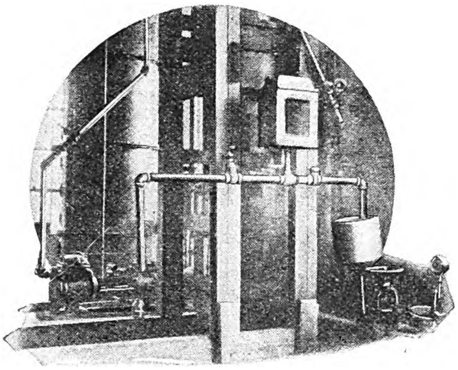
and four pounds of ammonium chloride (sal ammoniac) in three gallons of water.

Sodium silicate is fairly effective for interior decorations where change of color or luster is not important. For this purpose one volume of commercial water glass (1.39 specific gravity) is diluted with one to five volumes of water, depending upon the kind of fabric and the degree of fire-retardant effect desired.

Where Does the Bootlegger Get His Alcohol?

"RECENT indictment of corn sugar manufacturers, yeast companies, and industrial establishments engaged in various branches of the chemical industry has attracted attention to a new phase of alcohol control," points out I. D. Foos in a recent article in *Chemical and Metallurgical Engineering*. "There have been three cycles in prohibition enforcement. In its first stage, the authorities concentrated their energies on preventing the diversion of existing stocks of whisky. Next, they turned their attention to checking widespread diversion of industrial alcohol. Now they are attempting to block the movement of otherwise legitimate products to illicit distilleries and hence have brought yeast, corn sugar, and other industrial materials into the prohibition limelight.

"Through it all, the manufacture of 'moonshine,' defended by the southern highlander as a birthright, has persisted. But as the diverted supply of industrial alcohol has diminished, moonshining has assumed the characteristics and proportions of an industry. The moonshiner's kettle in the swamps and mountains has been supplemented by column stills, operated on a factory scale, located in or close to all the larger cities, particularly in the north. Here corn sugar mash is used in preference to cane and beet sugar, cornmeal, or molasses, because of its rapid fermentation. Usually, it is necessary only to add yeast to this, as the protein content of this type of sugar provides sufficient yeast food so that when accelerated by heat, a ripe mash is produced within 24 hours. Ordinarily, such corn sugar also enjoys a price differential of approximately $1.50 per hundred-weight; this, of course, is an advantage, even though cost is not a primary factor in this business.



When the "big-time" bootlegger sets up a plant in the city, his equipment usually includes vertical stills like the one illustrated above

"Estimated at one billon pounds last year, the production of corn sugar has increased sevenfold since 1921.

"The increase in production of this material from approximately 152,000,000 pounds in 1921 to 538,000,000 pounds two years later may not have had any prohibition significance, but the federal authorities certainly believe that the rapid increase which took place after 1926 was of serious import. They point out that this increase of corn-sugar manufacture occurred simultaneously with the voluntary curtailment of industrial alcohol. Furthermore, it is certain that not only this curtailment but also the improvement of denaturing formulas, did much to make more difficult and expensive the reclaiming for beverage purposes of alcohol from either partly denatured or fully denatured forms. In any event, seizures of stills conclusively prove that the art of bootlegging has taken on many of the improvements which have been currently effective in other industries which also demand chemical-engineering skill and equipment."

Two Gases Make Fertilizer

RECOVERY of ammonia as sulfate in gasworks and elsewhere is now confronted by so many economic difficulties that any process which promises to lower costs deserves serious consideration, says *Chemical Age*. A German chemist, Dr.

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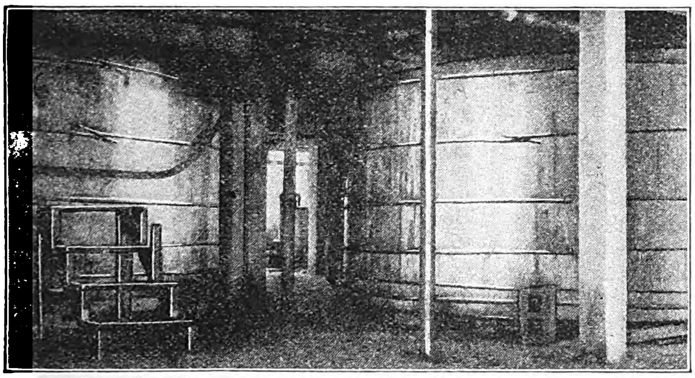
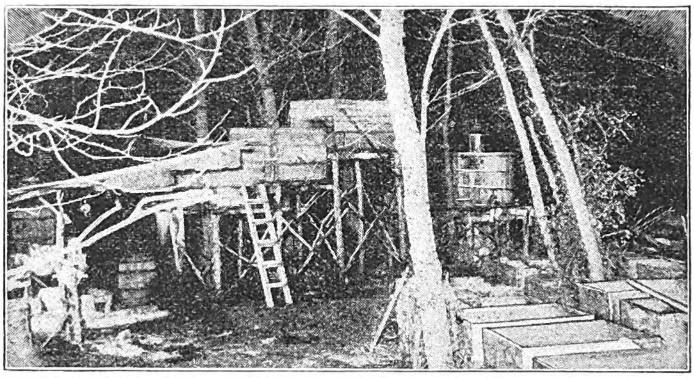
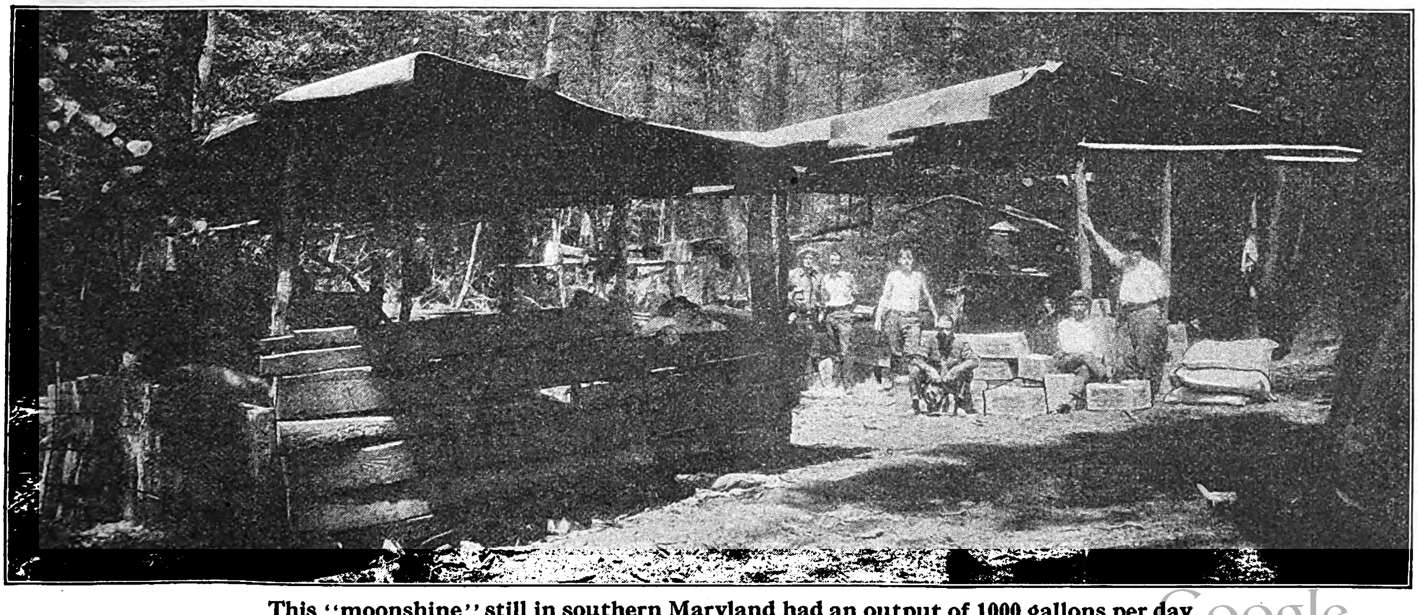


Large-scale production of illegal alcohol requires the installation of huge mash tanks such as the ones shown



Not efficient from the chemist's point of view, but picturesque, is this typical still found in the southern hills



This "moonshine" still in southern Maryland had an output of 1000 gallons per day

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Agriculture

FRESH AND CANNED FRUIT INDUSTRY OF PORTO RICO. (Trade Information Bulletin Number 669. Department of Commerce). A general survey of the Porto Rican fruit industry. *Superintendent of Documents, Washington, D. C.—10 cents, (coin).*

FOREST PLANTATIONS AT BILTMORE, N. C., by Ferdinand W. Haasis. (Miscellaneous Publication Number 61, United States Department of Agriculture). Describes one of the earliest large-scale reforestation projects. Fully illustrated. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

INDIAN CORN, by James B. McNair. (Leaflet, Botany Number 14, Field Museum of Natural History). Pamphlet deals with the origin, geographic distribution and varieties of Indian corn, its uses by the American Indian, and the modern industrial and experimental products. *Field Museum of Natural History, Chicago, Ill.—25 cents.*

THE CORN BORER IN CENTRAL EUROPE, by K. W. Babcock and A. M. Vance (Technical Bulletin Number 135, Department of Agriculture), is a report of a four-year research program carried on in central Europe in an effort to obtain information which might help to check the spread of the corn borer in the United States. *U. S Government Printing Office, Washington, D. C.—20 cents (coin).*

SELECTIVE LOGGING IN THE NORTHERN HARDWOODS OF THE LAKE STATES, by Raphael Zon and R. D. Garver (Technical Bulletin Number 164, United States Department of Agriculture). Selective logging is fundamental to industry of forestry in the hardwood forests. The pamphlet gives a wealth of information. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

INVESTIGATIONS IN WEED CONTROL BY ZINC SULFATE AND OTHER CHEMICALS AT THE SARENAC FOREST NURSERY, by W. G. Wahlenberg. (Technical Bulletin, Number 156, United States Department of Agriculture.) Pamphlet shows how the weed problem was solved at a tree nursery. It represents ten years of investigation. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

Metals

THE RELATION OF CARBON RESIDUE TO LUBRICATING PERFORMANCE. This issue of *Lubrication* gives valuable information on the subject. *The Texas Company, 17 Battery Place, New York.—Gratis.*

SIGNIFICANT DEVELOPMENTS REGARDING SOIL CORROSION, by Henry W. Hough. This reprint gives the important developments in soil corrosion research, the significant trends, and their effects is ameliorating the ever present corrosion problem. *Henry W. Hough, 46 Carnegie Ave., East Orange, New Jersey.—Gratis.*

COMMERCIAL CHROMIUM PLATING, by Richard Schneidwind (Circular Series Number 3). This pamphlet of 60 pages deals with general information necessary for the design of chromium plating equipment, and discusses the defects of chromium plating. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—50 cents.*

Periodicals

CELLULOSE. A new trade paper devoted to cellulose, its derivatives and products. *The Cellulose Publishing Co., 114 East 32nd Street, New York City.—$3.50 a year, 35 cents a copy.*

MACHINE DESIGN. A new trade paper devoted to machine design as it affects engineering, production, and sales. It is now in its second volume. *The Johnson Publishing Co., Penton Building, Cleveland, Ohio.—$3.00 a year.*

SPORTING GOODS JOURNAL CATALOG 1930, edited by H. C. Tilton. A combined catalogue of sporting goods manufacturers and cyclopedia of sports. A valuable treatise on sports. Supplied gratis to subscribers to the *Sporting Goods Journal, 521 Fifth Ave., New York City.—$2.00 a year.*

AIR TRAVEL GUIDE—A ready reference handbook published and revised on the first of each month and containing latest authoritative information for those who travel, mail, or ship by air. Full timetables and rates given. Excellent air passenger maps. *Air Travel Guide, Ltd., 565 Market St., San Francisco, Cal.—35 cents.*

Science

MOTION PICTURES AND ILLUSTRATED LECTURES. Illustrated catalogue of motion pictures, technical and non-technical, and films with synchronized sound, made and distributed by the General Electric Co. These films are of great educational value. *General Electric Co., Schenectady, N. Y.—Gratis.*

ETHNOLOGY OF AFRICA by Wilfred D. Hambly, Assistant Curator of Ethnology at Field Museum. Systematically sets the puzzled reader straight about the many African races—negro, Bushman, Bantu and especially the mixed white-black races of northern Africa. Virtually a text book. 222 pages, 42 plates. *Field Museum of Natural History, Chicago.—$1.59.*

ROOSEVELT WILD LIFE BULLETIN and ROOSEVELT WILD LIFE ANNALS. Two serial publications of interest to nature lovers, containing illustrated studies of bird life, fishes, trees, and so on. Each number is in the nature of a monograph. *Roosevelt Wild Life Forest Experiment Station, Syracuse, N. Y.—Bulletin $1.00 an issue and Annals $1.25.*

HOW TO MAKE AN INSECT COLLECTION, HOW TO MAKE SKELETONS, NOTES ON MARINE AQUARIA, and INSECT-EATING PLANTS are a few representative titles from the TURTOX SERVICE LEAFLETS. TURTOX NEWS, a monthly bulletin issued by the same firm, is sent to approximately 20,000 biology teachers in the United States and foreign countries. *General Biological Supply House, 761 East 69th Street, Chicago—Gratis.*

BRIEF HISTORY OF POLAR EXPLORATION SINCE THE INTRODUCTION OF FLYING, by W. L. Joerg. American Geographical Society's 50-page history of all arctic and antarctic expeditions using aviation. Colored maps (23 by 18) of arctic with all relevant data, and bathrymetric map (14 by 26) of southern seas and Antarctica. Both maps worthy of this society of professional geographers. *American Geographical Society, Broadway at 156th St., New York City.—$5.00.*

Miscellaneous

BIRTHSTONES. A beautiful little brochure, in which the gems are shown in color in the matrix, as cut, and as presented in jewelry. There is a "birthstone" map. Printed in full color. *Cartier, Fifth Ave. and 52nd St., New York City.—Gratis.*

TAKING THE RISK OUT OF HIDES deals with the hide futures market, explaining how it is used by packers, tanners, importers, exporters, dealers, and manufacturers. Other publications of a similar nature deal with such commodities as grain, sugar, rubber, cotton, and raw silk. *Harris and Vose, 60 Beaver Street, New York—Gratis.*

WATER POLLUTION RESEARCH, SUMMARY OF CURRENT LITERATURE (ABSTRACTS 1 TO 119), contains summaries under six main headings as follows: Water Supplies, Analysis and Examination of Water, Sewage, Trade Waste Waters, Pollution of Natural Waters, and Miscellaneous. *Department of Scientific and Industrial research, 16 Old Queen Street, Westminster, S. W. 1, England—35 cents (money order).*

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Cadillac	All	...	...	...	.x.	.x.
Chrysler	66, 70, 77	.x.	.x.	.x.	...	.x.
	Imperial	.x.	...	..	...	.x.
Cord	All	.x.	.x.	. .	.x.	.x.
Cunningham	All	.x.	.x.	.x.	...	.x.
DeSoto	All	.x.	.x.	.x.	...	.x.
Dodge	All	.x.	.x.	.x.	...	.x.
Durant	614	.x.	.x.	.x.	.x.	.x.
	617	.x.	.x.	.x.	...	.x.
Elcar	75	.x.	.x.	.x.	...	.x.
	95, 96, 120	.x.	.x.	...	...	.x.
Erskine	All	.x.	.x.	.x.	.x.	.x.
Essex	All	.x.	.x.	.x.	...	.x.
Ford	All	.x.	...	.x.	.x.	.x
Franklin	All	.x.	.x.	.x.	.x.	x.
Gardner	All	.x.	.x.	.x.	...	.x.
Graham	Standard Six	.x.	.x.	.x.	.x.	.x.
	Special Six	.x.	.x.	...	...	.x.
	Eights	.x.	.x.	...	.x.	.x.
Henney	All	.x.	.x.	.x.	...	.x.
Hudson	All	.x.	.x.	.x.	...	.x.
Hupmobile	S & C	.x.	.x.	.x.	.x.	.x.
	H & U	.x.	.x.	.x.	...	.x.
Jordan	All	.x.	.x.	.x.	...	x.
Kissel	73 & 95	.x.	.x.	.x.	...	.x.
	126	.x.	.x.	.x.	.x.	.x.
Kleiber	All	.x.	.x.	.x.	...	.x.
LaSalle	All	...	...	...	...	.x.
Lincoln	All	.x.	.x.	.x.	.x.	.x.
Locomobile	86 & 88	.x.	.x.	...	..	.x.
Marmon	69	.x.	...	...	...	.x.
	79 & H	.x.	.x.	...	...	.x.
McFarlan	All	.x.	.x.	.x.	...	.x.
Moon	All	.x.	.x.	.x.	...	.x.
Nash	Std. 6	.x.	.x.	.x.	.x.	.x.
——	All	.x.	.x.	...	.x.	.x.
Peerless	B & C	.x.	.x.	...	...	.x.
	A	.x.	...	...	..	.x.
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	15	.x.	.x.	...	...	.x.
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Roosevelt	All	.x.	.x.	.x.	...	.x.
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Stutz	All	.x.	.x.	.x.	...	.x.
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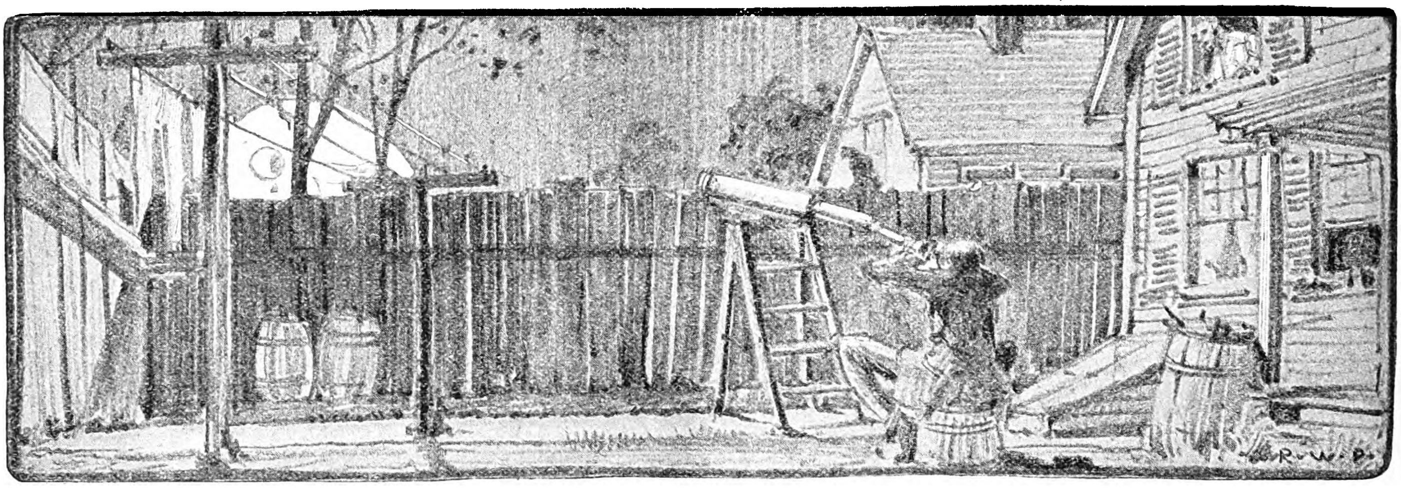
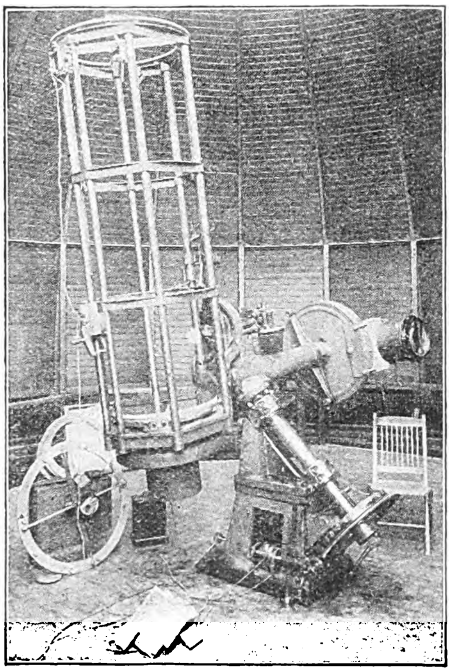


The Amateur Astronomer

AMATEUR telescope makers who recall the publication of the Reverend W. F. A. Ellison's picture in the March number, and the suggestion there made that it be clipped out and pasted in the instruction book, "Amateur Telescope Making," may wish to do as much with the photograph which appears at the right. This picture of Mr. Porter, which was taken by Dr. Clyde Fisher, president of the *Amateur Astronomer's Association,* (American Museum of Natural History, New York), is a much better likeness than the one on page 19 of "Amateur Telescope Making." Mr. Porter is still at Pasadena co-operating on various pieces of work, optical, mechanical, and architectural, preliminary to the final construction of the 200-inch reflecting telescope.

Russell W. Porter



24-inch at Yerkes

THIS month we shall discuss the merits of the open or skeleton tube reflector, in contradistinction to the more common closed or solid-sided tube, and two open-tube telescopes of this type are shown here. Of these the one below is a strictly professional job. The mirror was made some years ago by Ritchey, who also supervised the construction of the mounting. The figure of the mirror is very perfect, and extremely fine photographs of nebulae have been obtained with it, according to Director E. B. Frost of Yerkes Observatory, mainly by Ritchey, when the latter was connected with this Williams Bay, Wisconsin, institution. A detailed description of this reflector will be found in Volume 14 of the *Astrophysical Journal*, and a large photograph for those who care to study its structural detail may be had from the Observatory, for 50 cents.

The other skeleton tube telescope is one recently built by Professor Dinsmore Alter of the University of Kansas and Mr. William Pitt, retired manufacturer. As several requests for information have failed to bring forth much satisfaction (the photograph itself having been purchased from a news photograph agency), no details can be stated here, except that it has been known among astronomers for several years that Professor Alter was engaged in making the instrument. The 27-inch mirror was made from a 27-inch disk of Pyrex four inches thick.

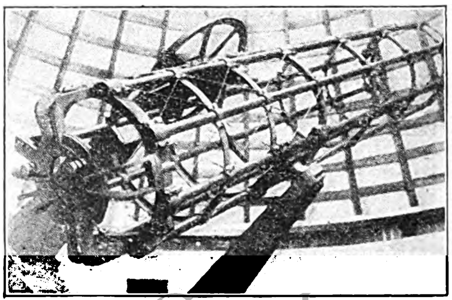
OPEN-TUBE telescopes of the kind just mentioned are strongly advocated by the Reverend T. E. R. Phillips, M.A., F.R.A.S., and F. J. Hargreaves, F.R.A.S., in comment reproduced by kind permission from the *Journal of the British Astronomical Association* (London). The Reverend Phillips is Director of the Section on Jupiter, and Mr. Hargreaves of the Section on Photography, of that organization. They write:

"There is a widely held view that reflectors are much inferior to refractors in defining power, assuming equal optical quality, and there can be little doubt that in most cases this is so, especially when the reflector tube is of metal and closed on all sides. Experience over a long period at Headley with an 8-inch refractor and a 12¼-inch reflector in an iron tube shows that the number of nights when the image in the reflector is as good as that in the refractor is very small.

"A third instrument at Headley, the Association's 18-inch reflector, formerly the property of the late N. E. Green, has recently been remounted in the dome formerly occupied by the 12¼-inch, and its performance since remounting is worthy of record insofar as it affects the question of the relative merits of the two types of instrument.

"Before the remounting, the 18-inch mirror was carried by a square wooden tube, completely closed on all sides, and the image usually had the well-known reflector characteristics—unsteadiness, lack

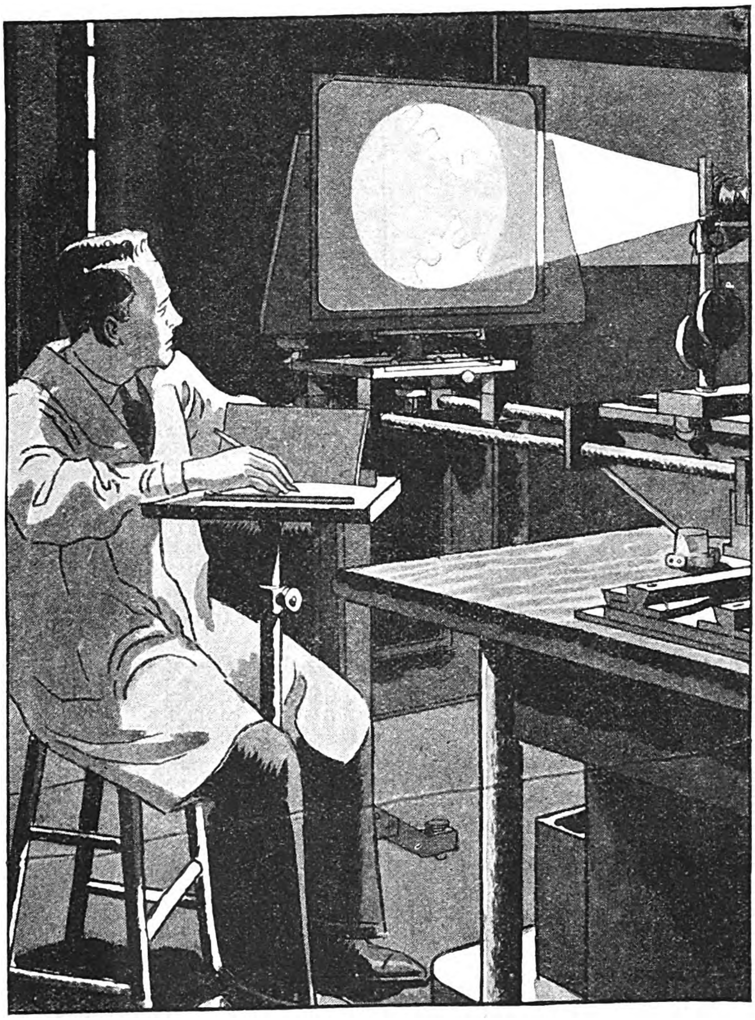
(*Please turn to page* 405)



Alter-Pitt reflector

A RAINBOW

now helps to make Better Machines



Up the hill to the busy Westinghouse research laboratories in East Pittsburgh come engineers of a great industry asking, "What shape shall we make these machine parts to get the greatest strength from our materials?"

Light flashes on a snow-white screen. Outlines on the machine part appear. Then someone turns a loading screw and areas of color are seen changing their hues as the load on the test model increases. Black turns to gray, gray to yellow, yellow to red, brown, green and so on. In this manner the machine part appears in colors of a laboratory rainbow that tells its own story for keen eyes to read—a well-directed ray of light discloses where the heaviest stresses are.

"Photo-elastic tests" the engineers call them. And from tests like these slight changes in shape give vast gains in strength without added material. Sometimes even less material actually gives greater strength. A laboratory rainbow does what the most elaborate calculations could not do.

These tests are but one instance of the methods by which Westinghouse research is engaged in finding new ways to help dollars in industry, in business, in homes, obtain larger returns for those who spend them. In finding new facts, and new ways to use old facts for new gain, Westinghouse serves the modern electrical age in which you live.

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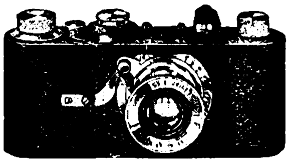

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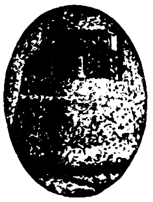

Weighs Less Than a Pound

Our Point of View

France and the Naval Conference

(*Continued from page* 349)

building program; and, thanks to their large additions to the cruiser strength made since 1921, they are in an excellent position to resume competitive building.

The economic position of France is better than at any time since the World War. There is no unemployment problem, her gold reserve is large, the reconquest of Alsace and Lorraine makes her self-sufficing for coal and iron, and as long as she controls the Mediterranean route to Algiers, her supply of foodstuffs is secure. So France faces the future with confidence, is encircling her land frontiers with modern fortifications, and purposes to provide sufficient naval force to secure her position in the Mediterranean. Tardieu's demand on Stimson and MacDonald for guarantees in exchange for naval limitation is suggestive of Clemenceau's demand on Wilson and Lloyd George for a security pact in exchange for the League of Nations. France pursues a consistent course in her foreign policy.

Italy stolidly reiterates her claim to absolute parity with France. England claims she must maintain a navy equal to the combined navies of the next highest European navies; and her agreement to reduce her tonnage to an amount acceptable to us is contingent on her tonnage being equal to the combined tonnage of France and Italy.

Britain is willing to give the guarantees required by France if we will countersign the guarantee, but our delegation well knows that though the American public is anxious for naval limitation, it will not purchase limitation by again involving the country in Europe's affairs. When the British delegation is asked to find a formula acceptable to France they point to their existing obligations under the Locarno and the Lausanne agreements to use their fleet to support the decisions of the League of Nations against an aggressor nation, pointedly remind us that we have not accepted any such obligation, and request us to share any further responsibilities Great Britain is called upon to assume. This part of the problem therefore is developing just as anticipated.

Great Britain and the United States could agree on a parity at a tonnage not in excess of that which the United States is willing to build, if France and Italy combined would not build a larger fleet than Britain's. If France insists on 700,000 tons, and Italy insists on as much, then Great Britain must have 1,400,000, which is more than the United States wants to build. Great Britain, on the other hand, is willing to build the larger tonnage and expresses a perfect willingness for us to achieve parity by building up to her requirements.

There is a small but influential section in Great Britain that rather welcomes the threatened impasse on the theory that the United States is unwilling to spend the money on its fleet necessary to achieve parity, and that Great Britain, having made its gesture of accepting parity with the United States, will, if the Conference fails, be free to continue its building program and once again achieve an overwhelming sea supremacy. For our part we believe that the American people are resolved to have a navy second to none and while they would prefer to spend their revenues on internal improvements, they are prepared to maintain their fleet if the complexities of European jealousies make this necessary. Ours are a busy people, more intent on their daily tasks than on world politics. They are a peaceful people, enjoying more prosperity than others and consequently unenvious of others, but they are fully aware that their prosperity is dependent on their sea-borne commerce, inter-coastal as well as foreign. In the World War, they saw the sea-borne commerce of Germany, who possessed the second best navy in the world, swept off the seas within 30 days and we are confident that never again will the United States be content with a navy that is not equal in every class of vessels to that of any other nation.

Japan and the United States are discussing the ratio of cruisers, destroyers, and submarines; Japan demands 70 percent but the United States claims that Japan is morally committed to a 60 percent ratio, the same as in capital ships. Japan has the legal right on her side, but unquestionably it was the understanding of this country when it agreed to restrict the fortifications of its Far East posses-

(*Continued on page* 407)

SHIP-BUILDING PROGRAM, 1921-1929—CRUISERS.

UNITED STATES			GREAT BRITAIN			JAPAN		
No.	Tonnage	Cal. Guns	No.	Tonnage	Cal. Guns	No.	Tonnage	Cal. Guns
10	7,000	6"	7	5 to 8,000	6"	13	5,200	5.5"
1	10,000	8"	13	10,000	7.5" or 8"	8	7 to 10,000	8"
11	80,000	6" to 8"	20	169,000	6" to 8"	21	136,000	5.5" to 8"
DESTROYERS								
None			30	38,400	4.7"	61	73,700	4.7"
SUBMARINES								
38	800	4"	8	800 to 1,000	4"	36	800 to 1,000	4.7"
4	2 to 3,000	5" to 6"	11	1,500 to 2,500	4" to 5"	19	1,400 to 2,000	4.7"
42	39,400		19	24,200		55	66,000	

The Scientific American Digest

(Continued from page 394)

on a wet soil is prevented. Water will sink through that kind of a furrow several times faster than from a shallow furrow.

The advantages of the deep-tillage system (with sub-soiling and without plowing) and cover crop culture have been summarized by the Agricultural Extension Division, University of California, as follows:

(1) The cost, as compared to plowing and ordinary tillage methods is reduced in some cases as much as 50 percent. (2) All cultural operations are speeded up, making it possible to take advantage of favorable weather conditions. (3) Incorporation of the organic matter (cover-crop) throughout the entire area of the soil, is facilitated. (4) The humus content of the soil is increased. (5) The soil is given greater water-holding capacity. (6) The soil (especially in orchards) is more easily kept level. This is important in irrigated districts. (7) By conservation of moisture, the number of necessary irrigations is lessened. (8) More complete aeration of the soil results, with consequent increase in the beneficial activity of soil bacteria and fungi. (9) Roots (of fruit trees) are pruned, with the result that fine feeder roots are put out, increasing the assimilation of moisture and plant food. (10) The friability and general physical condition of the soil are improved.

Strange Stone Head Discovered in Texas

A GREAT stone, naturally shaped like a human head and carved with teeth, ears, eyes, and flattened chin, is a strange new discovery from Texas, unearthed from its resting place beneath 16 feet of undisturbed gravel.

Dr. E. H. Sellards, geologist of the University of Texas, brought news of the discovery to the Paleontological Society. The stone head appears to be a new piece of evidence that man existed in America in ancient times.

Judging by the geological conditions of the region, the stone must have lain in place while the gravel from nearby streams washed over it forming finally a layer more than 16 feet deep, Dr. Sellards said. The streams have long since ceased to wash gravel over the site. The stone weighs at least 75 pounds, possibly 100, he reported. —*Science Service.*

Ford Adopts New Alloy

WHEN the redesigned Model A Ford was announced late last December, the official description stated that exterior metal parts were made of rustless steel. It is now learned that the metal referred to is not the usual rustless steel, but an entirely new alloy never before used in automobiles. The Ford company's adoption of the product has more than doubled its output in this country.

The new alloy is known as Allegheny metal. The original formula for its manufacture was developed in Germany during the war, when armament plants were seeking the hardest possible substance suitable for gun lining. At about the same time, the English also worked out the formula. It was not until after the war, however,

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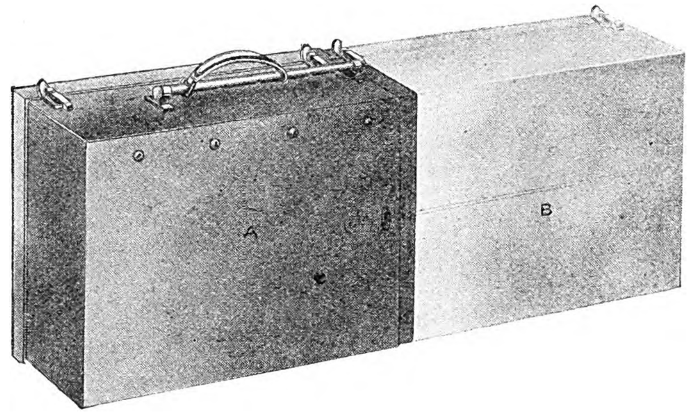
Aerial Wire Rope Tramways designed by this company have features that insure economical operation.

Luggage Manufacturers

I wish to interest buyers in purchasing license or royalty contracts of patent rights on the patent number 1748024.

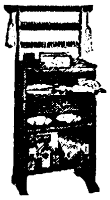


Here is an opportunity to acquire the manufacturing rights to an invention relating to collapsible cases which telescope lengthwise. The telescoping parts lock solid when the case is closed, the lid may be opened in any position, and a movable handle establishes balance for carrying. These principles can be applied to any type of carrier from a personal hand bag to a trunk. Any material could be used for construction, wood, canvas, leather, cane, fiber, composition, papier mache, metal, etc. One of the most popular and useful applications of this invention would be to bags such as the one illustrated.

The possibilities of this telescoping principle as applied to industrial shipping cases should not be overlooked. Such a case made of unbreakable waterproof papier mache would institute a tremendous saving in shipping certain types of products since they could be used repeatedly and are adaptable to the size of the shipment.

Manufacturers interested in this device should write the inventor,

WILLIAM W. MACHEMER
318 Schaeffer Street, Brooklyn, N. Y.



Permanent Waving Cabinet

Time and Labor Saving Device for Hairdressers. Open for Proposition.
Patent 1717217.
John L. Izan, 245 Bull St., Savannah, Georgia

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that the commercial production of the alloy was contemplated and it was only a few years ago that methods for its economical manufacture in large tonnage were developed.

The Ford requirements are said to be about 1000 tons a month. This represents two thirds of the entire output of the American factories and one third of the output of the world, which is now about 3000 tons. When he adopted the alloy, Mr. Ford had to scrap several million dollars' worth of equipment originally installed for fabricating and polishing the nickel used in the original Model A.

Allegheny metal is said to be nonrusting, untarnishable, non-corrosive, and not affected by weather in any way. It is also one of the hardest metals known to the steel industry. It is an alloy of refined steel combined with about 18 percent of chromium, 8 percent of nickel and smaller proportions of carbon, manganese, silicon, phosphorus, and sulfur. It is the complicated method of combining these elements that gives the alloy its properties, it is explained.

Before its adoption by the Ford Company, production of the alloy was limited, because it was used only for building trim, cooking utensils, dairy equipment, and other articles for which it met special requirements. It is now being considered for use in the bars of State penitentiaries, according to report, because it is so hard that it cannot be sawed or otherwise cut by any hand tool.—*The New York Times*

Measure Wind Passing Through Brick Walls

WIND blows right through brick walls. A well-laid 13-inch wall in the face of a 30-mile-an-hour wind will allow 14.75 cubic feet of air to pass through it every hour, G. L. Larson, D. W. Nelson, and C. Braatz reported to the International Heating and Ventilating Exposition in Philadelphia recently. This data is obtained from researches they have conducted at the University of Wisconsin.

But proper plastering with gypsum directly on brick, they find, will stop 96 percent of the leakage. Less air will leak through a wall which has been well constructed and in which all spaces between bricks are filled with mortar.—*Science Service*

Test Shows Efficacy of Auto Oil Filter

IF automobiles are equipped with oil filters, frequent changes of oil in crankcases are unnecessary, a test trip across the continent by A. H. Hoffman, associate agricultural engineer at the University of California agricultural experiment station, tends to show.

On the trip, during which the speedometer showed 10,025 miles of travel, Mr. Hoffman found that after a change of oil, the viscosity dropped rapidly for about 200 miles, and then changed little for 5000 miles.

The tests on acidity were much the same, the acidity rapidly rising for about 200 or 300 miles, then showing small variation.

Only one machine was used in the experiment. In addition to the oil filter it had a crankcase ventilator, and both carbureter and breather were protected against dust. The test was made in warm weather.—*Science Service.*

The Amateur Astronomer

(*Continued from page* 400)

of crispness, and inability to bear high magnification.

"The sides of this wooden tube were made after the manner of a door, with stiles, rails, and panels. The panels having for the most part rotted, they were removed prior to the re-mounting of the instrument, and it was decided not to close in at once the large openings left by their removal, in order to observe the effect of allowing the air to circulate freely through the tube. In brief, the effect is to remove completely the characteristic defects of the reflector, so far as planetary images are concerned.

"The performance of this instrument has surpassed all expectations—so much so that in spite of the great disparity of aperture it is now rare to find, on occasions of poor seeing, that the refractor image is steadier or better-defined than that of the reflector.

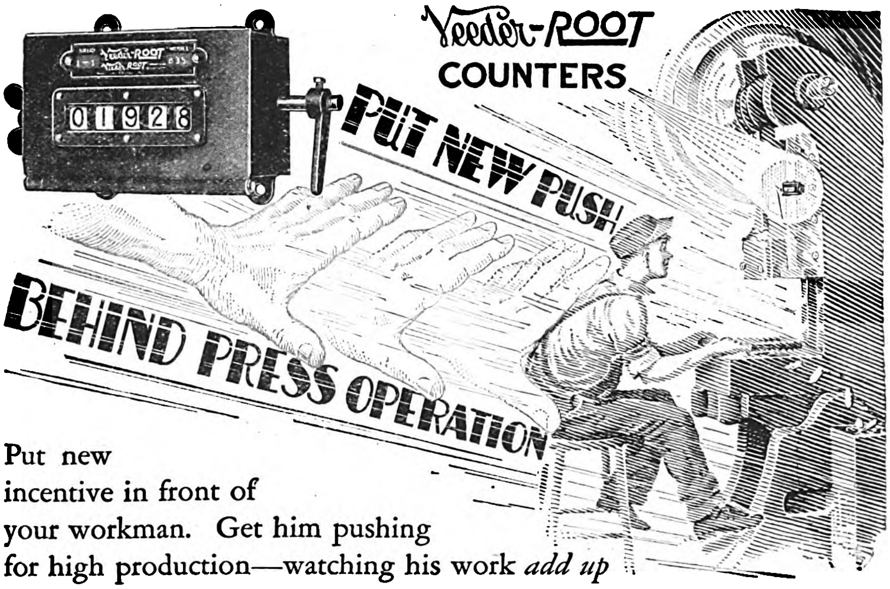
"It should be understood that no claim is made for novelty in the idea of the skeleton tube, which, of course, is used for all the very large reflectors; it is only desired to point out the very great benefits to be obtained by adopting this type of tube for the smaller instruments, for which it has not hitherto been generally used.

"Experiments have shown that when the external temperature is falling, as of course is the general rule at night, it is impossible to keep the temperature of the air inside a "closed" tube uniform and equal to that of the external air. An electric blower sending a current of air up the tube is a help in the smaller sizes, but the trouble begins again as soon as the blower is stopped. In the case of a metal tube, the upper wall becomes colder than the lower wall by radiation, thus setting up convection currents within the tube. If the tube is lagged with felt, or if it is of wood, this trouble is avoided in part, but the tube and the air within it will then remain warmer than the external air during the whole time that the temperature is falling, and for some time after.

"The presence of this mass of relatively warm air can be made visible readily when the conditions are suitable. The telescope should be directed to a bright star and the eye-piece racked out considerably to give a large out-of-focus disk, which will be seen to be irregularly in motion. If an assistant then opens the door near the bottom of the tube and flaps a piece of cardboard vigorously in front of the opening, the out-of-focus disk will "boil," owing to the inrush of the cooler air. The air within the tube can be readily set in rotation by this means, and the rotation is visible in the eyepiece; but no amount of flapping will bring about uniform conditions."

So much for one side of the question. In a long article entitled "Reflectors versus Refractors," in the March number of *Popular Astronomy* (Northfield, Minn.) Prof. W. H. Pickering discusses both sides.

STILL another telescope, a 19-inch reflector having an open tube, is described in the January, 1930, number of the *Journal of the Royal Astronomical Society of Canada*, by its maker, Professor R. K. Young, of the Department of Astronomy at the University of Toronto. The illustrated article is detailed (16 pages) and ought to be obtained by every amateur who aspires to



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make a fairly large telescope at some future date. The address is *Journal of the R. A. S. C.*, Mr. H. W. Baker, Treasurer, 198 College Street, Toronto, and the price is 25 cents.

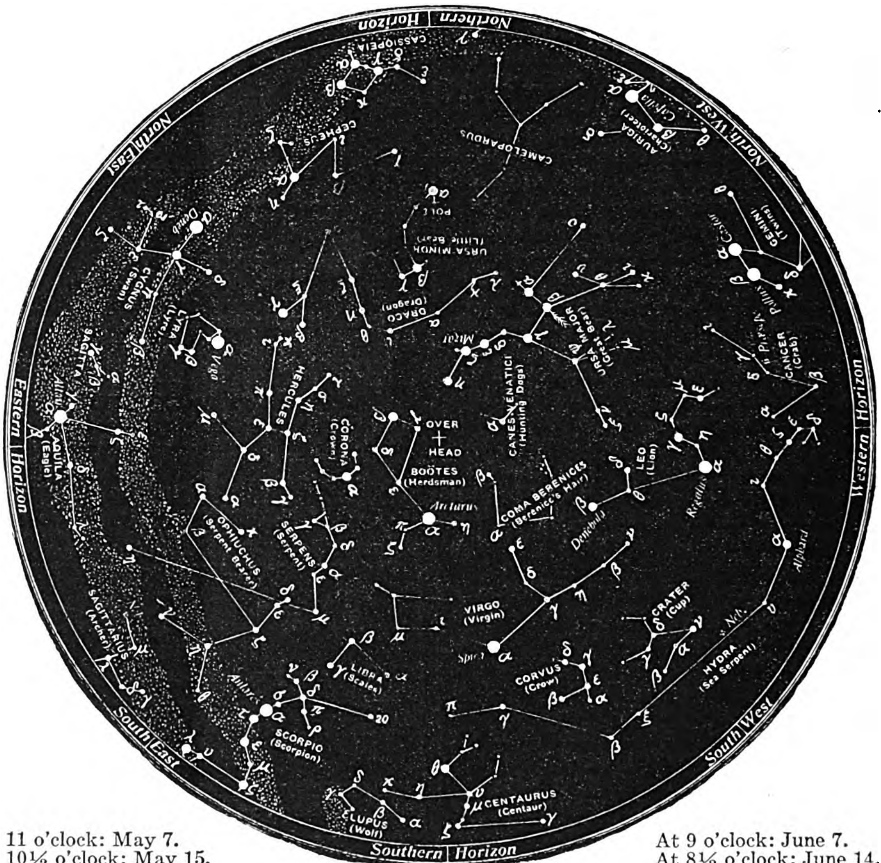
Another current scientific journal which those who are especially interested in the Hale spectroheliosope should not miss is the December, 1929, number of the *Astrophysical Journal* (5750 Ellis Avenue, Chicago; 75 cents), containing a 46-page article on that instrument written by Dr. Hale and strikingly illustrated by R. W. Porter. Since the publication of "Amateur Telescope Making" with its description of the spectroheliosope, numerous alterations in design have been made.

Professor Charles W. Woodworth of the University of California, is making a mosaic type of telescope containing 400 mirrors, each 15 inches in diameter, and all attached to a single rigid backing. Each is to be adjusted, if possible, to the position called for by theory. Dr. Woodworth submitted his idea to this journal a year or more ago and the opinion given through one of its corresponding editors was that the theory was correct but in practice the difficulties would probably prove insuperable (see "A. T. M.", page 242, near bottom). He is now trying it out, and this is the correct procedure in cases where there is any doubt. Dr. Woodworth is an entomologist who has specialized on microscope theory, with which telescope theory has much in common. The amateur fraternity will wish him success.

—*A. G. I., Tel. Ed.*

The Heavens in May

By PROF. HENRY NORRIS RUSSELL, Ph.D.


Northern Horizon
North West
North East
Western Horizon
Eastern Horizon
South West
South East
Southern Horizon
CASSIOPEIA
CEPHEUS
CAMELOPARDUS
AURIGA (Charioteer)
Capella
POLE
URSA MINOR (Little Bear)
DRACO (Dragon)
Mizar
URSA MAJOR (Great Bear)
GEMINI (Twins)
Castor
Pollux
CANCER (Crab)
CYGNUS (Swan)
Deneb
LYRA (Lyre)
Vega
SAGITTA
AQUILA (Eagle)
Altair
HERCULES
CORONA (Crown)
CANES VENATICI (Hunting Dogs)
OVER HEAD
BOÖTES (Herdsman)
Arcturus
COMA BERENICES (Berenice's Hair)
LEO (Lion)
Regulus
Denebola
OPHIUCHUS (Serpent Bearer)
SERPENS (Serpent)
VIRGO (Virgin)
Spica
CRATER (Cup)
CORVUS (Crow)
HYDRA (Sea Serpent)
Alphard
SAGITTARIUS (Archer)
LIBRA (Scales)
SCORPIO (Scorpion)
Antares
CENTAURUS (Centaur)
LUPUS (Wolf)

At 11 o'clock: May 7.
At 10½ o'clock: May 15.
At 10 o'clock: May 22.
At 9½ o'clock: May 30.
At 9 o'clock: June 7.
At 8½ o'clock: June 14.
At 8 o'clock: June 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on May 7, etc.

NIGHT SKY: MAY AND JUNE

MERCURY is an evening star till the 20th and then a morning star, but can be well seen only during the first few days of the month. Venus is an evening star, growing more and more conspicuous as she comes north and gets farther from the sun. She sets at 8:30 when the month begins and 9:30 at its close. Mars rises in the neighborhood of 3 A.M. but is still almost 200,000,000 miles away and in consequence looks but little brighter than a star of the second magnitude. Jupiter is still an evening star but is getting low in the west. By the end of the month he sets a little after 8 P.M. and can hardly be seen. Saturn is in Sagittarius and rises at 10:30 P.M. in the middle of the month. Uranus is a morning star rising at 3 A.M. in the middle of the month, while Neptune is in quadrature on the 22nd and becomes an evening star.

The moon is in her first quarter at noon on the 5th; full at noon on the 12th; in her last quarter at 11 A.M. on the 20th; and new at 1 A.M. on the 28th. She is nearest us on the 4th, farthest off on the 19th, and nearest again on the 31st. As she circles the sky she passes near Jupiter on the 1st, Neptune on the 6th, Saturn on the 16th, Uranus on the 24th, Mars on the 25th, Mercury on the 27th, Jupiter again on the 29th, and finally Venus on the 30th of the month.

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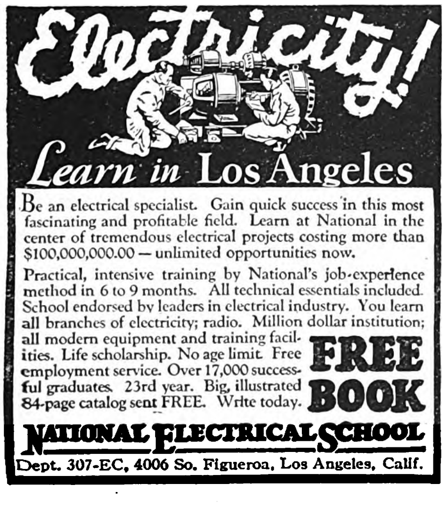

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Our Point of View

France and the Naval Program

(Continued from page 402)

sions that the 5 : 5 : 3 ratio applied to all classes. Australia, New Zealand, and Canada object as decidedly as we to an increase in Japan's auxiliary craft, but Great Britain is permitting our delegation to do the negotiating with Japan. If Japan proves obdurate, our only recourse will be to refuse to extend the agreement in the Far East in 1931.

Unquestionably both Great Britain and Japan are relying somewhat on our reluctance to spend the money necessary to create a navy, and they have some reason because of the ship-building program from 1921–1929 of the three countries, of cruisers, destroyers, and submarines, as shown in th table on page 402.

Thus since 1921, in the types of naval vessels not limited by the Washington Conference, Great Britain has built practically twice as many cruisers and Japan 40 percent more cruisers than the United States; in destroyers we have built none, while Great Britain has added 38,000 and Japan 74,000 tons. It should be added, however, that in 1921 we had a considerably larger number of modern destroyers than either Japan or Great Britain. In submarines, Japan has built over twice as many as Great Britain and 40 percent more than the United States. For eight years we practically refrained from adding to our fleet, with the result that except in capital ships we have been outbuilt by both Great Britain and Japan. If the Conference succeeds we will have to build to catch up with Great Britain and to regain the 5 : 3 ratio with Japan; if the Conference fails we will have to build still more or expose our commerce to the not over tender mercies of belligerent cruisers when we are neutral, or to the hostile action of enemy cruisers when we are a belligerent. As we go to press it looks as if the action of France would eventually decide the size of our Navy; to such curious results do international agreements lead.

Chemistry in Industry

(Continued from page 397)

M. R. Tern, of Zinnowitz, has lately been developing a process whereby the production of the sulfate is carried out without the use of sulfuric acid, and the process is said to have been successfully tried out on the large scale in Germany, where it has been attracting a good deal of attention.

The production of ammonium sulfate by passing ammonia gas through dilute sulfuric acid is such an old established process that no one but a German chemist would have thought it feasible to revolutionize the process. Dr. Tern's invention brings two gases together to form a shower of crystals, completely eliminating the saturators in which the ammonia gas is bubbled through acid. He produces sulfur dioxide gas by roasting the spent oxide, which is a waste product of the gas plant. Then he passes this gas through an electric arc, oxidizing it to sulfur trioxide. This gas then mixes with ammonia gas in an

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Chemicals Do Not Fool Chickens

THE United States Department of Agriculture warns that no known drug or combination of drugs when fed to poultry will increase egg production. It has objected repeatedly to the use of any label on drug preparations for fowls which indicates that the preparations will increase egg production, and will continue actively its action against any preparations appearing in interstate commerce violating the law in this manner.

Enzyme in Bleaching Flour

GIVE us our daily bread and give it to us white, say Mr. and Mrs. American Public; wherefore flour millers, at the insistence of bakers, bleach the flour with chemicals before it goes on the market. This demand for white flour is largely a psychological one, for the carotin in wheat which normally colors it is entirely harmless and the bleached flour is neither purer nor more nutritious.

Until recently all flour-bleaching processes were based on rather potent oxidizing agents. Chemicals such as chlorine gas, nitrogen tri-chloride, nitrogen peroxide, and benzoyl peroxide are the oxidizing agents generally employed by flour millers for bleaching flour. Three of these are used in gaseous form, the fourth being a powder. In addition to their bleaching effect, all these bleaching agents effect an alteration in the baking characteristics (volume, grain, and texture) of the flour so treated. The chemicals effect the desired whitening of the color of the bread, but they also act on the flour protein, which forms the gluten of the dough. It follows that the flour is not only bleached by the bleaching agents but is also more or less modified in its other characteristics. Moderate treatment seems to improve the baking quality of the flour; over-treatment (overbleaching) may have undesirable effects in terms of its adaptability to yeast-bread production.

The latest development in the field of flour bleaching is the utilization of color-removing enzymes. The first compound containing these enzymes in activated form has just been announced under the trade name of "Do-White," a finely-ground, white-colored powder with a pleasing leguminous taste. Do-White is a pure, edible, plant product, containing no added chemical salts. It is partially soluble in water; in a small quantity of water it has a tendency to form a stiff jelly. Its active principle is an enzyme that has the ability to destroy or decolorize the natural, carotinoid pigment of flour. One half to one pound of it will completely

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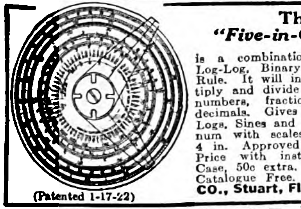
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New Plastic Material from Cornstalks

OUT in the "corn belt," chemists have dreamed of converting the useless cornstalks into a useful article of commerce. Indeed, the dreams have been realized to a certain extent by the recent perfection of a process for making wall board from the stalks that were formerly useful only as Hallowe'en decorations. The most obvious use however, namely their conversion into paper, has thwarted the efforts of chemists, mainly because of the difficulty of overcoming the tendency of the pulp to hydrate, a property which seems characteristic of this material.

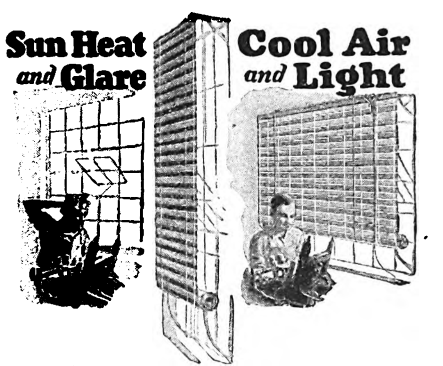
Scientists at Iowa State College finally hit upon the idea of turning this stumbling block into a benefit, and have produced a new material known as "maizolith." This material is somewhat like hard rubber in appearance and properties. It is believed that cornstalks may eventually find their way into the manufacture of insulating material, noiseless gears, and similar products. It has been found rather easy by severe chemical and mechanical treatment to hydrate the cornstalk completely so that the product is a jellylike mass with no vestige of fibrous structure. Maizolith is prepared by drying this jelly and then machining the finished piece into the desired shape.

Russian Chewing Gum Proves to be Rubber

A PLANT having a larval parasite which produces cocoons of a rubber-like substance has been discovered in Soviet Russia, following the search in that country for new sources of rubber, according to information obtained by the Department of Commerce from a Soviet publication. These cocoons have long been known to the local population and are used as a sort of chewing gum, but in the opinion of Soviet investigators they are thought to consist of rubber.

The constant development of the rubber industry in Soviet Russia has involved an increasing expenditure of foreign currency for the purchase of raw materials. Two methods have been suggested to remedy this situation: the manufacture of synthetic rubber and the cultivation of rubber-bearing plants. The Rezinotrest (the Russian rubber trust) has experimented in cultivating guayule shrubs in several of the southern regions of the Soviet Union, but these experiments cannot as yet be pronounced successful. Attempts have been made also to find other plants capable of producing rubber.

In Kazakstan, in the sands of Barkhan, several varieties of Chondrilla are found, which secrete a sort of rubber and which also is used by the Kazaks for chewing gum. This material has been examined by the Supreme Council of National Economy and Rezinotrest chemists, who classify the gum as rubber.



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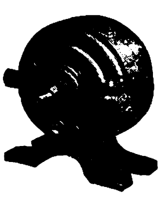
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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

American Corporations in Mexico

THE Supreme Court of Mexico has recently decided in a suit instituted by The Palmolive Company against an infringer of its trademark registrations in Mexico, that a foreign corporation, whether it be doing business in Mexico or not, is precluded from bringing suit in the Mexican Courts unless and until it is registered in the Commercial Registry. Such registration might be rather expensive, the fee depending largely on the amount of the capital of the corporation; thus, a corporation capitalized for 100,000 dollars would be required to pay from approximately 1000 to 1500 dollars for recording and legal fees. The registration referred to is not the registration of trademarks in Mexico but the registration of the corporation as doing business in Mexico.

The suit by The Palmolive Company was on its trademark, which had been duly registered in Mexico; actual infringement had been established but nevertheless the Supreme Court held that the plaintiff corporation has no standing in the Mexican Courts, because not being registered as doing business in Mexico, it has no existence in Mexico. This decision unless modified will have a far-reaching effect on the rights of American corporations in connection with their trademarks and other industrial property in Mexico. Although clearly erroneous, it will nevertheless be the law of Mexico unless it shall be set aside. The Department of Commerce has already laid the matter before our State Department.

Such a condition of affairs should not be permitted to continue. The Courts of every land should be open to afford complete relief to the owner of a registered trademark, and to prevent infringement thereof and imposition on the purchasing public by the substitution of the infringer's merchandise for that of the owner of the trademark.

Patents and Taxes

A RECENT decision of the Court of Claims in the matter of the claim of the Westclox Company for recovery of excess taxes paid by that company, reported in the *United States Daily* of February 6, 1930, is of considerable interest, not alone in showing that in computing income-and-profits taxes due consideration must be given to the advantages accruing to an industry because of patent protection, but also as outlining a rule for estimating the value of the savings resulting from the employment of the patented invention as compared with other processes and machines employed by competitors in the same line of business.

The patents covered a machine for automatically producing pinions and wheels, and also other patents for the design of the clocks manufactured by the claimant. Using as a basis the cost of producing ten thousand such wheels by the patented machine as compared with the machines and processes in use by others, the Court finally estimates the savings attributable to the patents; this is multiplied by the remaining life of the patents, in order to estimate the deduction which should have been made by the tax payer before computing the amount of its income-and-profits taxes.

In addition to the patents which were discussed, the value of the trademarks under which the clocks were sold was considered, and on the whole case as presented, the Court ordered that the parties compute the amount of the recovery and come to some stipulation with regard thereto.

This was a case where the patented inventions were not manufactured and sold, but offered protection only for the exclusive use of the machines employed in producing certain parts of the clocks. This is true, of course, excepting as to the Design Patents which covered the ornamental appearance of the clocks themselves.

If the protection of the exclusive right to use a certain machine, as compared with what one's competitor is compelled to use, is of so much value, it must follow that the exclusive patent protection for something that is manufactured and sold is of far more value. The theory on which the claim was allowed was that these protective patents were gradually expiring and that in time they would no longer be a source of profit to the owner, as upon their expiration the subject-matter thereof would be free to competitors.

Agreements Voided for Pooling Patents

THE United States District Court for the Northern District of Illinois has entered a decree in the so-called "oil-cracking case" by which agreements between several oil companies for pooling certain patents have been declared void. The case, as reported by the *United States Daily*, concerns agreements made between the Standard Oil Company of Indiana, the Texas Company, the Standard Oil Company of New Jersey, the Gasoline Products Company, *et al.* The patents involved covered processes and apparatus for producing gasoline by "cracking" petroleum. The agreements dealt with royalties for the use of such processes, as well as with the various patents. The suit was brought by the United States against the oil companies for alleged violation of the Sherman Antitrust Law.

In addition to holding the agreements null and void, the court said: "It is further ordered, adjudged, and decreed that the primary defendants and the secondary defendants and each and all of their respective officers, directors, agents, servants, and employees, and all persons acting or claiming to act on behalf of them, or any of them, be, and they are perpetually enjoined and restrained from further executing and performing said agreements.

"It is further ordered, adjudged, and decreed that jurisdiction of this cause be retained by this court for the purpose of carrying out the terms of this decree."

Junior Applicant Wins Stoker Patent

RULING that the patent application of Chauncey L. C. Magee, covering certain improvements in mechanical stokers or grates, was filed after the invention had been disclosed to Magee by John C. Heavey, the Court of Customs and Patent Appeals has sustained the latter's claims. This decision confirms the opinion of the Commissioner of Patents, which had affirmed the decision of the examiners-in-chief, which in turn affirmed the decision of the examiner of interferences. All of the tribunals found that the junior party had disclosed the invention to the senior party, who had then filed application for a patent covering the device.

The appellant contended that the invention had originated with him, that the testimony of the junior applicant had failed to establish disclosure of the invention to him, and that the junior applicant's testimony had failed to overcome the prior record date of the Magee application. The courts, after investigating the facts involved, decided that Heavey had invented the device in question and had persuaded the manager of a large building in Chicago to have the apparatus installed by Magee, who was engaged in such work. It was disclosed that Magee had sent one of his draftsmen to Heavey to obtain the details of the apparatus. The equipment was made and installed, and Magee filed application for patent on the apparatus soon thereafter. Heavey filed application for patent some six months later, with the result that the Patent Office declared an interference to determine which of the claimants deserved the patent.

The invention relates to certain improvements in stokers or grates for furnaces of the type in which the grate bars travel through the furnace, supporting the fuel. The fuel is consumed as the grate moves. The particular improvement claimed consists of certain provisions for dividing the area of the moving grates into zones or sections for the purpose of supplying air upwardly through the different sections of the moving grate. This arrangement enables the air to be cut off from one section or zone and to be supplied to another by means of sliding dampers.

Court Finds Copyrighted Maps Were Copied

BECAUSE the maker of a composite map entitled, "Cleartype Road Map, Featuring Main Travel Routes within the Greater Metropolitan Area," had reproduced many errors, misspellings, and other peculiarities of certain maps copyrighted by the General Drafting Company, Inc., the District Court for the Southern District of New York ruled the defendant guilty of infringement. The case in suit was General Drafting Company, Inc., *versus* Lews H. Andrews, *et al.*

After pointing out that automobile road maps similar to those in suit are clearly the subject of copyright, the court appraised the method by which the maps had been prepared. It was found that the plaintiff had gone to considerable trouble and expense to prepare its maps, and had shown a noteworthy amount of originality in their preparation. The elements of the copyright consist, according to the court, in the selection, arrangement, and presentation of the component parts. The plaintiff's maps are sold in great numbers to the highway departments of several states, and to a number of the larger oil companies, for distribution to motorists.

The court ruled that if the defendant's map had been constructed after an independent investigation of the original sources in the public domain, without copying, the plaintiff would have no complaint. It was found, however, that the differences between the defendant's composite map and the several maps of the plaintiff were superficial. The defendant rested its case on the testimony of one Tudor, who described the manner in which he made the composite map. The testimony of this witness was shown to be of doubtful credibility, upon cross examination.

The case of the plaintiff was based upon the *prima facie* evidence showing the similarity, in unimportant and almost minute details, between the maps. Some 20 common misspellings were introduced, as well as 17 common errors in population symbols, the inadvertent misplacing of part of a river, arbitrary endings for roads at points actually not their endings, and the meanderings of highways, which in maps of this type are rather freely drawn. The court ruled that the defendant should pay damages and attorney's fees.

"Back of the Brawn, the Brain"

FROM a recent article in the *Journal of the Royal Society of Arts* (London), we are reprinting a tribute in verse to the world's inventors, and all those who design, build, and operate machinery.

"Back of the motors humming,
Back of the belts that sing,
Back of the hammers drumming,
Back of the cranes that swing,

"There is an eye which scans them,
Watching through stress and strain,
There is the Mind which plans them,
Back of the Brawn, the Brain."
—Berton Braley.

Wood Preservative Process Patented

ALTHOUGH the use of oil and sugar in treating wood is not new, patent has been awarded to George Elton Rice (Number 1732420) for a process of treating wood with oil and sugar which involves a function not present in the prior art and eliminates one step from the prior art processes. This decision of the Board of Appeals of the Patent Office, *ex parte* George Elton Rice, held that the examiner improperly rejected claims in an application for patent, because none of the references cited anticipate the process claims which cover the dehydrating as well as the impregnating of wood by treatment with a solution which contains oil and sugar.

Although it is old to preserve wood by impregnating it with preservatives carried in oil, and it is also old to preserve it by impregnating it with sugar in aqueous solution, the applicant had substituted oil for water with sugar and in so doing eliminated the necessity of drying the wood either before or after the impregnation process. This process involves more than the mere substitution of one preservative for another, in view of the fact that the drying process or step is eliminated. In the absence of any showing by the examiner that the result urged by the appellant is old or obvious, the claims were considered valid and allowable.

Patent Holder Must Give Notice of Alleged Infringement

THE owner of a patented article must give notice of his right therein, either to the public by marking his article "patented" or to the particular defendant by informing him of its infringement. Unless this is done, according to the District Court for the Western District of Pennsylvania in General Electric Company *versus* George J. Hagan Company, the owner of the patent may not obtain an accounting for damages and profits, even though the infringer had knowledge of the patent for several years and had built the devices for a time under a license.

The suit was tried on submission of decree for profits and damages for infringement of claims 7 to 11 of patent Number 1310060 to Collins for an electric resistance furnace. The court found that the defendant had knowledge of plaintiff's patent in 1919. Under an oral license from the plaintiff, the defendant built furnaces from 1919 to 1923, then conducted negotiations about a renewal license. It was found that at no time did the plaintiff comply with the statutory provisions of notice to the public by marking, and at no time did the plaintiff either verbally or in writing notify the defendant that it was infringing the patent in suit. It was held, therefore, that the plaintiff was not entitled to an accounting for profits and damages.

Section 4900 of the Revised Statutes, title 35, section 49, reads: "Patented articles marked as such; notice of infringement.—It shall be the duty of all patentees, and their assigns and legal representatives, and of all persons making or vending any patented article for or under them, to give sufficient notice to the public that the same is patented; either by fixing thereon the word "patented," together with the day and year the patent was granted; or when, from the character of the article, this can not be done, by fixing to it, or to the package wherein one or more of them is inclosed, a label containing the like notice; and in any suit for infringement, by the party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued, after such notice, to make, use, or vend the article so patented."

Patents Recently Issued

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Pertaining to Aeronautics

AIRPLANE WING—The surface of which is made in a plurality of sections arranged in stepped relation affording air passages between the sections which, incident to the velocity of the plane, creates a maximum vacuum over the entire wing surface. Patent 1746140. Jarrot Bobo.

AEROPLANE STEERING MECHANISM—A combined steering mechanism and joy stick whereby an aeroplane may be controlled in flight in the usual manner or steered on the ground, and manually operable means for locking the wheels in landing position. Patent 1747344. Harry S. Bell.

AEROPLANE—Having a water tight fuselage, and equipped with a parachute and means for releasing the forepart of the plane from the fuselage so that the latter will be permitted to slowly descend in case of trouble. Patent 1748811. Charles C. Warren.

PONTOON FOR AIRPLANES—Providing means whereby an airplane may be used as a hydroplane, the pontoons being equipped with retractable wheels, which may be drawn for travel on the ground surface, thus combining several body units in one assembly. Patent 1747563. Joseph G. Yonkese.

CONTROL MECHANISM FOR AIRCRAFT—Whereby a slight movement of the joy stick will enable the pilot to handle and control the elevators, rudders and ailerons of a large passenger carrying plane as easily as a small scout machine. Patent 1747564. Joseph G. Yonkese.

EMPENNAGE STRUCTURE FOR AIRCRAFT—More particularly adapted for large double bodied aircraft, wherein means is provided for guiding the craft when rising or alighting, the operating mechanism being particularly strong, and enclosed in such manner as to present a smooth stream-line box-tail construction. Patent 1747565. Joseph G. Yonkese.

Pertaining to Apparel

HEEL GRIP—Of resilient material, shaped to the contour of the heel so that in its movement it will cause the boot or shoe to move almost as if it formed an integral part of the foot. Patent 1745726. Chester R. Snow.

Chemical Processes

PROCESS OF MAKING FUEL MIXTURES—Which comprises passing acetylene gas through pentane, whereby the acetylene gas will act as a vehicle for carrying predetermined quantities of the pentane, and so modify the mixture that the flame will give off no carbon monoxide. Patent 1746172. Paul E. and Frank A. Webb.

Process for Retting Textile Fibers—Consisting in agitating raw fibers from flax, or other vascular fibers, for about fifteen minutes in water and nitrogen fixing bacteria at 100 degrees Fahrenheit, letting the fibers remain immersed for three hours, draining, and drying the fibers. Patent 1746316. Morris Marcus.

Designs

Design for a Key Tag—Patent 80435. Benjamin C. Da Shiell.

Design for a Doll Head or Similar Article—Patent 80481. Adolph Gramlich.

Design for a Goblet—Patent 80512. George Dougherty.

Design for a Toy Soldier—Patent 80531. Peter J. Hemmer.

Design for Dish or Similar Article—The inventor has been granted four patents for ornamental designs of a similar nature. Patents 80520, 80521, 80522 and 80523. William P. Graham.

Design for a Dress—Patent 80574. Dorothy Long.

Design for a Coaster—Patent 80591. Albert S. Valchek.

Electrical Devices

Dynamic Radio Receiver and Amplifier—A transformer especially adapted for radio, providing a simple and efficient receiving circuit in conjunction with an amplifier which does away with the use of a battery and vacuum tubes and gives greater amplification. Patent 1747137. George Wald.

Electrostatic Loud-Speaker—Wherein a soft ductile membrane co-operates with a rigid perforated metallic plate, the perforations being parabolic so that even with large amplitude vibrations the electrostatic forces upon the membrane remain proportional to the applied electrical amplitudes. Patent 1747952. Eugen Reisz.

Membrane for Electrostatic Loud-Speaker—A process for manufacturing a metallic coated insulating membrane which includes the step of sticking metallic foil coating upon the rubber or other insulating membrane by means of a vegetable or castor oil. Patent 1748901. Eugen Reisz.

Of Interest to Farmers

Cultivator Attachment—Having a plurality of rotatable earth working elements which may be simultaneously adjusted to various angles with respect to the path of travel, particularly adapted for side hill cultivation. Patent 1747058. Daniel W. Duellman.

Cultivator—Having an angularly disposed wing at the side, by means of which grass and other vegetation may be uprooted from the ground in close proximity to the roots of growing plants, while the row is being cultivated. Patent 1747059. George F. Dugger.

Stock Muzzle—Having means whereby the size of the central feeding opening may be quickly adjusted to permit the animal to bite off more or less grass, according to the height, and thus prevent dangerous bloating. Patent 1748027. Chris M. Rasmussen.

Of General Interest

Jeweler's Tag—Of bendable material, which may be easily connected with an article of jewelery, and if desired easily removed for use on another article, a button structure securing the tag in folded position. Patent 1742982. Charles T. Wittstein.

Road and Street Construction—In which the road base is covered with bituminous rock, or a mixture of bituminous rock and clean hard stone, forming a levelling course, after which the wearing surface is formed of ground bituminus rock rolled cold. Patent 1747125. Guy F. Murphy.

Structural Form for Concrete Work—A metal form framing and retaining unit of general application and use in the building of walls, stairs, columns and the like, wherein the form serves as molds within which the concrete is poured and held until set. Patent 1747036. John H. Sullivan.

Refrigerating System — Particularly adapted for cooling syrup cans in soda fountains, the cooling mechanism taking up a minimum space, high pressure in one refrigerant being utilized to force the liquid through an additional cooling line to other containers. Patent 1746896. Franklin B. Hunt.

Card Holder—Which may be permanently fixed to a trunk, box or package, in such a manner that a card may be inserted or removed at will, a holding means retaining the card against accidental displacement. Patent 1747077. Irwin M. Ikelheimer.

Ice-Cream Holder—Which can be conveniently handled without soiling the hands from the melting cream, and which will be edible constituting in effect an ice-cream sandwich having a handle for holding the same. Patent 1747112. Warren E. Good.

Hand Protector—A covering guard particularly designed as a shield for the hand when manipulating a spoon in basting meat, or a fork or other culinary implement in the presence of hot grease or steam. Patent 1747097. Alvah D. Young.

Rack for Piece Goods—Especially designed for holding bolts of cloth or goods on shelving in the aisles of stores so that the goods may be conveniently displayed to prospective customers, thereby reducing to a minimum the handling of the goods. Patent 1747026. William W. Phillips.

Collapsible Case—Simulating the commonly known suit case, having a plurality of sections which enable the case to be enlarged or contracted, operating with equal facility at any adjustment, the handle being positioned according to the weight within the case. Patent 1748024. William W. Machemer

Combined Soap Holder and Massaging Device—Functioning as a soap cup of sponge rubber, having in addition one face with projections and the other face formed as a receptacle for soap with a pair of spaced handles permitting a secure grip for massaging. Patent 1748008. Harry Barnowitz.

Curtain and Shade Guard—In the form of a rod and brackets whereby curtains and shades may be kept from being soiled by the action of rain and dirt, and to tearing action on being blown outside of the room. Patent 1746269. Henry W. and Margaret Lupton.

Vacuum Cleaner Attachment—Whereby one of the two hooks, usually attached to the handle for holding the electric cord when not extended in use, may be swingable, so that the cord may be instantly released without unwinding Patent 1746246. Frederick W. Elworthy.

Tie Wire and Spreader—An elongated member having eyelets which may be secured to forms for concrete, and the like, at a number of points, thereby strengthening the connections between the inside form and the outside form. Patent 1746298. Charles M. Ally.

Plant Protector—For protecting young plants against destructive insect and worm life, as well as against injurious cold weather or frost, designed to hold more moisture in the soil about the roots that is usually possible. Patent 1747967. Robert B. Bell.

Expansion Plug for Pipes—Having an expansion head adapted to effect a closure of the pipe, and in which ample clearance, irrespective of elbow bends, is provided for the operation involved in expanding the head. Patent 1747933. Patrick Goodman and Beni Leone.

Fire Hose—Characterized by properties of high resistance, reinforced against permanent creasing which results in rapid deterioration and cracking, and reinforced against wear while being drawn over the ground or conveyed within the hose wagon. Patent 1747584. Russell P. Howard.

Juice Extractor—Embodying a cutter for dividing the fruit and a receptacle in which the extracted juice and pulp of oranges, lemons or limes is collected, and the juice strained from the pulp before being discharged. Patent 1747641. Robert C. Morris.

Vacuum Cleaner—Including a wheeled carriage constituting a solid base for electric motor and blower, is relatively small and compact, can be conveniently carried from place to place or may be readily stored within the carriage. Patent 1748853. Etta M. Squires.

Hardware and Tools

Pivot-Straightening Device—Particularly adapted for straightening the balance staff pivots and train pivots of watches, a tool with which accurate temperatures are assured, and which may be manipulated with the thumb and fingers without burning the hand. Patent 1747136. George F. Putnam.

Can Opener—Comprising a pair of handles, a cutter and a can-moving wheel, the cutter being riveted at two points will not work loose, and the movement of the can-moving wheel away from the cutter is limited. Patent 1744573. Axel W. Peterson.

Bed-Rail Connecter—So constructed as to render the side bed rails reversible to accommodate flat bed springs or coil or box bed springs, each being supported at the same level on the bed frame. Patent 1745653. Adolf Weston.

Trunk Lock—Comprising threaded means adapted to be secured to the trunk body in spanning relation to its door opening, for providing a fluid tight joint between the closure and the truck body and effectively lock the closure. Patent 1745422. Charles Hinde.

Vise—A portable tool with means for attachment to a bench, a pair of jaws of the screw adjustable type to function as a wrench when detached from its support, thereby being usable under varying conditions. Patent 1748886. Abelardo Linares.

Screw Adjustable Mechanism—A combination tool, combining a wrench structure with a support for its fixed jaw, and a hanger or jacking element for its movable jaw, to form a jack, the parts being separable for storage or shipment. Patent 1748888. Abelardo Linares.

Intermittent-Grip Device—A rotatable element having a ratchet wheel thereon, and a detachably mounted handle and co-operating pawl element, said member being demountable for convenience in storage or shipment, and being reversible for effecting reverse rotation. Patent 1748887. Abelardo Linares.

Heating and Lighting

Grate—Wherein a maximum natural draught will keep the interchangeable grate elements in a cool state, the construction being such as to give a maximum life to the grate, and a more perfect combustion to the fuel. Patent 1746126. Morton K. Moore.

Apparatus for Making Illuminating and Heating Gas—In which compressed air is forced through gasoline or oil, whereby a combustible gas is produced and stored in confined space, before being conducted to the burners or any form of motor power operated by gas. Patent 1747094. John Whikehart.

Machines and Mechanical Devices

Slip Flask—For molds, wherein the alignment and holding of the cope in proper position on the drag receives special attention, the planks of the flask being so clamped and reinforced as to prolong their period of usefulness. Patent 1746146. Adam Diehl.

Snowplow—Of the type adapted for use with tractors, whereby the necessary parts may be controlled by the operator from his seat, effective means being provided for gathering and delivering snow on either or both sides. Patent 1746167. Richard Robertson.

Cotton-Feeder Mechanism—For cotton cleaners, burr extractors, boll breakers, etc., which is entirely automatic, the speed of the feed being regulated with extreme accuracy by the pressure of the cotton in the roll box. Patent 1746135. Jackson L. Walker.

Paint Stirring and Mixing Device—Including a rotary blade and manipulating crank, adapted to be attached to a paint can for facilitating the stirring and remixing of the liquid and solid ingredients, after they have settled in the container. Patent 1747032. Frederick Schlageter and Fabian Maletsky.

Mechanism for Cutting and Facilitating the Removal of Material from Machines—A machine for manufacturing noodles, which insures the separation and cutting of the noodles into uniform quantities, thus obviating the necessity of weighing, means being provided for their removal without physical contact, whereby sanitation is insured. Patent 1747075. Joseph Horowitz.

Ball-and Socket Joint—Which is simple in construction, easy to assemble and effective in operation, and is particularly useful in lubricating systems in lieu of flexible tubing. Patent 1745755. Coy C. Goodrich.

Glass-Gob Cutter—Adapted to be positioned near the outflow of glass from a melting tank, for cutting the glass gobs, at right or various angles by a liquid or gaseous substance, without leaving any visable mark. Patent 1747087. Charles H. Schlalz.

Surfacing Machine—For finishing the interior of manhole casings, a portable machine which is rotatably supported on the work, and incident to its rotation about the same, automatically feeds a cutting element evenly over the entire surface. Patent 1747944. Charles H. Lyne.

Wave Motor—Which is characterized by its responsiveness to record every impulse of the water due to wave motion, roll, weight of water and undertow, and to convert such impulses into power to perform useful work. Patent 1746613. Chester E. Shuler.

Developing Rack—A manually rotatable disk support, whereon photographic films may be detachably held without contacting with each other, and may be passed through the developing, washing, fixing, and washing processes, and eventually dried by centrifugal action. Patent 1747930. Irving L. Cook.

Harness-Tape-Selvage Motion for Looms—A salvage harness so constructed that it may be used with the heddles used in connection with the usual harness, reducing wear of the parts to a minimum, and is readily removable for retying warps. Patent 1748001. Edward P. Taft, Payton L. Videtto, and James A. Gaddy.

Automatic Control for Well-Flowing Devices—Wherein no delicate springs or other unsubstantial elements are used to urge the plunger or valve element to an open position or to resist its action in closing, the action being governed by the velocity of the liquid column, is therefore positive in operation. The inventor has been granted three patents of a simular nature, Nos. 1747570, 1747571 and 1747572. Alexander Boynton.

Current Motor—Particularly adapted for use in bodies of flowing water, such as rivers or streams, is capable of being adjusted with respect to the direction of the water, whereby the power of the flow may be utilized. Patent 1745356. William H. Crofton.

Valve Mechanism—For air compressors, functioning as either an inlet or outlet valve means, comprising a cup shaped element having an axially disposed duct there through and a flat annular valve seat surrounding the inner end of the duct. Patent 1746612. Elmer F. Seager.

Gas-Orifice Meter-Chart Calculating Machine—By which the pressure and differential curves of such charts are employed as indices for the production of a computation of the quantity of fuel that has passed through an orifice during any determined period. Patent 1748783. John B. McGaughy.

Graduated Magnetic Control of Brakes or Clutches—A brake mechanism having means for controlling the same, whereby the brake may be either gradually or quickly applied and held at any degree of application, by combined electromagnetic and fluid operated means. Patent 1748773. Frank L. Johnston.

Margin-Adjusting Device for Writing Machines—Adapted for open front paper carriage machines, whereby the margin may be set and fixed by displacing the carriage as a whole, or may be locked on the carriage or left free to slide. Patent 1748896. Camillo Olivetti.

Apparatus for Applying Soft-Metal Linings to Hard-Metal Tubes—Which facilitates the application of soft metal, such as lead, to hard metal tubes, the lining operation being continuous, and the lining uniform, without necessitating subsequent finishing operations. Patent 1748851. Warren R. Smith.

Dish-Washing Machine—By means of which dishes of various sizes, as well as table silver, may be washed and rinsed thoroughly and rapidly, the soiled dishes being continuously fed to the machine. Patent 1748530. Aurelio R. Torres.

Musical Devices

Piano—Wherein the percussion strokes of the hammers are automatically shortened or lengthened correspondingly with the actuation of the soft pedal control, and a greater range of volume and tone is obtained, with precision not heretofore possible. Patent 1748777. Bernhard F. Laukandt.

Plumbing and Fittings

Faucet Fitting—Comprising a pipe divided interiorly into passages, and outlet ports for separately conducting hot and cold water to a single nozzle, the valve seats are readily accessible for replacement when necessary. Patent 1747640. George J. Morris.

Prime Movers and Their Accessories

Safety Device for Liquid-Supply Lines—Adapted for use in preventing failure of a supply of fuel for internal combustion engines, in the event of a break or other source of leakage in the supply line, particularly adapted for air craft. Patent 1746095. Frank E. Tugwell.

Valve Construction—Which has means for receiving the general formation of carbon and directing the same so that it will not interfere with the valve operation, the contacting portions being out of the path of the exhaust gases may be lubricated. Patent 1746927. Carl F. Burgmann.

Railways and their Accessories

Railroad Tie—A tie structure in which both sections are identical, whereby any two sections may be properly mated, eliminating the number of operations required for the production of a complete tie, thereby effecting economy in labor. Patent 1747054. George B. Cox.

Wheel-Flange Lubricator—Using grease in stick form for lubricating the flanges of railway cars, locomotives, street cars or other vehicles running on rails, whereby the lubricant will be constantly applied, and the stick easily replenished. Patent 1748028. Lester J. Rickard.

Hinged Top for Box Cars—By means of which the entire top of the car may be opened, permitting the use of cranes, instead of human effort, for unloading, resulting in cheaper handling, the construction forms an entirely watertight closure. Patent 1747423. Blair B. Campbell.

Pertaining to Recreation

Toy—A combat device in the form of two boxers or fencers, the arms of the figures being manually operable to deliver or parry blows, and to automatically become inoperative when the target portion of the body has been struck. Patent 1745434. John F. McIntosh.

Swimming Appliance—In the form of a glove with rubber webbing, or the like between the fingers and thumb, as an aid in swimming, and to increase the effectiveness of the propelling stroke. Patent 1748317. Thomas B. Sykes.

Pertaining to Vehicles

Visor for Motor Vehicles—Having a window and a shutter, and means within reach of the driver for regulating the vision area of the window whereby an unobstructed view of elevated traffic signals may be had. Patent 1745197. Joseph E. Tirpak.

Cylinder Grinder—Which may be secured to the engine block, and has means for automatically centering the mechanism within the cylinder for grinding automobile motor cylinders, without removing the motor from the chassis. Patent 1745015. John Johnson.

Brake Equalizing and Operating Mechanism—For vehicles, comprising a plurality of brake actuating members and a wedge-shaped member contacting therewith, the wedge-shaped member having a slight rotative motion and means for imparting endwise motion for operating the brake members. Patent 1744643. Nicholas A. Kristmann.

Method of Making Tires—A built up tread portion for pneumatic tires comprising a central section of annular fabric rings and alternate annular rubber tread webs, their edges forming a wearing surface which will prevent lateral slipping. Patent 1744025. Virgil C. Anderson.

Oil-Gauge-Rod Wiper—For use in connection with cleaning automobile gauge rods, before use in testing the amount of oil in a crank case, whereby the wiping may be accomplished by a single stroke, without the operator handling the wiper. Patent 1747100. Alton W. Ashworth.

Foot Control for Motor Cars—Adjustable to a given point in a range of settings for the throttle valve of the carburetor, and when adjusted may be left at that point so that the speed of the car will be substantially held. Patent 1747083. Henry J. Ries.

Blow-Off Gauge—Adapted to be applied to the valve stem of an inflated tire for allowing only a predetermined amount of air under pressure to pass the valve stem, having a novel means for forming an air-tight connection. Patent 1746923. Esten B. Beeler.

Water Gauge for Automobile Radiators—Having a supportng plate and a floating member with signs indicating the water level, the entire formation covering only a part of the radiator opening, thereby permitting water to be inserted while the gauge is in use. Patent 1747022. Albrecht zur Nieden.

Collapsible Wheel Chuck—A block which will be strong, yet can be carried in a relatively small space, opened and placed in operative position under and at the rear of a wheel, to prevent any possible movement of the wheel. Patent 1746415. Joseph A. Burkart.

Three-Wheel Vehicle Chassis—Having means for moving the front wheel slightly to one side when turning to carry the weight directly to the ball bearings removing the strain from the chassis and preventing the device from turning over. Patent 1747526. Ernest L. Pearson.

Antiglare Device—Which is applicable to automobiles of the closed or open type, and when in applied position may be adjusted to effectively intercept glare producing lights, yet permit an unobstructed vision of the roadway. Patent 1745695. William O. Hunter.

Rumble-Seat Top—Wherein a top and sides are provided and so arranged that the top may be used alone or in connection with the sides, thereby providing a complete enclosure, the cover is removably connected. Patent 1748031. Julius N. Wiener and Henry Aretsky.

Bus Seat Switch—A double deck bus, wherein the operator may act as driver and conductor, all passengers being compelled to pass him in entering and leaving, and a signalling device indicating the vacant seats on the upper deck. Patent 1747960. Charles Weiss.

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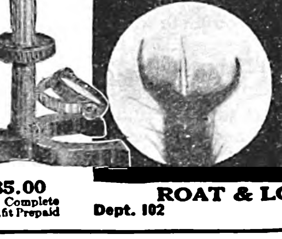

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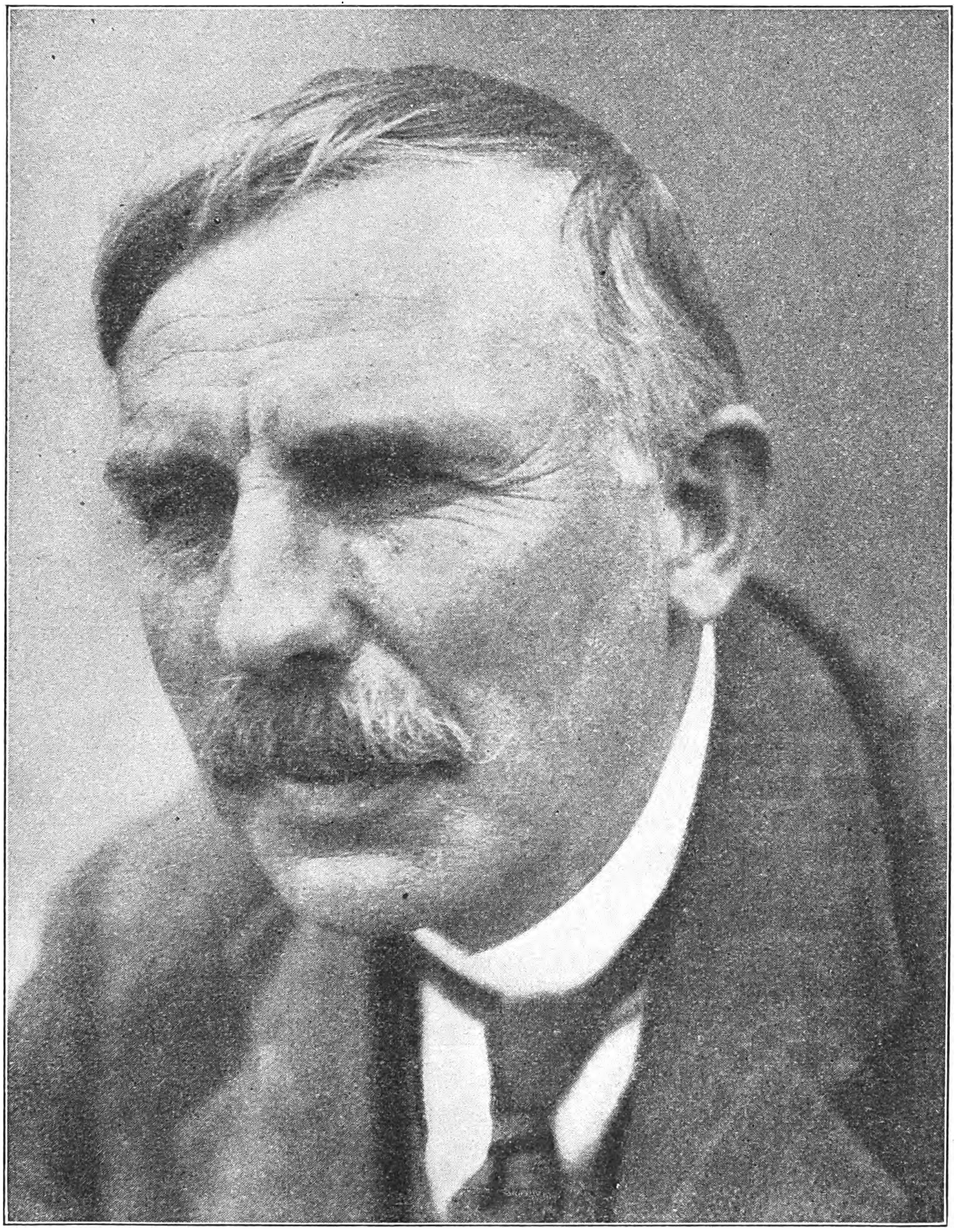
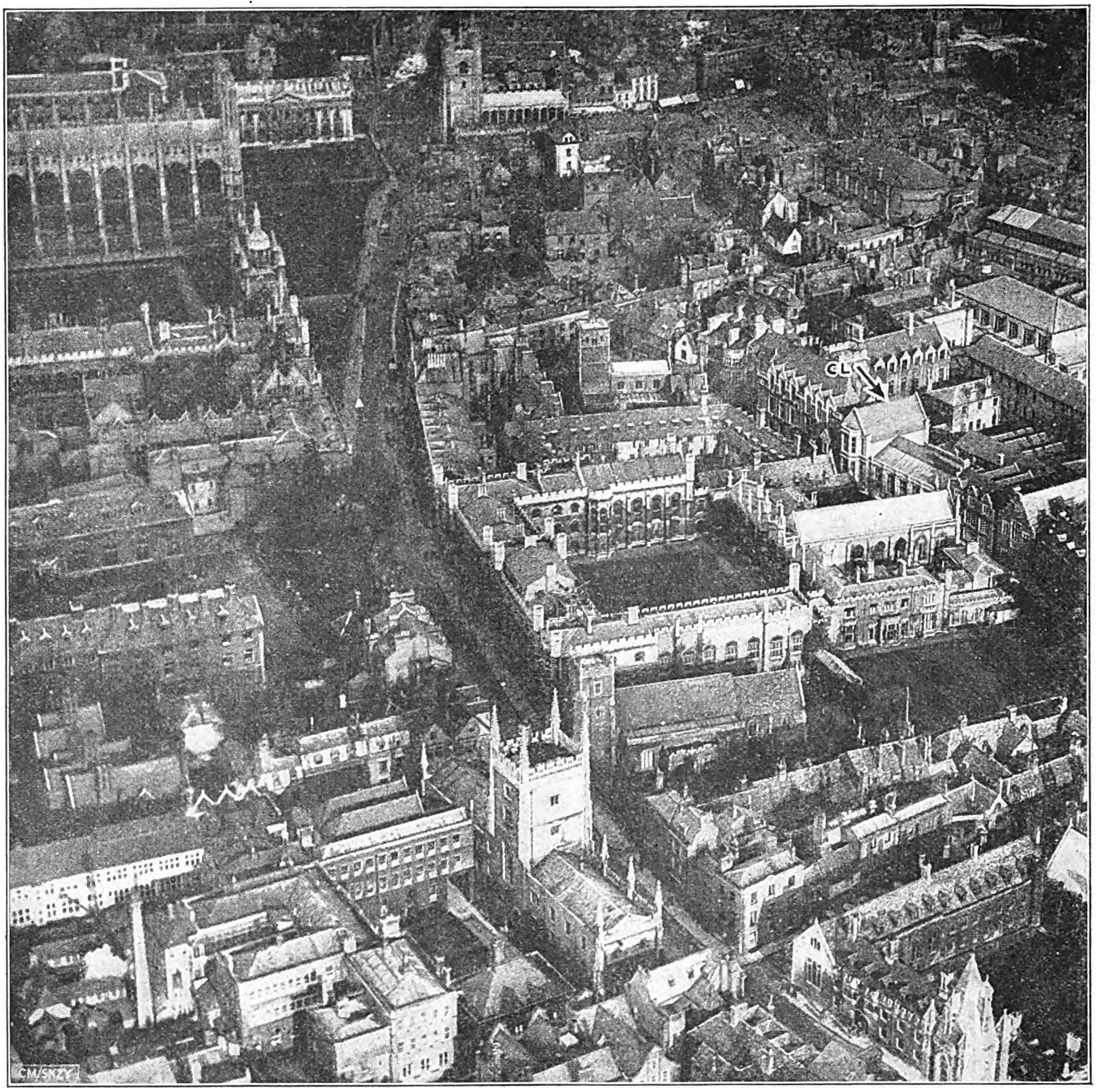


Sir Ernest Rutherford

SIR ERNEST RUTHERFORD was born and reared a New Zealander; he was professor of physics at McGill University in Canada for nine years; and in 1919 he succeeded Sir J. J. Thomson as Director of the Cavendish Physical Laboratory at Cambridge in England. His fame is founded mainly on his basic researches in radioactivity; the new student of that domain of physics may scarce turn a page without encountering his name, linked in many cases with those of Soddy, C. T. R. Wilson, and others who about two decades ago were pioneering in work which has since been seen to be of the utmost significance in physics. His is the discovery, for example, of the alpha rays or alpha particles. Honors too numerous to mention have been heaped upon him—degrees from European and American universities, and coveted medals, including the Franklin Medal of the Franklin Institute in Philadelphia. At present he is President of the Royal Society (properly The Royal Society of London for the Improvement of Natural Knowledge), the highest honor at the disposal of British science.



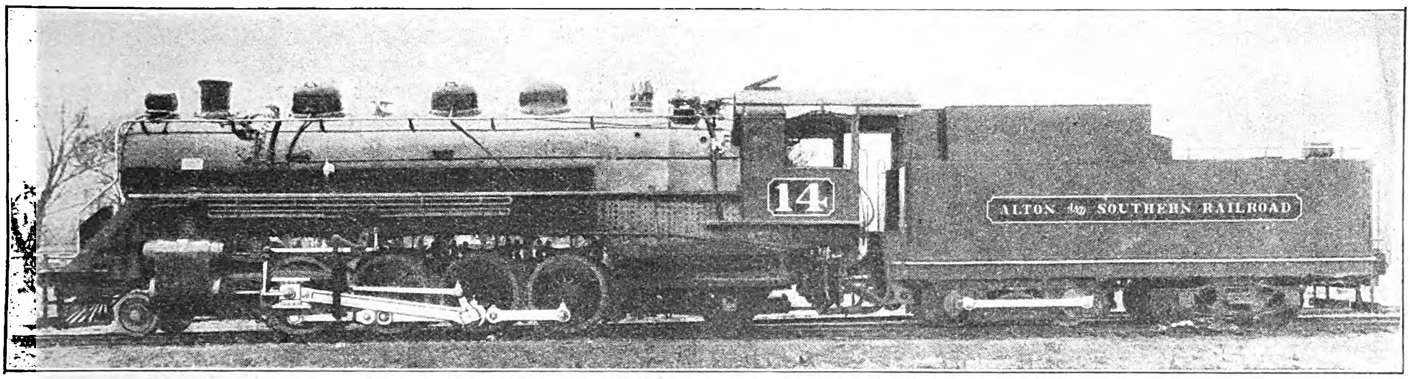
Great Britain's Foremost Physical Laboratory

In the April number, on this page, we presented a photograph of Ryerson Laboratory at the University of Chicago, which was there characterized as "America's foremost physical laboratory." Now is shown a picture of a part of Cambridge University in England, including the famous Cavendish Laboratory of Physics (marked "CL" on the picture) which men of science regard as Great Britain's foremost physical laboratory.

Cambridge University as a whole is British headquarters for science, and has been so for centuries. It was here that Newton, profoundest intellect of the ages, performed his classic experiments on light and gravitation; and that Darwin, whose concepts of general evolution have had stronger impact on thought than those of any modern human being, obtained his education. Jeffreys the geophysicist, and Eddington the widely know astrophysicist, are Cambridge professors.

Cavendish Laboratory of Physics was organized by the great physicist Clerk Maxwell.

Just as, in Chicago, the Ryerson Laboratory's achievements have mainly been derived from Michelson's inspired leadership, so those made at Cavendish Laboratory have been the resultant largely of the personality of its former director and leading spirit, Sir J. J. Thomson, discoverer of the electron. Among Thomson's students now risen to eminence in physics are Sir Ernest Rutherford, the present Director of the Laboratory, Sir William Bragg, Charles G. Barkla, C. T. R. Wilson, F. W. Aston, and O. W. Richardson. "This," as Professor Arthur H. Compton, of Ryerson Laboratory, puts it, "is the largest group of Nobel Prize men that can be boasted by any laboratory. Under Sir Ernest Rutherford it continues to carry on with increasing vigor the work which Thomson started. To this laboratory can go the credit for having established the existence of both the electron and the proton, largely through the work of J. J. Thomson and Rutherford."



LOCOMOTIVE PARTS OF STRONG ALUMINUM ALLOYS

Aluminum alloys are now being used on some railroads in place of steel for cross-head assemblies, valve motion parts, main rods, and side rods. Aluminum is used to improve the general balance, to increase the boiler power, and to obtain the required durability

Aluminum and Its 'Hard-Boiled' Alloys

How a Chemical Curiosity Became a 225,000,000-Pound Industry in Forty-Three Years

By ALBERT A. HOPKINS

INVENTIONS are not all made in woodsheds, although it seems rather a logical place for a shop. Given a shop and an inquisitive mind, who knows what may happen? There is, however, one woodshed which Mr. Ford will never have for his Dearborn collection, although he uses large quantities of the product that was born there. Unfortunately, this particular woodshed in Oberlin, Ohio, will also never be marked by a tablet, as it has been removed, but there is one on the house which adjoined it that reads: "In This House Charles Martin Hall Discovered the Electrolytic Process of Making Aluminum, February 23, 1886, the Year Following his Graduation from Oberlin College, Thus Making Available for Industry a Metal Long Known but Little Used." The tablet tersely describes the invention of a process vitally necessary for the commercial production of one of our most useful metals, particularly when alloyed.

ALUMINUM was separated from its chloride in 1825 by Oersted. Wöhler continued the Danish scientist's experiments but it remained for the French chemist, St. Claire Deville, to produce the first aluminum commercially. This was approximately 25 years after Oersted's discovery. In 1852 the metal was worth 545 dollars a pound but in five years the price had dropped to 27 dollars a pound. Thirty years later an Oberlin College student was destined to shake the metallurgical world with an epoch-making discovery and in a short time thereafter aluminum sold for two dollars a pound in 1000-pound lots, a remarkable decrease.

Professor Jewett, of Oberlin College, was lecturing one day and said that if anyone should invent a process by which aluminum could be made on a commercial scale that he would not only be a benefactor to the world but would amass a fortune as well. Charles Hall turned to a classmate and said, "I'm going for that metal." Six months later he came into Professor Jewett's office and said: "Professor, I've got it!" In his hand were little globules of aluminum. Inventor at the age of 23, this young man had carved his way to fame and fortune.

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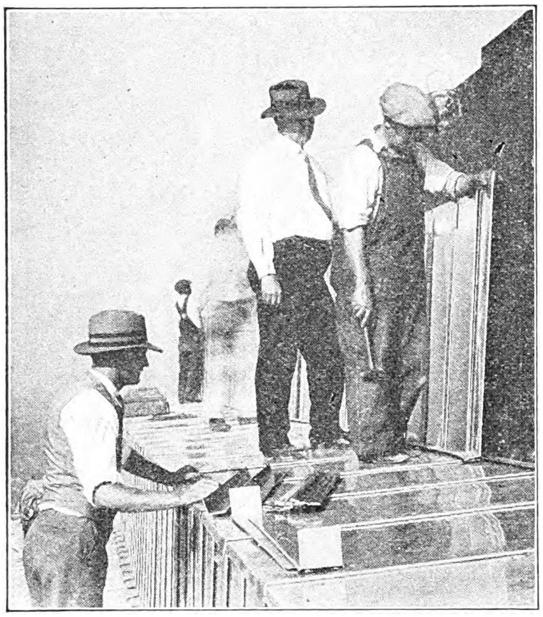
This is not a feather weight, but is certainly light, weighing 3 1/3 pounds a foot

A month or two later a French chemist, Heroult, of the same age, made the same discovery independently. On the occasion of the award of the "Perkin Medal" to Hall in 1911, Heroult crossed the Atlantic to congratulate him.

A COMMERCIAL plant was established in Pittsburgh in 1888 by a company called the Pittsburgh Reduction Company, which was the forerunner of the Aluminum Company of America. The first week's production was 100 pounds and it was kept in a safe, as aluminum was still a more or less semi-precious metal. But nobody wanted the product, so the company had to go out and make a market. They succeeded so well that the production of aluminum in the United States in 1928 as given by the American Metal Market was 198,414,000 pounds. In 1929 the production showed an increase but definite figures are not yet available. The average price of virgin aluminum has fallen to 24.3 cents per pound, a far cry from something that had to be kept in a safe and which nobody wanted.

It must not be supposed that Hall's invention did not thrive uncontested. The Cowles Electric Smelting and Refining Company, of Lockport, New York, reduced aluminum oxide with carbon in electric furnaces but only a copper-aluminum alloy was produced; it was a high-temperature reaction, and not electrolytic. The late Judge Taft who was destined to be President and Chief Justice of the Supreme Court, rendered a decision in the United States Circuit Court of Northern Ohio in which he said: "Hall was a pioneer, and is entitled to the advantages which that



ALUMINUM IN BUILDING

The pyramidal roof of the St. Louis, Missouri, Civil Court House was all fabricated from aluminum

fact gives him in the patent law." Other litigation followed, but finally all obstructions were swept away. With the cheap water power at Niagara and elsewhere we are able to obtain vast quantities of aluminum, which is gradually entering more and more into our daily life. It is used in our automobiles, airplanes, buildings, locomotives, and kitchens. It is used so much in everything to do with locomotion that it is interesting to note that its use in bicycles really brought aluminum into prominence. The war helped the aluminum industry; the light weight aluminum alloys dictated their use in aeronautical parts and today aluminum propellers, forged under huge air hammers, are standard on many of the finer planes. The dirigible depends largely upon aluminum alloys and aluminum sheet has even been used in place of a fabric as an outer shell for the ship.

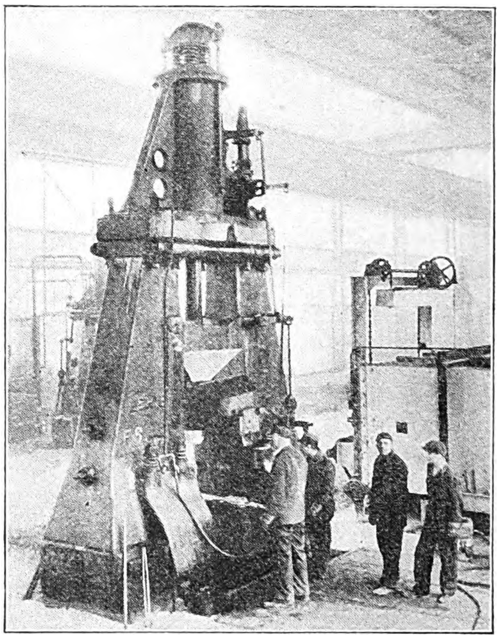
Because of the fact that manufacturers did not have uses for the new metal when it was first made commercially available, the Aluminum Company of America was really forced into designing and making all kinds of things such as bottle caps and seals, foil, and so forth, as well as plates, sheets, bars, castings, forgings and articles fabricated from them. The writer well remembers as a boy seeing the Cowles electric furnaces in "Lower Town" in Lockport, New York. These were under open sheds and it was a puny affair compared with the immense "pot room" at Niagara Falls, where the ingots are now produced.

The aluminum comes to the mills and shops in the form of "pigs" or ingots which weigh about 50 pounds. While large quantities of aluminum are used without alloying for consumption in foil, bottle caps, kitchen utensils, and hundreds of other uses, much of the aluminum of commerce is consumed in the form of alloys. The aluminum and the alloying metal, copper for example, are melted under the most precise pyrometric control, and cast into ingots weighing between one and 30 pounds. The alloys thus made are subsequently remelted and cast into rolling ingots or castings.

IN the case of sheet, tubing, and forgings, the ingots generally weigh between 50 and 300 pounds, but for structural shapes these ingots may weigh upward to 3000 pounds.

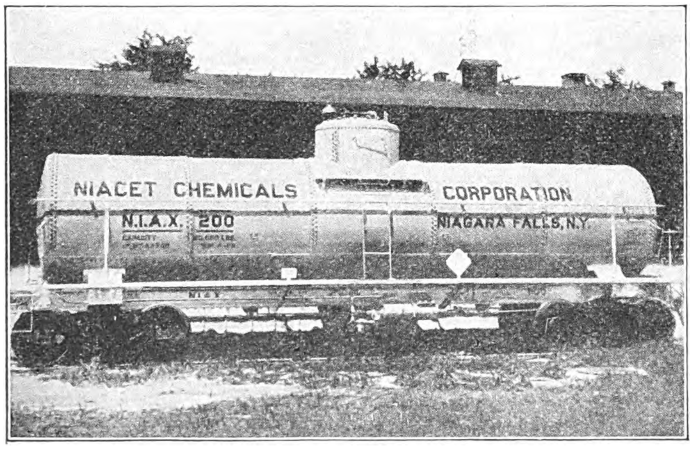
Aluminum and its alloys are cast in a number of ways—by gravity in sand molds; by gravity in accurately made fixed molds (permanent mold process) and by die casting under great pressure. The alloys can be forged under a steam or air hammer just as are iron and steel; airplane propellers are so forged. Remarkable effects are produced by heat-treating aluminum alloys. The end is to secure the best possible distribution of the alloying element and then to fix it. The heat treatment is conducted in electrical furnaces and steam-pressure tanks. Aging of alloys, both natural and artificial, also enters the case, but here we are treading on a metallurgical morass so we had better retreat while there is time. Alloys have been developed which can be forged from one piece without reheating. Strong alloys are also made proof against corrosion. Pure, comparatively weak, aluminum is used as a protective coating over strong aluminum alloys. Indeed, the results obtained by heat treatment are so peculiar that it is sometimes called "voodoo" treatment by the scornful. The more you see of the processes of manufacture, the more respect you have for the magnificent laboratories which control it all.

Strong aluminum alloys have been developed to supply engineering materials, having mechanical properties comparable with those of steel, and,



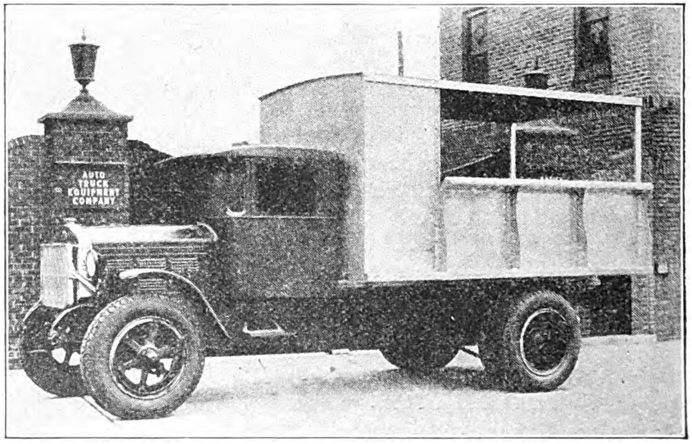
FORGING ALUMINUM

An 18,000-pound hammer is forging an airplane propeller. Some aluminum alloys can be forged



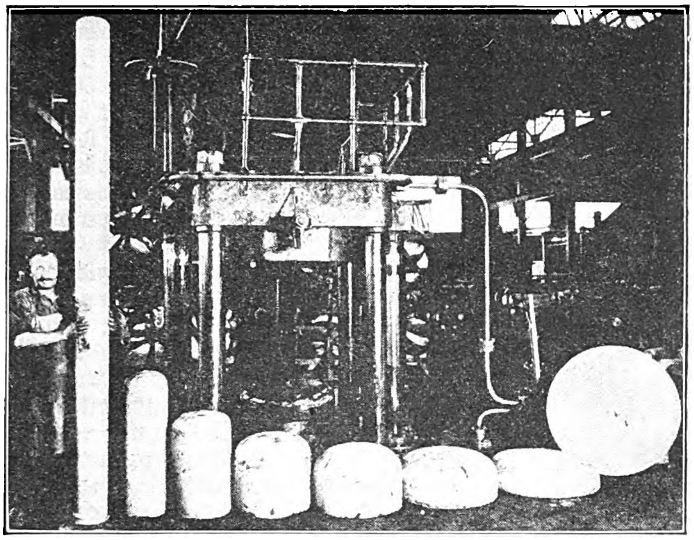
FOR ACETIC ACID

An all-aluminum tank of riveted construction is used for acetic acid, which does not affect aluminum. Capacity is 80,000 pounds



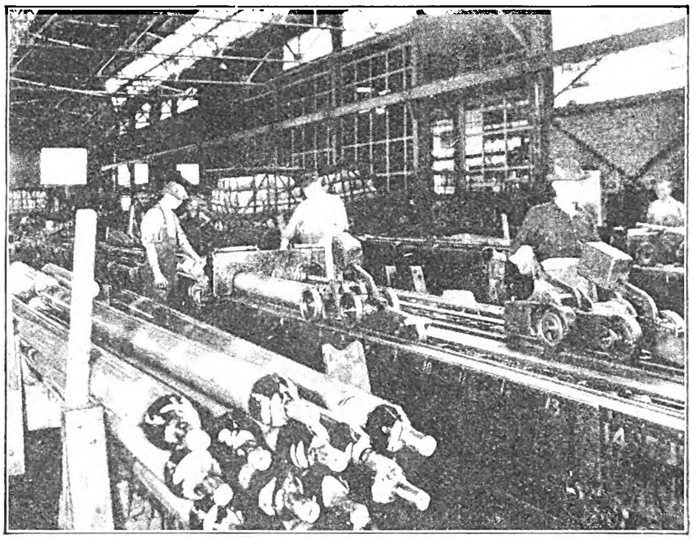
ALUMINUM TRUCK BODY

Every pound of weight that can be saved in the construction of the body of a heavy-duty truck is a pound added to the pay load



ALUMINUM TUBES BY CUPPING

An aluminum sheet is drawn on a cupping press into the form of a tube. Tubes thus produced may be further reduced by drawing



DRAWING TUBES

Round and square aluminum tubing has many uses. Tubes are also produced from the billet by means of an extrusion process

at the same time, retaining the well-known characteristic properties of the parent metal. Briefly summarized, these include low specific gravity, good resistance to corrosion, high thermal and electrical conductivities, and pleasing appearance. Pure aluminum has a tensile strength only about one sixth that of mild steel but "17ST" has a tensile strength of 55,000 to 63,000 pounds per square inch and a yield point of 30,000 to 40,000 pounds per square inch, fully comparable with low-carbon nickel and carbon steels.

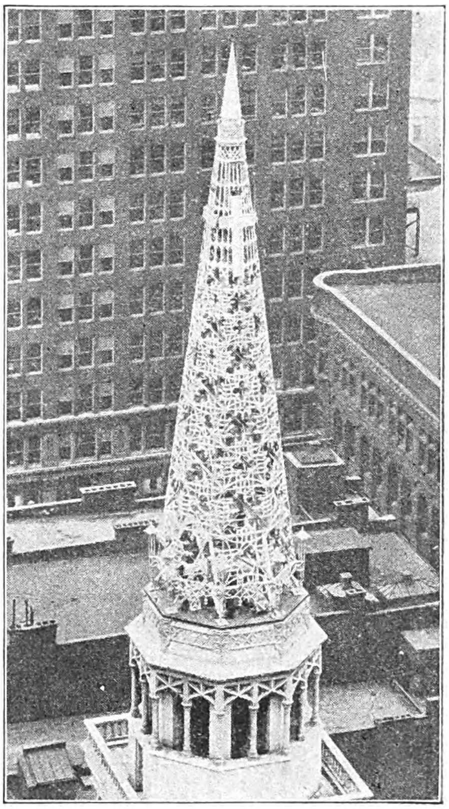
These aluminum alloys are of rather recent development, but they have found immediate application in the aircraft and automotive industries, and their use has rapidly spread to other fields. From the truck and the bus, where the light alloys have already proved their worth, it is only a step to the electric and steam railway car, and this step has already been taken. Here the strong aluminum alloys have replaced steel. Such a substitution is not possible on the basis of first cost alone, even when it is considered that the low specific gravity of these alloys results in a very much lower metal requirement for any given part.

ALUMINUM HELPED

Over 100,000 pounds of aluminum sand-cast spandrels were used in the Koppers Building

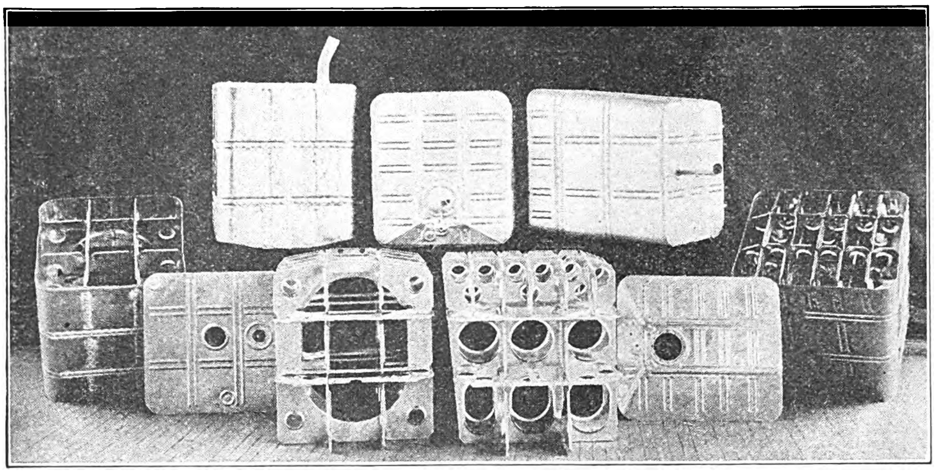
WHEN, however, the saving in power during the life of the assembly is considered, and also the lower maintenance cost resulting from the decreased inertia and vibrational stresses, as well as the increased resistance to corrosion, the advantage of the aluminum alloys becomes apparent. When, however, the strong aluminum alloys are substituted for other non-ferrous alloys, there is frequently an actual saving in metal cost.

Almost at the birth of the automobile industry aluminum was recognized as an important material of construction and the automobile manufacturer is aluminum's largest customer. Aluminum is ideal for truck bodies in that it increases the pay-load or decreases the dead weight of the truck. Fuel consumption and wear and tear on the chassis are also lessened. Even if an aluminum body costs 600 dollars more, the revenue is increased some 800 dollars a year and the scrapped body can be sold for around 300 dollars. Trolley cars with aluminum bodies are giving excellent service and show the way to increased economies. The Navy's metal-clad dirigible *"ZMC-2"* not only has an aluminum framework but is enclosed in aluminum sheeting. The use of aluminum in airplanes is almost an old story now. Aluminum is ideal for many parts of the radial motors and forged aluminum propellers are largely used. Outboard marine motors afford a fine field for the use of aluminum. In washing machines, vacuum cleaners, and other household appliances aluminum enters the house as well as via the kitchen. Seals for bottles are made at New Kensington, Pennsylvania, by the hundreds of millions and are used on products packed in various places all over the globe. Aluminum foil is largely used in place of tin foil and can be obtained in all the colors of the rainbow. Aluminum tanks make good oil storage containers and aluminum tank cars carry acetic acid safely.



ALUMINUM CHURCH SPIRE

Two hundred and twenty castings were used in the spire in this new church



AIRCRAFT TANKS

Here we have finished and semi-finished gasoline tanks for aircraft. Lightness is essential in such parts, and for this reason they are fabricated from aluminum sheet. Note the baffles

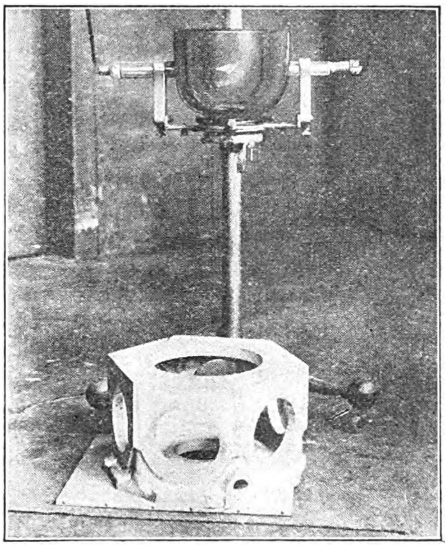
Aluminum furniture has come into its own. An average aluminum chair weighs only about seven pounds.

Aluminum is very successful in the building field. Over 900 aluminum spandrels were used in the Koppers Building in Pittsburgh, while in the new Chrysler Building in New York the spandrels, copings, and sills are of aluminum. Aluminum shingles and cast aluminum ornaments and crestings are being largely adopted.

Shingles made of aluminum have many points of excellence due to the inherent properties and qualities of the metal itself. They are wind, water, and weather tight. They are unbreakable and non-inflammable. They are frost proof; they cannot crack nor leak, because they are flexible. They are, of course, non-rusting and are light in weight, thus relieving the roof framing timbers of excess weight. These shingles are laid from the top downwards, so no scaffolding is laid over them and they are not injured by being walked on. Sheets of aluminum have been exposed to the ravages of the elements for over 25 years and at the end of that time they show no appreciable deterioration. This is worthy of note, when considering various shingle materials for building.

One of the most striking uses of aluminum for architectural purposes will be found in a church in Pittsburgh in the downtown section, surrounded by lofty office buildings. This church is the German Evangelical Protestant Church which is built in a modification of the French Gothic style. The spire is made up of aluminum castings. There are 221 castings used in this striking edifice which towers 259 feet above the level of the street. The spire is octagonal and is 80 feet in height. It rests on a concrete base 179 feet above the street. The crosses on both sides are also made of aluminum and are illuminated at night. The extreme tip of the spire is a single casting weighing 201 pounds. This spire will never have to be painted and it stands out brightly under Pittsburgh's rather trying climate. Aluminum also caps the Washington monument. The capstone weighs 3300 pounds and is finished off by a small pyramid of aluminum 5.6 inches at its base and 8.9 inches high. It weighed 100 ounces, being the "largest piece of this metal ever cast in any country." This was in 1884; recently a 3800-pound base for a Diesel engine was cast.

Aluminum paint is used in many industries. The pigment base is "albron," which is made by stamping pure aluminum into small, flat, and very thin *flakes*, which, when mixed with a suitable oil or varnish vehicle form aluminum paint. These tiny flat flakes overlap one another when applied. They arrange themselves layer on layer much like falling leaves. Thus there is formed a metallic sheath that can be readily washed. One coat will completely hide a black surface.

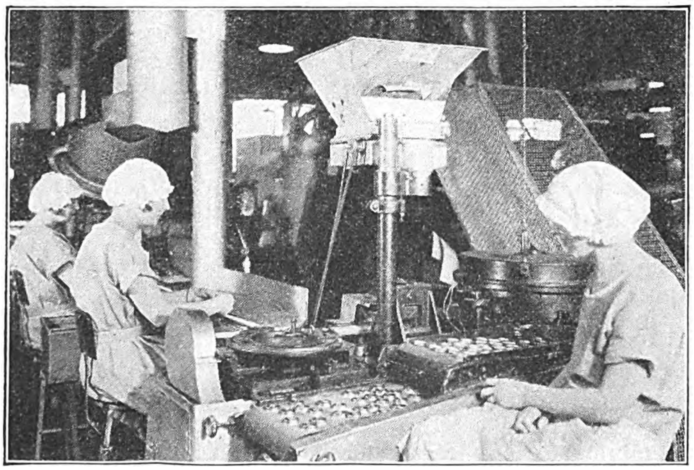


LOOKING FOR DEFECTS

X-raying a crankcase. Heat treatment and forgings necessitate such inspection

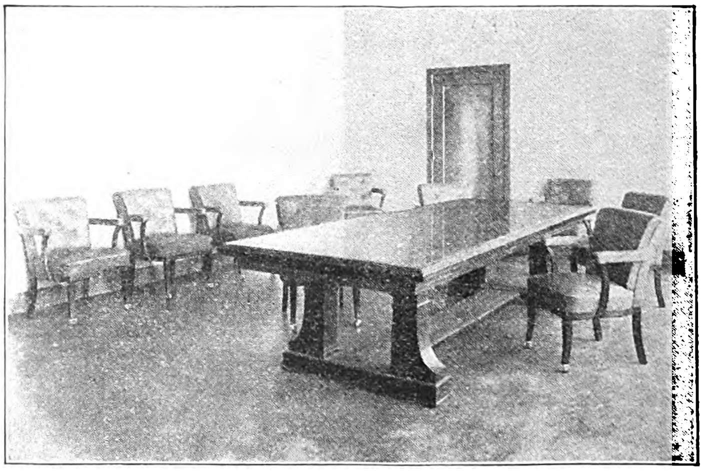
ONE more example of the application of strong aluminum alloys, in this case to locomotives, and we are through. It has been found advantageous to provide reciprocating parts of aluminum alloy. Any weight saving in the reciprocating or rotating parts can be put into boiler capacity without increasing the weight on the drivers. The saving in rail hammer is very great.

So here we must take leave of this very light and versatile metal and its useful "hard-boiled" alloys, to mill out new uses in our machine world.



BOTTLE SEALS

Girls place tin disks in the aluminum capsules as they pass by on a conveyor. A cork liner is dropped in and a groove secures it



ALUMINUM CHAIRS

Here is a director's room entirely equipped with aluminum chairs. Having no dowels they are especially valuable for dining cars

OUR POINT OF VIEW

The Rights of the Governed

PROBABLY no one will dispute the affirmation that the Constitution of the United States was promulgated with the inherent idea that, insofar as it is possible, the people shall have a direct voice in their own government.

As the years have passed, the practical operation of law-making and law enforcement has been more and more delegated to representatives, which though a proper procedure in itself, has resulted, in many cases, in the evolution of a situation where representatives do not always represent the opinions and beliefs of their constituents. This is evident in the agitations for the "referendum and recall"; by the pressure of public opinion which forced the passage of the XVII Amendment, the election of United States Senators by direct popular vote; by direct primary nomination in certain states, and so forth.

Even these reversions to older tradition of self-government have not entirely ameliorated the conditions, for we still find some of our representatives being governed by the opinions of a close coterie who are accessible and whose influence has weight with them, or by a part of their constituency who are most vociferous. It is true that when the situation becomes flagrant, the people will correct it by the removal of such misrepresentation, but in the ordinary run of events a representative can continue to misrepresent the majority of his constituents for long periods before retaliating wrath can be organized to overthrow and punish by elimination.

If popular vote can make, it surely has the same right to unmake. The aphorism that because a law is on the statute books it must remain and be enforced regardless of popular will, is as fallacious as that a man should continue to do something injurious to himself simply because it is a custom or a fad.

Criticism appears in some quarters of the nation-wide poll on the prohibition amendment now being taken by the *Literary Digest*. Yet, fundamentally, what is censurable in any honest effort to learn what the public really wants? Without a doubt this effort is an honest one, and to our mind it is representative, although as to the latter there is a basis for argument.

If the XVIII Amendment was put through as a war-time measure, at a time when we were ready to agree to anything that might help us to victory, and we now wish to reconsider that action in the light of present peace-time prosperity, who can gainsay us such a right?

It's Not the Cost

CRITICISMS of the increased rates for American naturalization papers seem partly justified by statistics. For the July-December, 1929, period as compared with the same period of 1928, the number of first-paper applications fell from 114,469 to 79,346, and second-paper applications fell from 106,028 to 65,887. Under the old rates, first papers cost one dollar and second papers four dollars; under the new, five and ten dollars respectively.

Unregenerate Criminals

IN a letter to *The New York Times*, Ranulph Kingsley, of New York, declares that we have become too good-natured and easy-going in our dealings with criminals. He believes that "Even if we have to pock-mark the state with prisons, we should put every confirmed criminal in one and keep him there." Mr. Kingsley states that since holding up the United States mail with gunplay was made punishable by life imprisonment some years ago, that kind of crime has noticeably decreased. He would have the states adopt laws as stringent as this federal law; and, further, he believes it inadvisable to take pistols away from honest people yet very necessary to teach the criminal that when he goes out at night with a pistol, "he goes to his own swift and inevitable imprisonment for life."

We heartily agree with Mr. Kingsley. Under the present lax system, too many politicians are working hand-in-glove with the underworld, too many murderers are brought in simply for questioning and then are let go with a smirk on their faces, too many foreign-born are conducting rackets that terrorize honest citizens. It is all very well to philosophize about the exploitation of human beings that leads them to become criminals, to prattle of reforming them, to pity them for their supposed lack of advantages, but that is not enough. All this is the fault of the system; therefore the system should be changed. Many years will elapse, however, before we have made a start in this direction and, in the meantime, confirmed criminals, with minds warped irreparably, continue their depredations on society. What we need right now is a Mussolini to round up our "Mafia" and a few jurors who are not too chicken-hearted to send the criminal up long enough to pay fully for his crime.

The drop in the number of applications has been laid to the increased cost, and the principal criticism of this increase seems to be that the tendency will be "to perpetuate an alien group." It is contended that the alien most often belongs to the low-income class and finds it exceedingly difficult to spare the money for naturalization papers while maintaining himself and his family, building a home, and educating his children. To some extent, then, the criticisms are justified, but—

The alien, as a rule, comes to this country because of his intolerable poverty in some other. If he belongs to this class, citizenship should be cheap at any price. There are some, of course, for whom the expenditure of the few extra dollars would work a hardship but the amount is so small even under the new rates that they can and will manage somehow if they seriously desire to share the benefits and prestige of American citizenship. As for those who can afford the price and will not because of indifference or lack of appreciation of what it means to them, and those who cannot because their earning power is too low, we do not want them. They are not the stuff of which good American citizens are made.

Questionable Success in London

A THREE-POWER Pact has been agreed upon by Great Britain, Japan, and the United States. For the present the differences between France and Italy have proved irreconciliable; but it is the intention of Great Britain, France, and Italy to continue negotiations in the hope of developing a formula that will enable the two Mediterranean powers to join the pact. We have a direct interest in the solution of the problem between Italy and France, because it may affect the number of cruisers considered necessary by Great Britain.

If the tentative agreement is carried out, the fleets of Great Britain, Japan, and the United States would be as follows:

	United States	Great Britain	Japan
Capital Ships	15	15	9
Cruisers (tons)	323,500	339,600	208,900
8″ Cruisers	18	15	12
6″ Cruisers	19 or 20	34 or 35	12 or 13
Destroyers (tons)	150,000	150,000	105,000
Submarines (tons)	52,000	52,000	52,000

(*Please turn to page* 485)

Super Magnetic Fields

Some Remarkable Experiments in England—"The Most Interesting in the World"—Promise New Revelations in Physics

By J. G. CROWTHER*

THE behavior of the compass needle is described by saying that a magnetic field of force exists on the earth's surface. The magnetic force turns the needle to the north. Clearly this field of force must have a definite strength at any particular place; it must be at least strong enough to deflect the compass needle. The strength of the earth's magnetic field is in fact about one half of the unit used for measuring such fields, that is, half a gauss. It is known that the sun has a surface field of about 50 gausses, and in sun-spots the field may rise to 5000 gausses. Very strong electro-magnets can generate fields of upwards of 100,000 gausses, though 30,000 or 40,000 is about their usual manageable limit.

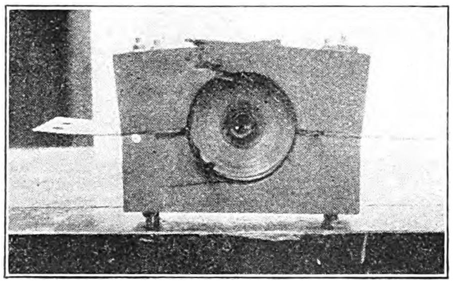
One wonders what will happen in more intense magnetic fields. Superficially, it looks quite easy to discover. You take a bar of iron and wind copper wire around it. You run current through the wire. This produces a magnetic field within the coil and in the iron. The iron concentrates the field around its ends, called the pole-pieces. Put more current through the coil, and the field in the interior becomes stronger.

But this phenomenon occurs only up to a certain point. Iron has only a limited appetite for magnetic fields; it can not absorb them beyond a certain strength. So very strong fields must be made without the assistance of concentrating iron poles. This means that still higher currents must be put through the coil, since the iron will not be there to assist in the concentration.

BUT copper wires heat when currents are passed through them. When the currents are above a certain volume, the wire is heated above its melting point. Thus, seemingly, there is a limit beyond which the field inside a copper wire coil can not be raised—the limit determined by the melting point of the coil.

Dr. Kapitza, working at the Cavendish Laboratory at Cambridge University, has shown how this limitation can be evaded. Suppose an enormous current is sent through the coil, but only for a tiny fraction of a second. Even the most powerful current takes some time to heat up the wire. May it not be possible to get the enormous current through the coil and cut it off again before it has had time to melt the copper wire? This is Dr. Kapitza's method. He sends the current through the coil for not more than 1/100th of a second.

Although this sounds simple, the execution of the method bristles with difficulties. Obviously, everything has to be done in less than 1/100th of a second. Even after the apparatus itself is successfully designed, all the experiments have to be carried out and measurements made within periods of 1/100th of a second. The fields exist for a period of 1/100th of a second. If their duration has to be accurately defined, they must be started and stopped almost instantaneously. Dr. Kapitza's switch for making and breaking the circuit can operate in 1/10,000th of a second.



AN EXPLODED COIL

The magnetic field, 600,000 times as strong as the earth's, is produced at the center

The powerful currents are obtained by short-circuiting a dynamo. The machine Dr. Kapitza uses is of a special design. It is wound so that the current alternates its direction during a revolution, that is, it has a single phase winding. At the beginning of a revolution the current is zero. It rises to a maximum at the quarter revolution and then declines to zero again at the half revolution. The current then changes its direction, rising to a maximum in the new direction at the three quarter revolution, and declining to zero again at the full turn. With such a machine, the current will be zero at the beginning, the middle and the end of a revolution. The volume of the current at the maxima will depend on the size of the machine. In Dr. Kapitza's machine the maxima are about 30,000 amperes. By special winding the maxima can be reduced but spread out a little. In this way, he obtains a steady 30,000 amperes for 1/100th of a second, instead of, say, 72,000 amperes for a far shorter fraction of a second.

We now come to one of the many highly ingenious features of this machine. Dr. Kapitza has his source of 30,000-ampere current; how can he tap it?

We all know that when a current is broken, sparks occur; for instance, when a street car trolley jumps off the wire. Will we not get a tremendous spark if we try to break a current of 30,000 amperes? And will not a big spark at each end of the 1/100th of a second period rather blur the definition of the interval? We can avoid all that, says Dr. Kapitza, by seeing that the current is tapped from the machine when it is at one of its zeros.

So the coil for producing the magnetic field is switched on to the dynamo in 1/10,000th of a second when it is producing zero current. As there are limits to mechanical accuracy, the current may not be quite zero, but perhaps a mere 3000 amperes. So the switch must be capable anyway of breaking a current of a few thousand amperes in 1/10,000th of a second. That is why it has to be so large and complicated. Dr. Kapitza considers that the switch was the hardest to design of all the parts of his apparatus.

THE coil has now been switched into the current when the current was comparatively feeble. In a small fraction of a second it rises to 30,000 amperes and remains at that strength for the next 100th of a second. All the experimenting has to be done in this short interval.

For the small fraction of a second when it is short-circuited, the dynamo develops about 50,000 horsepower, and the energy discharged into the coil is about equal to that discharged when a field gun is fired.

The machine was made to Dr. Kapitza's design, in consultation with Professor Miles Walker, of the College of Technology at Manchester, by Metropolitan Vickers at Old Trafford, in England.

The magnetic coil for producing the magnetic field consists of layers of square copper wire, or copper-cadmium alloy. When a current is sent through the wire the opposite sides of the coil repel each other. If the current is small the repulsion is not great but if the current is large the force on the coil tending to make it expand can amount to several tons per square inch of copper.

In his earlier designs, Dr. Kapitza

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*See "Among Our Contributors," page 421.

found that the metal of the coil spread like putty under these repulsive forces. But it is possible to design the coil so that these forces cancel out, except directly outward. So this was done, and a strong steel strap was clamped around the coil to bear the resultant outward thrust. By using copper-cadmium alloy, the coil itself can be made four times as strong as when copper is used, and yet retain 90 percent of the conductivity of copper.

Then a worse snag arose. The repulsive forces tending to make the coil expand made the coil unwind itself a little. Its ends were torn away from their terminals. Coil after coil burst in this way, and the experimenter had the unnerving experience of seeing his experiments failing after all the labor and expense on the dynamo and other apparatus.

After some months of disappointment, the experimenter devised a solution of the bursting coil trouble, and it was possible to proceed with these epic experiments. He designed coils which "breathed," that is, expanded automatically. The central winding in the coil was made out of a piece of copper-cadmium tubing with a helical saw cut. A ring was made to slide around this tube, and then the end of the wire was brazed to the ring. When the coil expanded, the wire just slid the ring around the tube. After being used once, the coil settled into a permanent position cramped against the outer steel strap and the trouble was overcome.

Another difficulty was caused by earthquakes. When a dynamo about to produce 50,000 horsepower is short circuited, it suffers a severe shock which it communicates to its foundations. A small earthquake travels through the laboratory at the rate of about two miles a second. Measuring apparatus, spectrographs, and so on, are thrown out of adjustment. Now these magnetic field experiments last one 1/100th of a second. So, if the coil is placed some distance away from the dynamo, the whole experiment will be over before the earthquake shock has had time to reach the measuring instruments, and so Dr. Kapitza has arranged it. All the photographs and observations are taken before the shock arrives, even though it is traveling at two miles a second.

The unleashing of energy at the rate of 50,000 horsepower for a fraction of a second, has been calculated to produce an exceedingly high momentary temperature inside the coil, possibly the highest temperature the earth has known since it condensed out of solar material. This calculation, and Professor Rutherford's disintegration of atoms at Cambridge, prompted Professor Eddington to remark humorously that, though the interior of a star may be at a temperature of millions of degrees, centigrade, it is quite a mild place compared with the Cavendish Laboratory.

Dr. Kapitza has already made two discoveries of great interest, besides extending magnetic field technique ten times beyond its previous limit. The late Kamerlingh Onnes, the Dutch scientist, discovered that when certain metals were reduced to a very low temperature their electrical resistance decreased almost to zero. Other metals decreased steadily until a low temperature was reached, after which there was a sudden drop in resistance. Still other metals were always left with a certain residual amount.

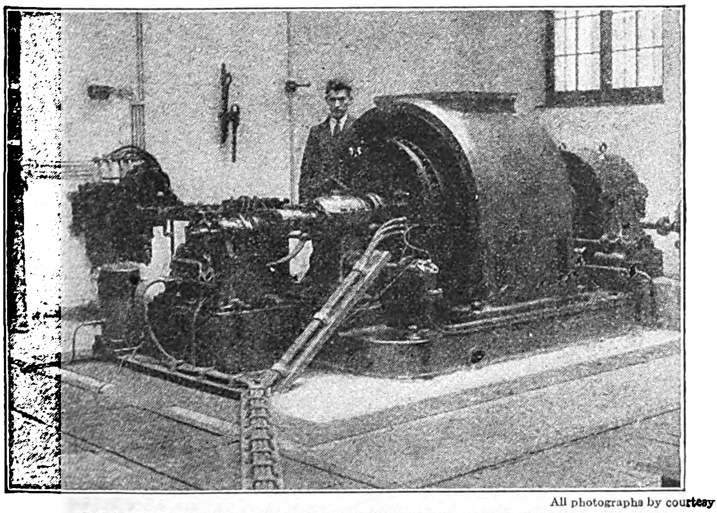
NOW the resistance of metals increases in strong magnetic fields. With the range of field strength at his command, Dr. Kapitza has shown that the residual resistance is due to internal disturbances in the metals. If the temperature could be lowered sufficiently, these disturbances would disappear. Thus he has shown that the same laws of variation of resistance control all metals under undisturbed conditions; the exceptions are due only to disturbances which can be removed by adequate technique. A jumble of varied data has been reduced to order.

His next remarkable result was published recently. He has discovered the phenomenon of atomic magnetostriction; that is, the stretching in a magnetic field of the bonds between atoms. It has long been known that metal rods change their length when placed in magnetic fields. This old phenomenon is completely describable in terms of the elasticity of the metal and what is known as its magnetic susceptibility. It is due to slipping or rearrangement of the polar crystal units of which the rod is built up.

Kapitza's phenomenon is quite different. The crystal units themselves are distorted under the enormous stresses of his intense magnetic fields. He finds that the strong fields tend to increase the strength of strong short bonds between close atoms, and to weaken the weaker bonds between atoms farther apart. Thus Kapitza has started a completely new line of attack on the nature of certain of the forces acting between the atoms of magnetic solids.

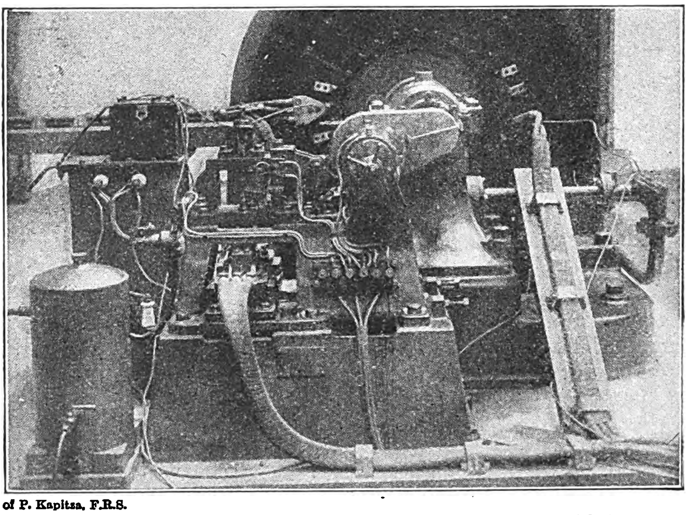
The greatest achievement in science consists in the invention of new methods. Once a new method is devised, it can be applied to hosts of objects, and must almost necessarily reveal new facts, many of which must be important. Dr. Kapitza has devised a new method. It is not at all unlikely that the next great advance will be the outcome of applications of this method.

For many years the study of magnetism has been in a jumble. Straightening the jumble will almost certainly reveal an atomic design of the profoundest significance. It looks as if Dr. Kapitza is in a fair way to do this straightening. At the moment, no one in the world is making more interesting experiments in physics.



MACHINERY FOR PRODUCING THE FIELDS

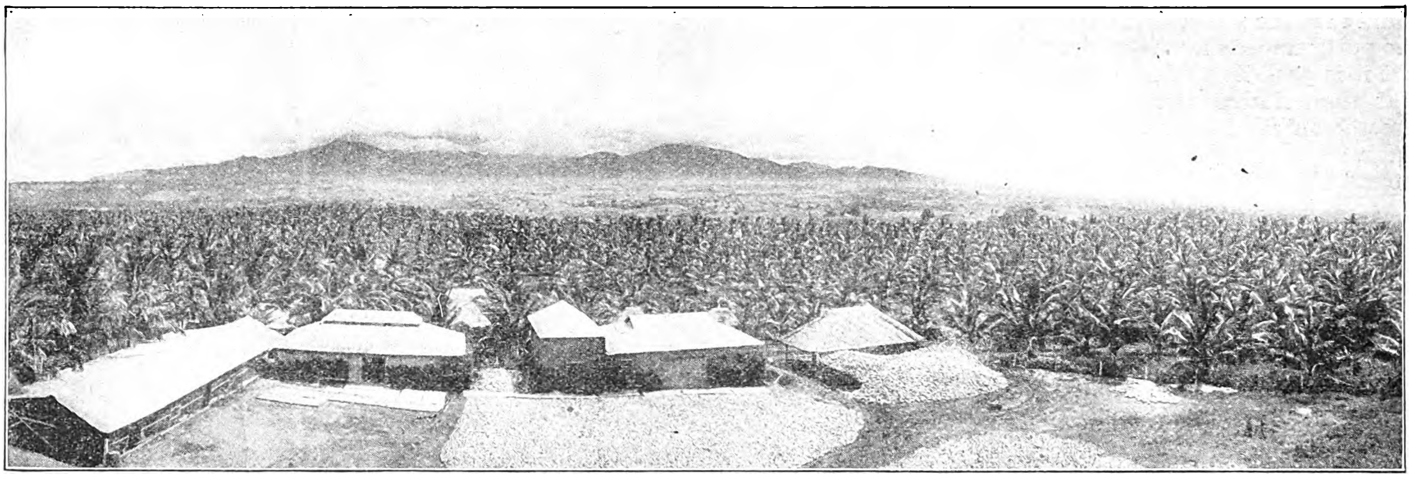
The dynamo gives electrical energy at the rate of 50,000 horsepower during a period of about 1/100th of a second. It has a special single phase winding, which is described in the text



All photographs by courtesy of P. Kapitza, F.R.S.

THE SWITCH, AN UNUSUAL PIECE OF DESIGN

This must be capable of cutting off a current of about 5000 amperes in 1/10,000th of a second; the maximum is 30,000 amperes, which flows through the circuit for 1/100th of a second



A COCONUT PLANTATION IN THE PHILIPPINE ISLANDS

Piled against the side of the thatched hut to the right of the center of this photograph are thousands of coconuts. In the center foreground is a large area covered with coconuts that have been broken open and exposed to the sun to dry. The resulting dried meat is called copra

From Coco Palms to Coconut Oil

The Coconut Has Exerted a Tremendous Influence in the Industrial Life of the Philippine Islands

By CHARLES W. GEIGER and RUTH SABICHI

COPRA, the dried meat of the coconut, has figured in the romance of world trade since the days of Magellan. The story of the coconut is the story of the economic progress of the Philippine Islands, to which it has contributed more than any other product, with the possible exception of hemp. Few plants, if any, are as serviceable to primitive man as is the coconut. The nut meat is eaten as food; the oil is useful in making edible fats and soap, and is also used for illumination; the tree roots provide a dye, and the trunks, building material; the leaves are employed for thatching roofs; the midrib of the leaf is used for making baskets, brooms, and brushes; the fiber from the nut husk is woven into ropes and mats; and the nut shells, in addition to providing fuel, are shaped into cups, ladles, spoons, and other utensils.

UNDER primitive conditions, the production of coconuts, copra, and coconut oil was confined to the groves of wild palms that skirted tropical shores. These wild or uncultivated trees still constitute a considerable source of supply when the market price is sufficiently attractive to the natives. The coco palm, however, is now cultivated like any other staple agricultural product. Large plantations are to be found throughout the tropics, for supplying the international trade in copra and coconut oil.

In domestic cultivation, it is customary to set out trees in rows, about 30 feet apart, giving room for about 48 to the acre. Crops of abaca, or Manila hemp, and other quickly growing plants, are usually grown between the rows. During the fifth or sixth year, the trees begin to bear, and after the seventh year the planter can reap an annual harvest of 15 or more nuts from each tree. The trees reach maturity at the age of 10 years, when about 70 nuts per tree are collected annually. In rare instances, as many as 500 nuts have been harvested in a year from a single tree, and trees have been known to continue to produce after reaching an age of 150 years.

IN THE JUNGLE

At the right is a coco palm. In the left background is a primitive cart for hauling nuts

The natives pick or shake the nuts from the trees and crack them open with a machete. The broken nut meats are then placed in the sun to dry. Sometimes the broken pieces are placed on drying racks under which coconut husks are burned to speed the drying process. The resulting smoke-colored copra is called "smoke-dried" to distinguish it from that which has been sun-dried. The fire-drying method is used in regions where excessive rain makes natural drying impossible. Mechanical driers are employed on some of the larger plantations, but the practice has not become prevalent.

MATURE nuts yield copra of the best quality, but it is customary for the natives to harvest the nuts before they are ripe and depend upon a month's curing on the ground. Copra made from immature "meat" has a tendency to re-absorb moisture after drying, as well as to become moldy and sour, but dry-curing before removing the husk that surrounds the shell overcomes this objectionable tendency.

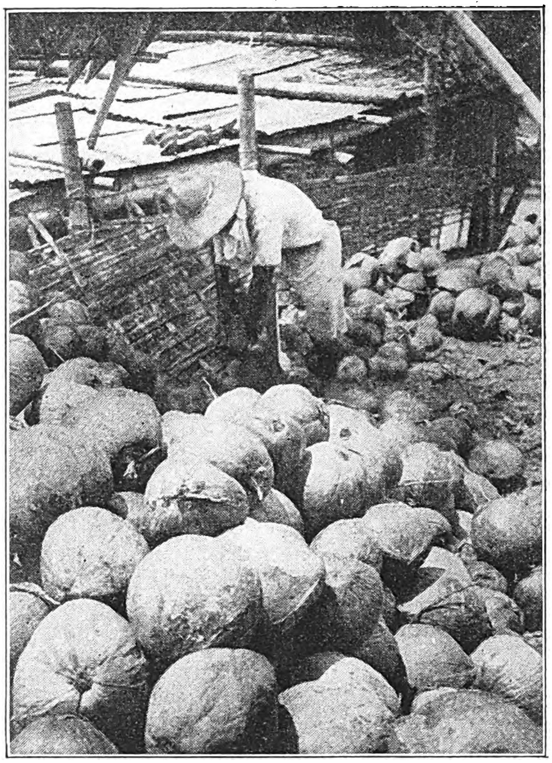
In some parts of the islands, where sunshine during the harvesting season is very uncertain, the copra is dried by the use of a *tapajan*. This device is a bamboo grate, about 20 feet square, under which a rough earthen oven has been prepared. Over the grate, a roof or watershed is erected, composed of coconut fronds. The nuts are husked and the shells split, and the broken coconuts are placed on the bamboo grate. A fire is built under the grate, and the meat shrinks from the shell as it dries. The shells, when removed from the meats, are used as additional fuel for the fire. The total drying time by this method is from five to 12 hours.

THE natives have various ways of disposing of their crop. In some districts, they sell their copra direct to the dealers at trading stations operated by the exporters. Chinese merchants in the small towns also acquire much of the local copra stocks, usually giving merchandise in exchange. The merchant, in turn, settles his accounts in the form of copra shipments. The coconuts are frequently made into "rafts," and are floated down the rivers to market.

Some years ago it was the practice to ship almost all of the copra overseas for crushing and conversion into coconut oil, but a few mills have been established in the Philippines, in India, and in the Dutch East Indies. These local oil mills have become important factors in the copra market, exerting a balancing influence on the market price of copra and oil. However, the proximity of raw material, and the cheap native labor available for operation of the mills is offset by lower power costs, more efficient labor and machinery, and more convenient marketing conditions in the United States.

Copra first became an important item in world commerce in 1886, although a French sailing vessel had carried a load of coconuts to Marseilles as early as 1750. Marseilles soon became a manufacturing center for copra products, and is still one of the most important copra importing ports of the world. It was in France that the first butter substitute, consisting of coconut oil and peanut oil, was produced.

Traders, operating sailing vessels in the South Seas about the year 1890, brought copra and other native products to the United States. Coconut oil mills were established at San Francisco and Berkeley. The phenomenal growth of the copra industry in the United States is shown by the fact that imports in 1920 amounted to 218,521,916 pounds, of which only 7 percent came from the Philippine Islands. By 1927, our copra imports had increased to 450,994,519 pounds, of which 72 percent came from the Philippines. Of the 238,471 tons of copra exported in 1928 from the Philippines, 181,111 tons came to the United States, and 57,360 tons to Europe. About two thirds of the American copra imports were consigned to the major Pacific Coast ports — San Francisco, Los Angeles, Portland, and Seattle.



REMOVING HUSKS

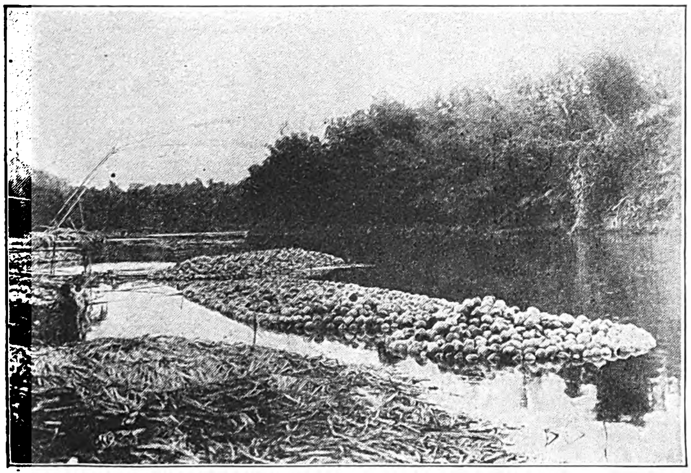
Before the nuts are broken and meats extracted, the thick, fibrous, outside husk must be removed

Originally coconut oil extracted from copra at the source was shipped to San Francisco and other ports in five-gallon cases, barrels, and drums.

THEN a system was perfected whereby the oil was shipped in tank steamers and in deep tanks on passenger and cargo vessels operating between America and the Orient. This practice immediately revolutionized the transportation situation; for years the great ocean steamers had been carrying petroleum from this country to the Orient and returning in ballast, until someone thought out a practical scheme of carrying the coconut oil on the return voyage. A number of tank steamers are now engaged in transporting petroleum from Pacific Coast points to the Orient, returning with a capacity cargo of coconut oil in the same tanks.

Of course it was necessary to devise a very effective system of cleaning the tanks of the ships before filling them with edible oil. After the petroleum cargo has been removed, a charge of live steam is forced into the tanks. This is continued for a period of 12 to 24 hours. After pumping out the bilges, and waiting a sufficient length of time for the interiors to cool, men are sent down into the tanks to clean them as thoroughly as possible. Later, upon arrival at the port where the coconut oil is to be taken on, the tanks are given a final cleaning.

A fleet of specially designed coconut oil barges, with two large pumps, transfer the oil from the copra crushing plants in Manila to the oil tankers or

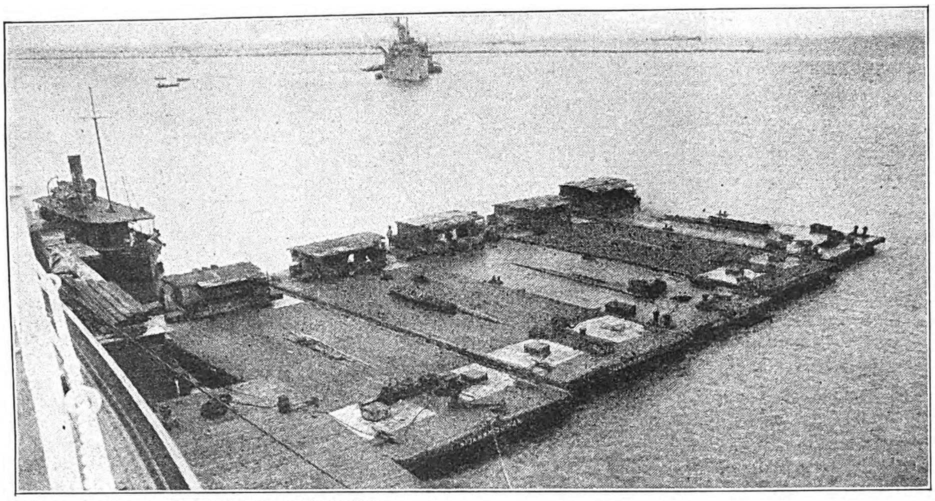


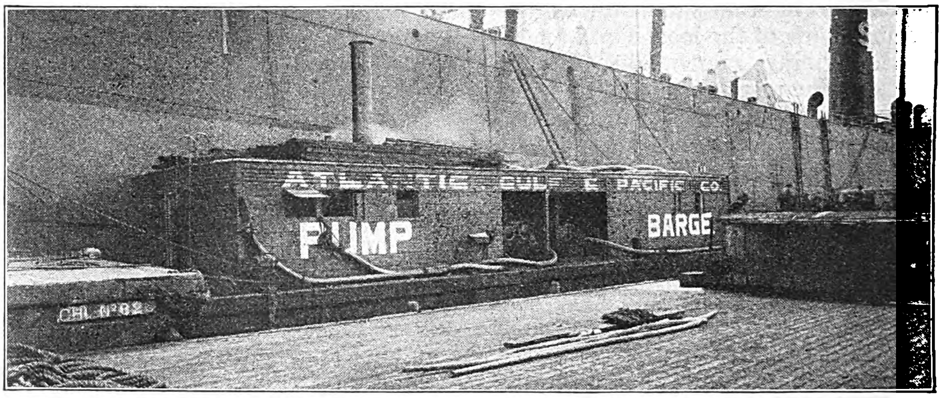
COCONUT RAFTS

When a river is near enough to a coconut plantation, the nuts are bound together in rafts and floated down stream to the market

ON A SMALL SCALE

Scene outside a typical native habitation, with a small quantity of coconuts broken open and exposed to the drying action of the sun





OIL TRANSPORTATION

Above: Specially designed coconut-oil barges are used to transfer the oil from the crushing plants to huge tankers. *Right:* A pump barge alongside a tanker. The machinery pumps the oil from the barges to the tanks on the ocean steamer

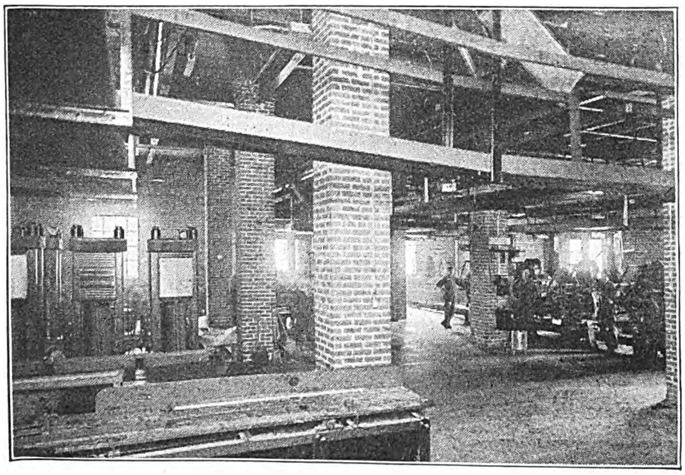
passenger vessels equipped for transporting oil. Each barge has a capacity of 250 tons of coconut oil. Pump barges are equipped with two duplex pumps, each of which can pump 100 tons an hour. There are always a number of loaded barges on hand, so that there will be no delay in transferring the hose when one barge has been emptied. A loaded barge is pushed into place while an empty one is being removed, and the pumps seldom stop running until the tanker has been filled to capacity or the supply of coconut oil available at the time has been exhausted.

The most important factor in handling coconut oil is temperature, for in order to keep the oil in a liquid state, the temperature must be more than 70 degrees, Fahrenheit. Under cooler conditions, it hardens into a dense material resembling butter or lard. Consequently it is necessary to provide heating pipes in the tanks of the steamers, in storage tanks, and in the tank cars used for distributing the oil in the United States. In many cases, the delivery pipes or hoses have a small heating tube running down the center, carrying steam or hot water. Compressed air is sometimes used to force the oil out of tankers and the loading pipe, in order to expedite the transferring operation.

When the copra is not to be pressed at its source, it is transported in much the same way as other bulky materials are handled. One of the most familiar sights in San Francisco Bay is the process of transferring copra from the holds of ocean-going ships to the dock. By means of large metal tubs operated by the ship's tackle, overhead hoppers on the dock are filled. Dump wagons and trucks back up under the hoppers, where they are loaded and then proceed to the warehouse or crushing plant. Copra is also transferred directly from the ship's hold to railway cars. On the Oakland waterfront there are several pneumatic boat unloaders which "suck" the copra from the hold, loading it into a railroad car or warehouse.

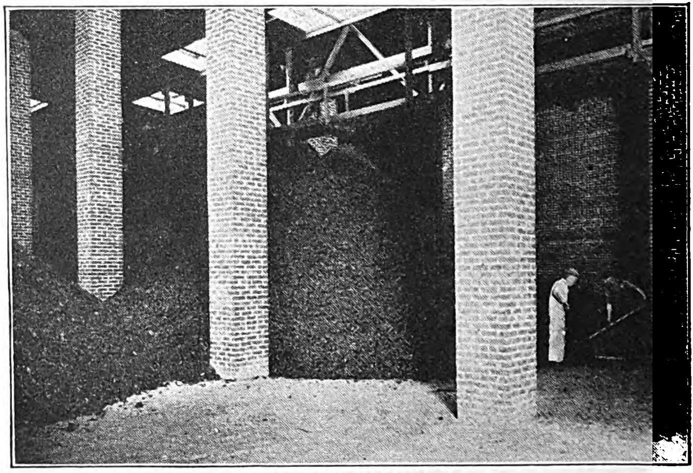
In making coconut oil, the copra is first put through expellers which force out about 25 percent of the oil content. The residue is then ground into meal, and the remaining oil content is squeezed out by hydraulic presses. Most of the oil is then filtered, and used for the manufacture of soap, shaving cream, shampoo solutions, and a long list of cosmetics. Some of the coconut oil is used for edible products, and must be refined several times to remove free fatty acids, color, and odor.

Besides being used in making margarine, the oil is employed in manufacturing thin sugar wafers, cookies, candies, and for shortening in cakes and pies. About 63 percent of the copra is converted into coconut oil, and the remaining 37 percent is used as coconut meal, which has high food value and is used as a feed for stock and poultry. About three fifths of the coconut oil consumed in this country is used in the soap industry; one fifth is used in the production of margarine, and practically all of the remainder is consumed in the manufacture of candy and biscuits.



IN AN EXTRACTION PLANT

This copra crushing plant is located in Berkeley, California. In the left background are three hydraulic presses for pressing oil



COPRA STORAGE

Part of the dried copra is shipped direct to this country, where the extraction of oil takes place. This pile of copra awaits pressing

Birds of a Bleak Arctic Island

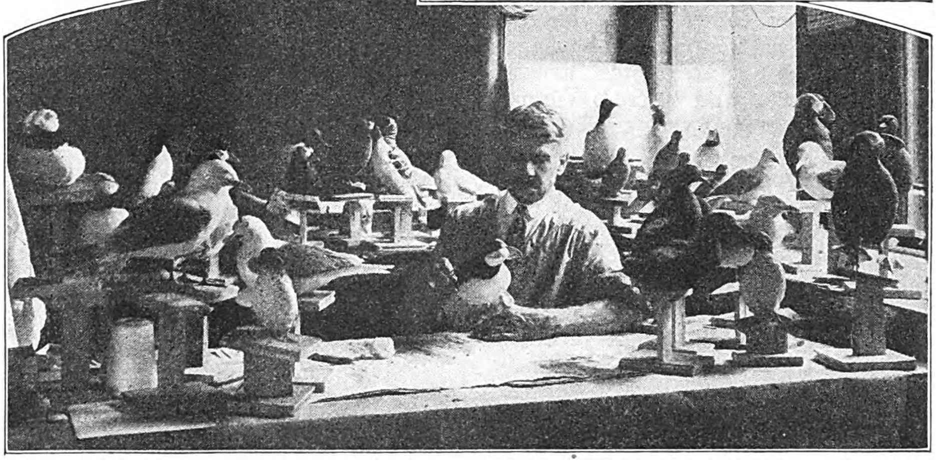
A Bit of the Far North Is Borrowed for a Museum Habitat Group

IN Bering Strait, a few miles south of the Arctic Circle, lie two granite islands. The larger, Big Diomede, seven miles long, is Russian; Little Diomede, much smaller, is American. Here where the East and the West are but little over two miles apart, the East is to the West, and the West is to the East! The International Date Line, here a line of convenience, swings east of the 180th meridian and passes between the two islands. The days are born on Big Diomede, follow the sun around the earth and end 48 hours later on Little Diomede.

AT Little Diomede was collected the material for the Bering Strait Bird Group which completes the series of habitat groups of North American Birds at the American Museum of Natural History, under direction of Dr. Frank M. Chapman. Mr. Francis L. Jacques, Assistant in Preparation, says in *Natural History* that his problem was to suggest to the museum visitor, through sight alone, some sense of the flying gray clouds, the wind-whipped sea, the cool salt air, the towering cliffs with their teeming bird life, and the savage loneliness of the scene. The group space is 20 feet in width, 7 feet from front to back, and 12 feet high.

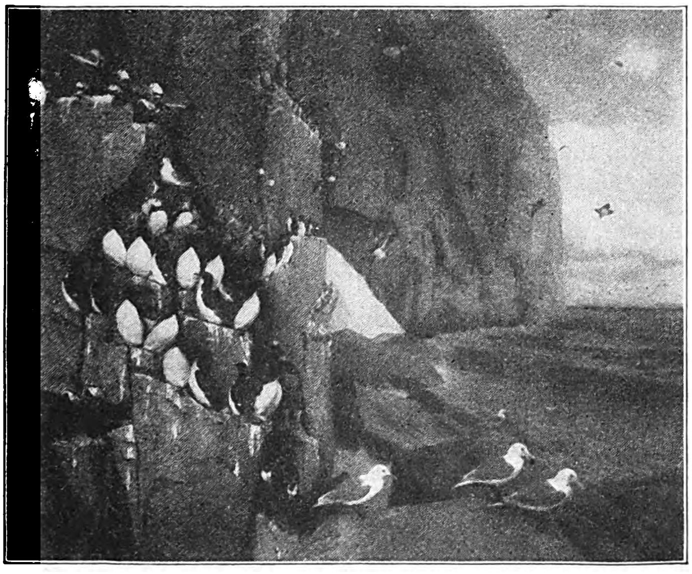
The birds having been collected, and the skins properly prepared, the artist faced the problem of how to use the material obtained. The first step in making a museum group is the construction of a scale model. The model made for this group was about 30 inches long, or one and one half inches to the foot. About 65 mounted birds are used in the group. Each bird is mounted to fill a certain place according to the scale model.

The American Museum has a large staff of preparators and artists under the direction of Mr. James L. Clark, and a number of habitat groups are now being prepared, each with problems of its own as difficult, or more so, than those of the group described. Museum standards are being raised so that we may expect even more perfect groups.



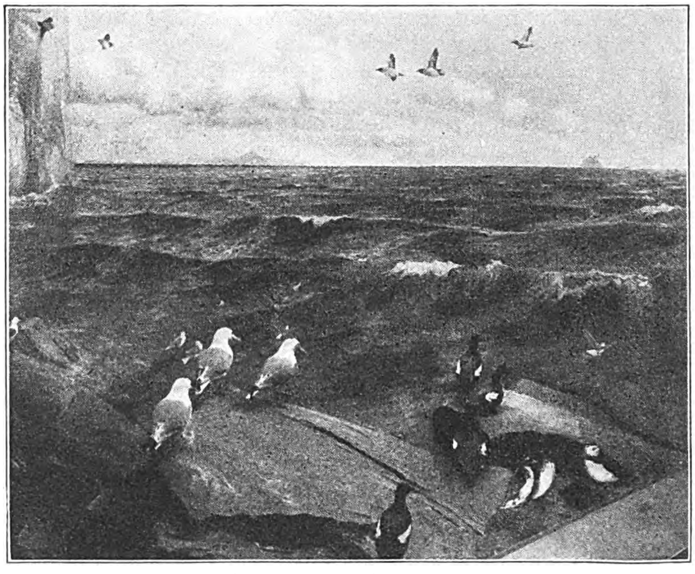
BEHIND THE SCENES

Trained taxidermists mounting the birds in the Department of Preparation and making the plaster rocks which will support them. Realism is the result of careful attention



ARCTIC BIRD GROUP

Here the artist has transferred his impressions of a remote arctic island through the medium of paint, plaster, and mounted birds



SEA, ROCKS, AND BIRDS

The Bering Strait bird group shows almost inaccessible places where the birds gather. There are 65 mounted birds in the group

Fragmentary Molecules of the Sun

On the Sun Most of the Elements Are in Isolated Atoms, Because of the Heat. Unfamiliar Compounds Are Being Discovered

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

NOT long since (February and March) it was told how an analysis had been made of the sun's atmosphere, giving not only a list of the elements present there but the approximate quantities in which they appear. The upshot of this work was that the solar atmosphere consists mainly of hydrogen mixed with a much smaller proportion of the other prominent gases (perhaps one part in 12) and a still smaller quantity of metallic vapors.

The question then arises, are the other bodies known to astronomy of similar composition? How about the stars—and the earth and the other planets?

The answer comes easily for the stars, far off as they are. Thousands of them have spectra almost exactly like the sun's, and therefore must have atmospheres of very similar composition. For the rest, which are hotter or cooler than the sun, the spectra often appear at first sight very different, but when allowance is made for the different manner in which atoms are set up in the business of absorbing light or put out of business at different temperatures it is found that the stars too do not differ greatly in composition. Indeed, Miss Payne, whose work at Harvard has given us most of our information in this matter, concludes that the stars are "remarkably similar in composition."

FOR the earth the resemblance is apparently much less close. We know with certainty only the composition of the outer crust of our planet down to a depth of perhaps a few dozen miles, though the general nature of the denser material in the deeper interior is fairly well assured. This is composed mainly of *rocks*—compounds of the metals with silicon and oxygen. Hydrogen, instead of being predominant, is present only in a small percentage, mainly in the ocean water.

It is important, however, to notice that the relative proportions of the various metals in the terrestrial rocks are not very different from those of the same substances in the sun. Just those metals which are the main constituents of the rocks—aluminum, iron, calcium, sodium, potassium and magnesium—are the most abundant in the solar atmosphere; and silicon and oxygen, still more abundant in the rocks, are also present in great quantities in the sun. The detailed proportions are different; there are more aluminum and silicon on earth and less magnesium. But it is probable that if we could get at the dense deep-lying rocks which form the main bulk of the earth the discrepancy would be smaller.

The earth, then, is very similar in composition to what we would get out of the sun's outer layers if we let a great mass of them cool down and preserved the portion that liquefied or solidified, throwing away about all the excess of uncondensed gases. But this is exactly what might be expected to have happened if the earth was produced by the ejection of incandescent matter from the sun—as all present theories of its origin assume. Hydrogen would escape most easily of all and it is no wonder that there is relatively little of it left on earth.

FOR the other planets we have no chemical data to go on, but only general information about density and the like. The smaller bodies, Venus, Mars, Mercury, and the moon, are probably much like the earth in composition, for similar reasons. The great planets, from Jupiter to Neptune, are so much less dense that it is certain that they contain a much greater proportion of substances of low density than does the earth. Chamberlin and Moulton years ago suggested that this indicated that these larger masses had retained a greater proportion of the light constituents which were originally present in the matter ejected from the sun, and this view is now generally accepted.

In all these respects, then, the composition of the sun, the stars, and the planets appears to be very much the same. But some exceptions are still to be found. There are several important elements and many less familiar ones, the lines of which do not appear at all in the solar spectrum. We know precisely where to look for them, and they are not there. Among the list of missing we find fluorine, phosphorus, and chlorine, which are all present in abundance on the earth; as well as less abundant but familiar ones like neon, argon, bromine, and iodine. Are these substances really absent from the sun?

Modern spectroscopy gives a definite answer. The lines which these substances give in the laboratory (within the range of the spectrum which we can get at in the sun) are all produced and absorbed only by very highly excited atoms heavily loaded with internal energy. Even at the high temperature of the sun only an exceedingly small fraction of all the atoms of fluorine (for example) would be in a state to absorb the lines in question (which in this case lie in the red). Calculation shows that unless fluorine was more abundant than any other metals, or even than oxygen, its lines would not be strong enough to detect. The same is the case for all the other "missing" elements which are at all abundant on earth or even moderately rare there. The more striking cases of apparent absence are thus fully explained.

Some of the heavy metals such as bismuth, have the strongest line in the accessible region and if there was much of them in the sun we would surely detect them. But all the heavy metals, even those whose lines appear, are present in but small proportions and a moderate decrease in abundance would put them beyond detection. So even in this last instance there is no evidence of any real difference of importance between the composition of the earth and sun, beyond those which may be reasonably explained by the circumstances surrounding the origin of our planet.

IN another respect, however, the difference in composition between the earth and the sun is very great. The earth is made up almost entirely of chemical compounds. Metals in the free state are rarely met with, though platinum and a few others are sometimes found "native." Among the non-metals only the oxygen and nitrogen of the air are counted "free" and these are not composed of isolated atoms but of molecules in which a pair of atoms are tied very tightly to one another. Only the inert gases—neon, argon, and the others—which can not enter into combination are found on the earth in the atomic state.

But upon the sun isolated atoms are in the overwhelming majority. All the spectral lines of which we have so far spoken are produced by free atoms and many atoms which have not only been released from combination, but themselves partially decomposed by the loss of an electron.

This, of course, is a result of the sun's high temperature and so obvious a result that it has been understood and generally accepted since Lockyer pointed it out in the very dawn of astrophysics.

It was not until the last 20 years indeed that any definite evidence of the presence of chemical compounds in the sun's atmosphere was forthcoming. About this time it became clear that the molecules of such compounds, if they stood up at all without decomposition under the rough treatment required to get them to emit light, gave spectra of a very complex sort, consisting of thousands of lines closely packed together in certain regions to form conspicuous "bands." A few such bands appear in the solar spectrum, the most prominent being in the violet (Fraunhofer's G group) and in the ultra-violet (the well known "cyanogen" bands).

WITH the rise of spectroscopic theory it was shown that the complexity of these spectra arose from the fact that a molecule can do many things which an atom can not. The separate atoms within it (or at least their heavy nuclei) can oscillate, changing their distance apart, while at the same time the molecule as a whole rotates about an axis. We have now in many cases a good idea just what processes correspond to each of the multitude of lines in the band spectrum. Molecules of three or more atoms are too complicated to tackle as yet, but when there are only two it is possible to find the distance of the two nuclei, and various other things. Spectra due to a number of different molecules have thus been definitely identified in the sun, the list including CN (cyanogen), C_2 giving bands in the yellow and green, CH (the G band), and OH and NH (bands in the ultra-violet).

Very little knowledge of chemistry is required to make the reader exclaim at these formulae. CH_4, H_2O, NH_3—these represent very familiar molecules; but what are these other queer things? Exactly what the formulae indicate. They are not familiar molecules of methane, water vapor or ammonia, but *fragments* of these molecules already partially though not completely decomposed. The CN molecule, too, is recognizable not as that of the well known cyanogen gas, C_2N_2, but as one half of it.

Clearly, then, at the temperature of the sun the dissociation of such molecules as are familiar to us has already advanced far, though it is not complete.

The amounts of these various molecules in the sun's atmosphere can be found by the same methods which are used in the atoms. They come out small. Cyanogen, the most abundant of them, is present in smaller quantities than even the rare element scandium, and for every such molecule there are thousands of atoms of uncombined carbon or nitrogen. This is in harmony with the fact that for stars only a little hotter than the sun the bands disappear, showing that all the molecules are dissociated into atoms. In the sunspots, which are well known to be cooler than the rest of the sun, new kinds of molecules are recognizable but show no bands in the solar spectrum—hydrides of magnesium and calcium, MgH and CaH, and oxides of titanium and boron, TiO and BO. These molecules are evidently decomposed at normal solar temperature. Like the others they are chemically incomplete or "unsaturated"—the familiar stable compounds being MgH_2, CaH_2, TiO_2, and B_2O_3.

It seems curious that only these fragmentary molecules should reveal themselves, but there is a good reason. The spectra of molecules consist partly of bands which are absorbed by the molecule in its normal state, and partly of those which are absorbed only by excited molecules loaded with energy like the excited atoms discussed above. The number of excited molecules, too, would be a very small fraction of the whole, so that only the bands absorbed by molecules in the normal state should be expected to appear unless the compound in question was present in great quantity.

NOW the analysis of laboratory spectra shows that for all the saturated stable gaseous compounds with which the chemist ordinarily works the strong absorption bands due to the unexcited molecules lie far out in the ultra-violet, while for the unsaturated, fragmentary molecules they are usually to be found in the visible spectrum or just outside it. This probably means that ordinary saturated molecules are, so to speak, so well satisfied with themselves that it takes a powerful disturbance such as is given by light of short wavelength to stir them up, while the half molecules are much more easily irritated. Anyway it explains why the latter have been depicted in the solar and sunspot spectra and not the former. There might be, however, a very considerable quantity of molecules of the stable sort in the solar atmosphere without our knowing it, since the lines which would reveal their presence are in the inaccessible part of the ultra-violet. Proof that this is actually true in the case of hydrogen has very recently been given by a brilliant young Italian physycist, Professor Piccardi of the University of Florence.

Besides the familiar line spectrum, which appears so strongly in the stars, hydrogen in the vacuum tube shows a second, and much more complicated, "secondary" spectrum which is now known to arise from the hydrogen molecule H_2. The lines of this spectrum, at least in the visible region, are not visibly grouped into bands but the spectrum has been worked out and found to be similar in nature to other molecular spectra. The bands absorbed by the unexcited molecule lie very far in the ultra-violet and the visible lines are produced only by highly excited molecules.

THE energy which is required to dissociate a hydrogen molecule into its two atoms is not accurately known and Piccardi, calculating from this, showed that at the ordinary temperature of the sun's atmosphere and the pressure prevailing there practically all the molecules should be dissociated, but that at the lower temperature of the spots one percent or even more of the hydrogen atoms might be combined into the molecules.

Working with a copy of the great Mount Wilson map of the sunspot spectrum he found faint lines in the position of most of the strongest lines of the "secondary" hydrogen spectrum—except for some which were obviously "masked" by strong lines of the ordinary solar spectrum that happen to fall close by. These lines appear only in the spots, as they should do if they really belong to H_2. Moreover they show no trace of the Zeeman effect due to the magnetic field in the spots (as lines belonging to atoms practically always do but those of molecular spectra practically never). Some of the strong lines observed in the vacuum tube failed to appear in the spots but this supports rather than weakens the argument.

This mass of cumulative evidence justifies most thoroughly Piccardi's conclusion that hydrogen molecules are present in the sunspots. The number of excited molecules which absorb the observed lines is very small compared with most other constituents of the atmosphere. But the unexcited molecules must be enormously more numerous and they may outnumber even the atoms of abundant metals like iron. Since only a small percentage of all the hydrogen atoms are combined in the molecules we have here another proof, perhaps the most convincing of all, of the overwhelming preponderance of hydrogen at the sun's surface.

It is probable that molecules as well as atoms of some of the other familiar elements such as oxygen and especially nitrogen are to be found in the sun's atmosphere. We may soon be able to calculate what proportion of such molecules there may be, but there is no hope of detecting them spectroscopically.—*On the Nile, Jan. 7, 1930.*

Beautiful Bridges On New Rail Line*

Exceptional Engineering Problems Involved in Construction of European Railway

BRIDGES of remarkable beauty, and several long tunnels, are the outstanding features of a railway extending from Nice, France, to Coni, Italy, with a branch to Ventimiglia, Italy, which was opened a little over a year ago. The new railway is approximately 63 miles in length, of which total about 39 miles are situated on French territory. Its construction presented a large number of serious engineering problems, owing to the fact that the line extends through extremely mountainous territory.

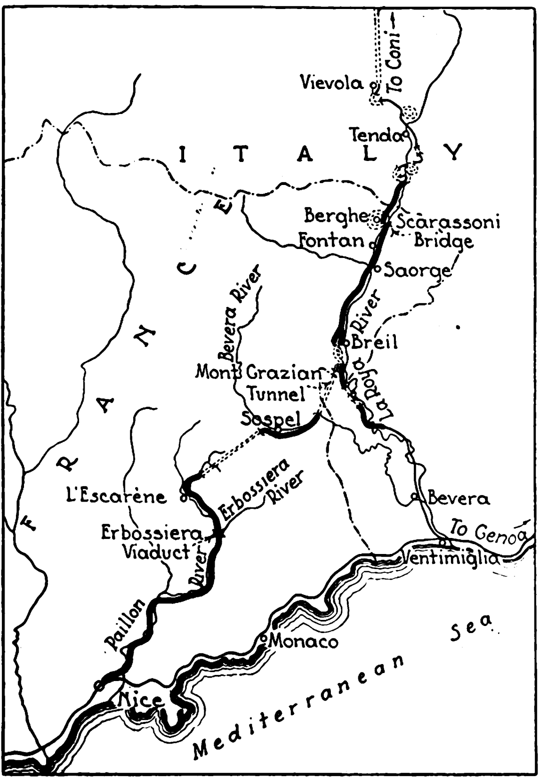
Prior to the construction of the new line there was no direct rail connection between southern France and northern Italy with the exception of the northern line from Lyons to Turin and the coast line from Marseilles to Genoa, via the Mediterranean coast. Neither of these existing lines provides a direct line from Turin, Milan, and the important towns in the plains of Lombardy to the south coast of France and the western section of the Italian Riviera, the only route to these places being a long detour via Savona.

THE need for such a direct link led to an investigation by the Italian government into the possibility of the extension of the existing line from Coni to Col de Tenda, as far as Ventimiglia on the Mediterranean. It was soon discovered that the only feasible and economically practicable route for this extension would be through the communes of Fontan, Saorge, and Breil, in the French Department of the Alpes-Maritimes.

As a result of an international conference, an agreement was signed between France and Italy in 1904, under which both governments agreed to construct, each in its own territory, a railway line linking up Nice and Coni via Sospel, while another line, leaving the main line at Breil, would prolong the railway to Ventimiglia. It is these lines which have now been completed, 24 years after their construction was authorized.

Owing to the rugged character of the mountains in the Alpes-Maritimes, it was necessary to construct no less than 45 tunnels, with a total length of 14¾ miles, nearly a quarter of the whole mileage. Of these, the longest is that under the Col de Braus—3¾ miles. In addition, the numerous ravines and deep valleys which abound throughout the traversed territory called for a large number of bridges and viaducts, many of which are of unusual interest, as they involved exceptional forms of construction.

Among the most remarkable of the bridges is that over the narrow gorge of the Bevera River. Since the location was unfavorable for the construction of a span of 300 feet, an intermediate pier was desirable, but such a pier would have almost completely blocked the waterway. The problem was solved by constructing an arch rib, approximately parabolic, spanning between the walls of the gorge at right angles to the center line of the bridge. The skew arch has a span of 82 feet, a height of 49 feet, and is 10½ feet thick at the base. It is surmounted by a bridge seat which supports two lattice steel trusses 147 feet 8 inches long. (See February, 1929, issue, SCIENTIFIC AMERICAN.) The solution of this problem consists of a variation of that employed in the "hanging bridge" on the Denver & Rio Grande Western.



SERVING A TOURIST SECTION

Map of the Nice-Coni Railway, with its branch line to Ventimiglia, showing bridges and tunnels

Another interesting structure is the Saorge Bridge which spans La Roya River at a height of 197 feet and has an arch with an opening of 131 feet 3 inches, while another remarkable crossing of the same river is the Scarassoni Bridge near the frontier. This consists of a main span comprising an open-spandrel arch of 160-foot span with its crown 148 feet above the stream. It is flanked by approaches embodying arches of 42½-foot span.

Many of the difficulties which confronted the engineers in the construction of the Nice-Coni line must be ascribed to the unstable rock formation of the Alpes-Maritimes. This is largely of a chalky nature in distorted and faulted stratification. In some cases the strata stand almost vertical or lean toward the valley so that loss of support through excavation could easily have resulted in great slides. As a result, large expenditures were made for retaining walls, while on some mountain slopes where ordinary practice would call for side hill cuts, it was deemed unsafe to disturb the slope by excavation and the line was supported on solid or arched masonry viaducts.

IN addition, it was found that the water from many underground water pockets caused the rapid disintegration of the mortar used in the masonry of tunnels and retaining walls, and special steps had to be taken to prevent this water from reaching the mortar. The large amount of special construction which was thus necessary throughout the length of the line naturally had a marked effect on the cost of construction, which amounted to nearly 450,000 dollars per mile.

Apart from the value of the new line from an economic standpoint, it will also tend to foster a very considerable tourist traffic. Hitherto there has been little opportunity for the visitor to the Mediterranean coast to penetrate into the interior of the Alpes-Maritimes and the adjoining provinces of Italy except by the comparatively slow motor coach service. With the coming of the new railway, however, a more rapid route has been opened, which abounds in picturesque scenery and new playgrounds.

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* Abstracted by permission from article by F. C. Livingston in *Railway Age*. Illustrations courtesy *Railway Age*.

Sinanthropus, the Peking Man

As Evidence Accumulates, the Million-Year-Old Fossils Found in China Are Assuming Increasing Importance

ANTHROPOLOGISTS are attaching vast significance to the fossil finds that have been reported from time to time from the vicinity of Peking, or Peiping. As the possible significance of these fossils gradually emerges, men of science are filled with eagerness to see the excavations completed; likewise to know the full evolutionary meaning of the finds already made. It is manifestly impossible to make more than a preliminary determination short of painstaking, detailed study at present. No discovery of fossil man since that of *Eoanthropus*, the "Dawn Man" of Piltdown, England, has aroused interest to such a fever pitch among anthropologists.

Owing to the accident of geographical location the belief appears to have become widespread that the fossils of *Sinanthropus* were those of an ancestral Chinese. No such asumption is justified by the facts, for the antiquity of *Sinanthropus* is doubtless a million years. The existence, even 10,000 years ago, of a race in a part of the world which the original owner of the bones in question inhabited 100 times as far back in the remote past is doubtless little if any more than a coincidence.

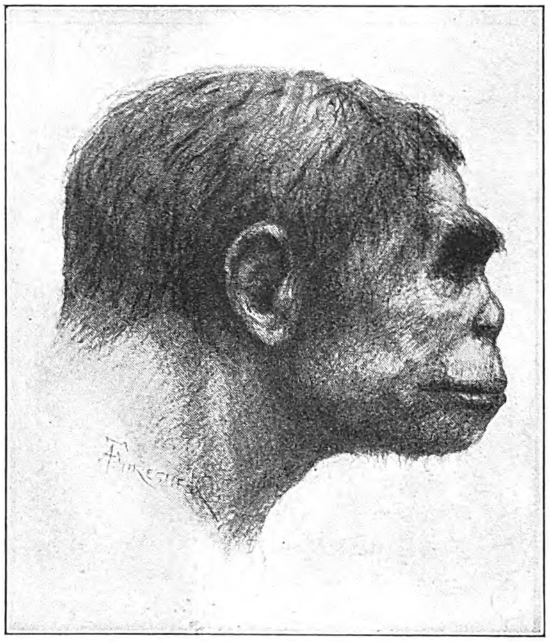
SCIENCE has but small knowledge of the origin of the human races, with regard to time, place, cause, or manner. In 1,000,000 years, or even 100,000 years, a race would have ample time to have passed through many vicissitudes, wandering far afield from its point of origin. Therefore the search for the "cradle of the human species" is likely to prove elusive. The human species evolved from some earlier animal, and this process doubtless took place gradually, covering a vast period of time. When, then, and where in its possible wanderings, can the human species be said to have been cradled? Had we a perfect rather than a fragmentary collection of ancestral fossils the impossibility of attempting to choose the "beginning" of humanness in what would then be seen to be a long, gradual transition doubtless would become more patent.

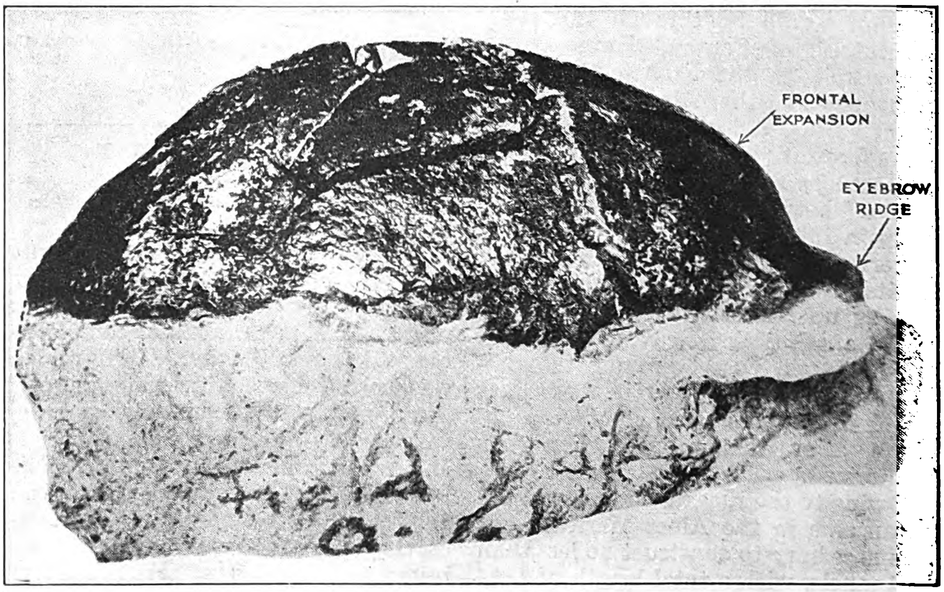
From our contemporary, the *Illustrated London News*, we reproduce the accompanying illustrations and quote the following comment on the Peking Man (by the way, the single skull found has turned out to be that of a woman), written by Professor G. Elliot Smith, Professor of Anatomy in the University of London, author of "The Evolution of Man" and other books, also of several articles previously published in the SCIENTIFIC AMERICAN, and one of a dozen leading authorities on human evolution. Professor Davidson Black, to whom Dr. Elliot Smith refers in his opening paragraph, is a Canadian anatomist attached to the Peking Union Medical College, and has had more to do with the discoveries of *Sinanthropus* than any other man of science.

"The discovery of the first complete brain-case of one of the three earliest and most primitive members of the human family is obviously an event of exceptional interest and importance. Most people are sceptical of reconstructions of ancient skulls built up from fragments. Hence the finding of a specimen which is intact provides a more convincing demonstration. Professor Davidson Black's courtesy in permitting the reproduction of the photograph, which reveals part of the wonderful fossil, makes it possible for us to appreciate something of the significance of what is probably the most illuminating discovery of early human remains ever made.

"Until November, 1928, nothing was known of the existence of the early Pleistocene Man in China, beyond some teeth, on the basis of which Professor Davidson Black, with great daring, created the new genus and species of the human family, *Sinanthropus pekinensis*, to which he assigned approximately the same antiquity as the famous apeman of Java, *Pithecanthropus*, found by Dr. Eugene Dubois in 1891. On the last day of the excavations in 1928, however, Dr. Black's boldness was completely justified by the discovery of fragments of two jaws, those of an adult and a child, in association with the fragments of two brain-cases of corresponding ages.

"History repeated itself last winter: again on the closing





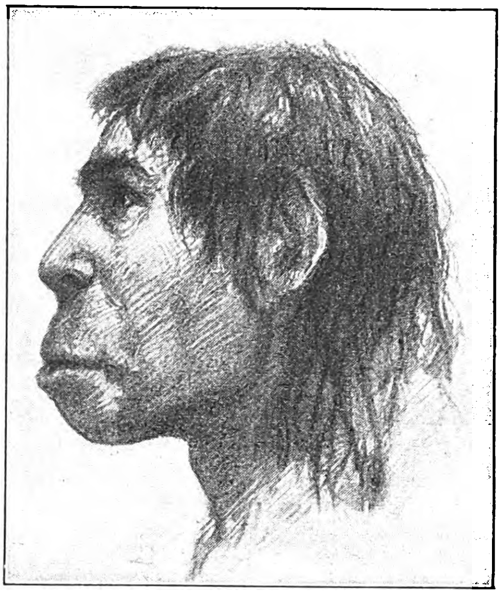
SINANTHROPUS PEKINENSIS

Above: Restoration drawing from *Illustrated London News*, by A. Forestier, from scientific data by Prof. G. Elliot Smith. *Below:* The Peking skull mounted on a plaster of Paris base day of the season's excavations (Dec. 2, 1929), the young Chinese paleontologist, Mr. W. C. Pei, of the staff of the Geological Survey of China, while excavating the sheltered recess of the main deposit at Chou Kou Tien, discovered the greater part of an uncrushed adult skull of *Sinanthropus pekinensis*. Mr. Pei at once recognized the importance of the specimen, and personally carried out the difficult work of excavation and preparation of the block of matrix in which it lay. It is entirely due to his skill and devotion that this bulky mass, with its unique and fragile contents, reached the Peking Laboratory quite undamaged.

"CONTRARY to the reports which have been circulated, no skeletal parts other than the skull and numerous isolated teeth have been recovered during this year's excavations. The different sites where *Sinanthropus* has been discovered in the Chou Kou Tien deposit are all clearly contemporaneous with one another, being Lower Quaternary in age. The evidence collected in a preliminary report on the geology and paleontology of the site by Père Teilhard de Chardin and Dr. C. C. Yong definitely establishes this fact. Though hundreds of cubic meters of material have been examined, no implements or artifacts of any kind have been found, nor has any trace of the use of fire been observed.

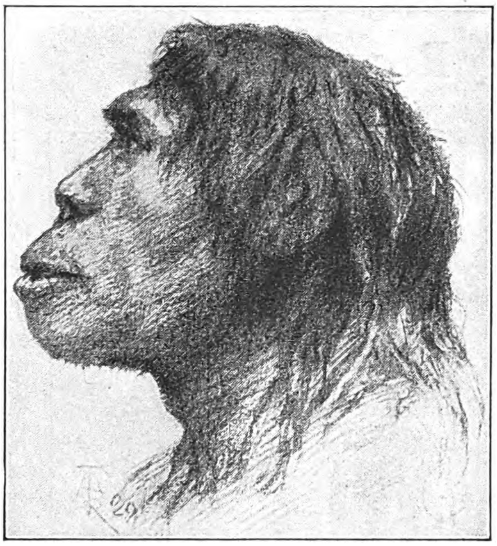
"The photograph of this skull enables us to get a much more exact idea of the nature and affinities of this early inhabitant of eastern Asia than earlier descriptions conveyed, and we are able to correct misunderstandings arising out of the telegraphed reports. The greater part of the left side and the forepart of the base of this unique skull is still embedded in a block of very hard travertine. The vault, from its massive brow-ridges in front to the back of the skull, and the whole right side seen in the photograph, were embedded in a relatively soft matrix, which has now been removed. The brain-case has been almost completely preserved, while most of the facial region would seem to be lacking.

"The skull of *Sinanthropus* is of approximately the same length as that of *Pithecanthropus*, and, like the latter, is provided with massive brow-ridges. However, *Sinanthropus* differs from the Java ape-man in the following important features: there is a slight filling out of the forehead; expansion of the localized parietal eminences on the sides of the head above the ears; and a greater height of the vault. All these differences point to a relatively greater brain capacity in *Sinanthropus*. The mastoid processes (not seen in the photograph) are small and rugged. The sockets in which the lower jaw articulated are well preserved on both sides, a circumstance which will be of great value in the restoration of the lower jaw from the fossils recovered in 1928. While the new specimen bears out what little was already known from the fragments found in the previous year, the perfection of its preservation will enable much to be learned that is now obscure concerning the evolution of the head in early man.



EOANTHROPUS, PILTDOWN MAN

Like the drawing below, this was made by A. Forestier from Prof. G. Elliot Smith's data

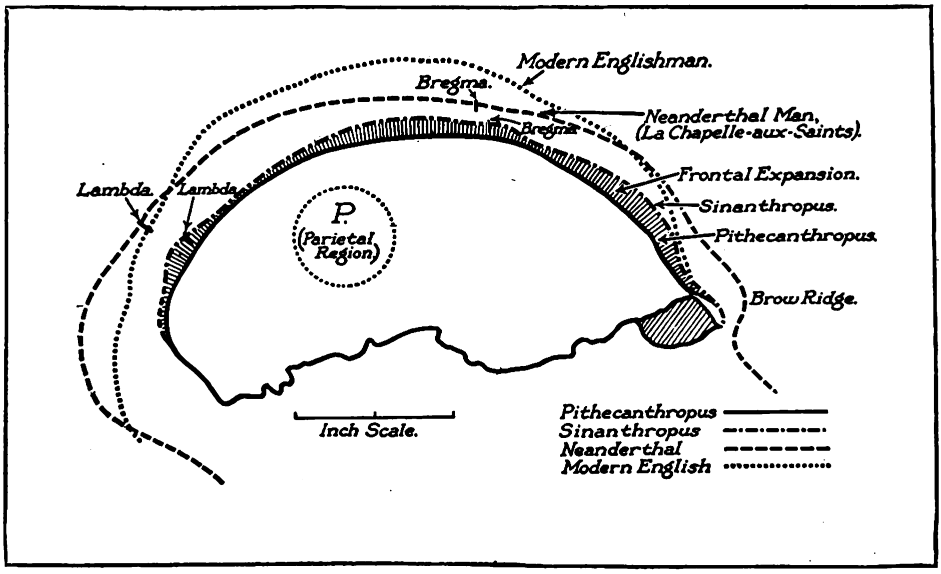


PITHECANTHROPUS, OF JAVA

The Java ape-man was a more primitive being than the Peking man, who was human

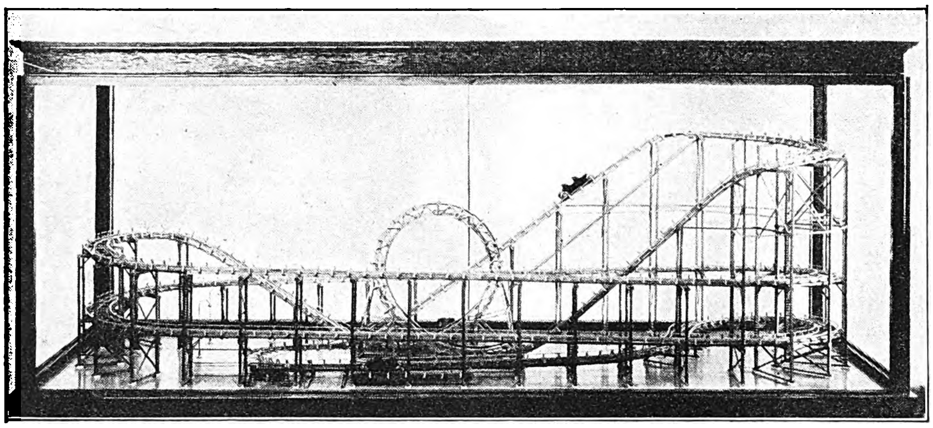
"TO show the distinctive characters of this newly found specimen, its outline, as seen from the right side, has been superimposed (in adjoining diagram) on similar projections of the cranial fragment of *Pithecanthropus*, the La Chapelle skull (Neandertal species), and a random sample of a modern Englishman's skull. Neandertal man and *Pithecanthropus* have been chosen for comparison because the new skull presents a much closer analogy to these two types than it does to the Piltdown man. There is a similar flattening of the skull, and all three have very pronounced eyebrow ridges. It will be seen, however, that in the frontal region there is a distinct fullness of the skull of *Sinathropus* in comparison with that of *Pithecanthropus* in the region marked 'frontal' in the drawing; and that the skull is slightly loftier. According to the report (quoted from Professor Davidson Black), there is a greater fullness in the parietal region marked 'P' in the diagram, which is one of the significant areas in which the human brain differs from that of the apes, and modern man from primitive man.

"The skull is, therefore, one of particular interest."



THREE FAMOUS FOSSILS COMPARED

A drawing by Professor G. Elliot Smith. Skull of Peking man compared with the Java ape man, Neandertal man, and modern man. Shape, not size, is the principal criterion



"LOOP THE LOOP"

This daring amusement device of 1901 consisted of a roller coaster with a loop in the center. The car is raised to the highest point. The centrifugal force prevents falling out

Coney Island's Museum

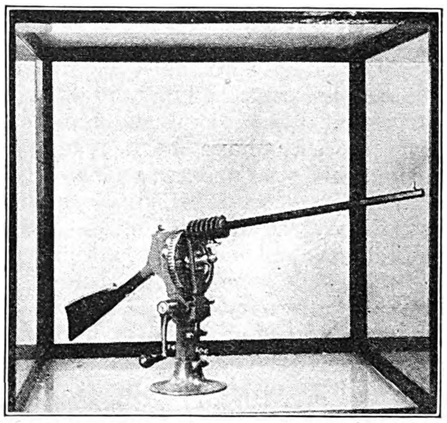
The First Institution Designed to Show Human Play-Reaction

IN a small building not far from the Coney Island boardwalk, where pleasure-seeking crowds pass up and down, is a museum which epitomizes the whole idea of the amusement center. This summer resort furnishes facilities for enjoyment which are fully equal to its more aristocratic New Jersey neighbors. Once you are on the wide boardwalk you have the sand, the same sun, and the same ocean. In no other country can such a fine sea resort be reached from a center of population, for only five cents. You can go from Queens Borough through Manhattan and Brooklyn to the "Island" for a nickel.

This summer will probably see plans mature for a larger museum building located on Ocean Parkway and accessible from all quarters. The City of New York will give a plot of ground of sufficient size to build a museum which will be adequate to the subject and which will be a fitting monument to the period of the Elegant Eighties and the Golden Nineties when the amusement enterprises of Coney Island were raised to a high, clean level. This was done with the aid of a band of inventors who are to be commended for their efforts to promote a good time for many who live a rather drab life and whose occasional outing by the sea gives healthful relaxation.

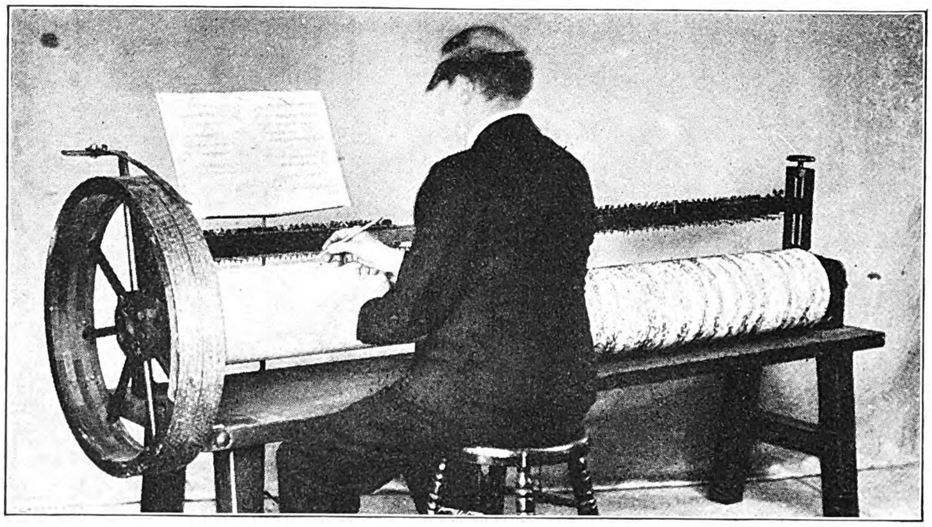
THROUGH the courtesy of Mr. William F. Mangels, himself a well-known inventor of amusement devices and one of the moving spirits in the enterprise, we are enabled to give our readers the first description and illustrations of the "American Museum of Public Recreation."

At present the Museum is housed in a temporary laboratory and storehouse on West Eighth Street, on the corner of Sheepshead Bay Road. The underlying plan is to resurrect the Coney Island of other days from authentic sources. This is the first institution ever devoted to the showing of the human play-reaction as expressed through facilities which man has created and developed. Recreation has become a scientific study in recent years. The establishment of a museum which will show the genius and development of outdoor amusements, the change in public taste and demand from year to year, and the psychology on which the success of recreations depends, fills a well defined need. The functions of such a museum are defined in the Charter which states that the institution acts "as an historical museum of public recreation exhibits, with power to collect and publicly exhibit amusement and recreational devices, novelties, inventions, mechanical and decorative amusement conceptions, and to accumulate and maintain a library and records pertaining to the history and progressive development thereof." The wealth of material



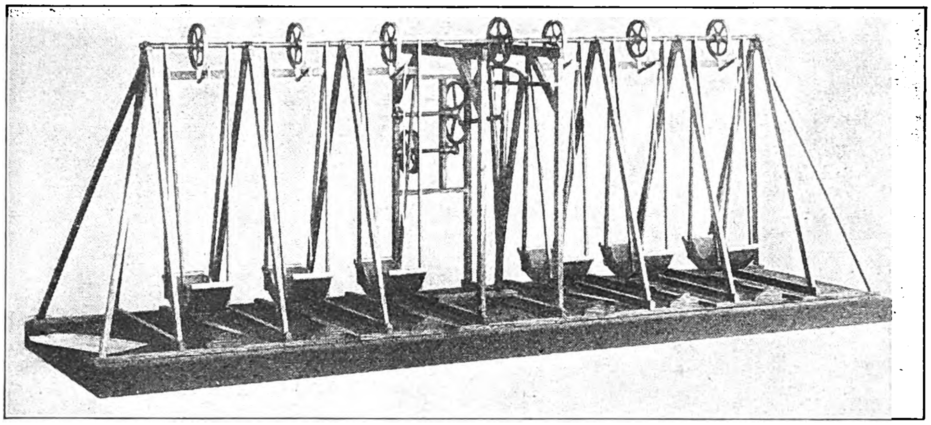
MACHINE GUN FOR GALLERIES

The gun fires by turning a crank. It can be pointed to all parts of the gallery



ORCHESTRIAN

The "orchestrian" was a forerunner of the unit orchestra of today. It was operated by weights and was coin controlled. Instead of a perforated roll it had pins driven in a barrel available for this institution is apparent. America leads the world in the production of novel recreational devices and the development of municipal playgrounds. The National Association of Amusement Parks is sponsoring the Museum.

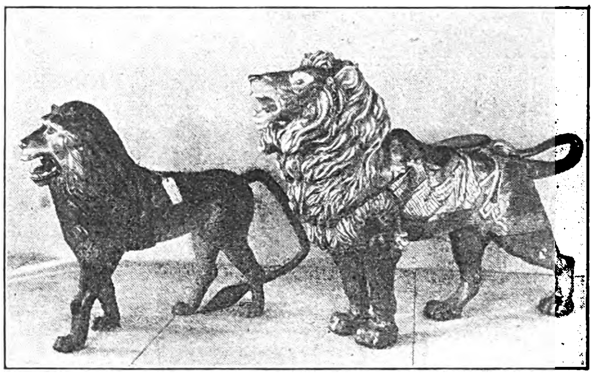


STEAM OPERATED SWINGS

Here operation by the exertions of the persons occupying the seats was replaced by steam power. The occupants started swinging by pulling the cord which operated a band brake

HERE we find examples of the work of Frederick Thompson, who was the creator of "Luna Park," "A Trip to the Moon," and "Toyland," and who built the New York Hippodrome that is so soon to succumb to the crowbar and torch of the house-wrecker. In the Museum will also be found a unique set of carving tools, benches, hand screws, et cetera, used in carving some of the original lions for carousels by the American founder of this industry, G. A. Dentzel. The collection of musical instruments is highly interesting and includes some of the early "orchestrions" operated with pin cylinders and weights. There is also a monkey organ 150 years old and a street piano of 1862 which inspired the ever-popular "Sidewalks of New York." Most of us have forgotten the "melodian" but an example is here. Some time the phonograph of 1885 will be a great rarity, but one will be found in this collection.

Some of the framed photographs and posters are priceless to the collector and student. Many of the devices can only be shown by models, their bulk is so great. A model of a roller coaster may cost several thousand dollars. Such models are being built at Mr. Mangels' amusement device factory a short distance away, where expert model makers are engaged in their fabrication. It is fascinating to watch these clever mechanics work to the minute scale which the model demands.



A PAIR OF LIONS

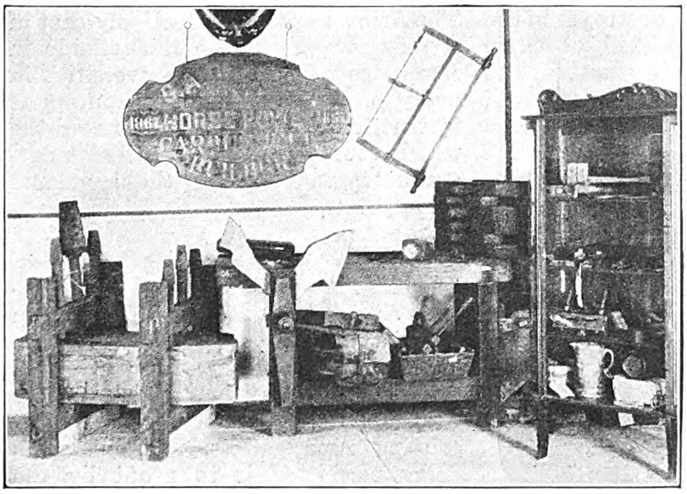
Here we have a pair of carousel lions. There is approximately one hundred years difference in their ages

THE MODEL MAKER

The clever little models are made to scale. The "loop the loop" model shown on opposite page cost 3200 dollars to build

Perhaps the most amusing exhibit in the entire Museum is a pair of carved lions. The smaller lion is of the vintage of 1831. It was carved by Michael Dentzel and was brought to this country on a sailing ship. The other lion was carved by his grandson, William A. Dentzel in 1926. This exhibit shows a real development in the art. We are now going to give away a secret of the business—most of the "merry-go-round" horses, lions, and other animals are now not carved at all but are cast of aluminum and are made of two pieces joined together.

The Museum is one which does not rule out modern devices. For example, Mr. Mangels exhibits one of his machine guns for shooting galleries. The revolving disk holds 60 .22 caliber cartridges. The gun is operated by turning the crank. It can be pointed to all parts of the gallery but stops prevent its being turned in other directions. The empty disk may be quickly replaced by a loaded one. The barrel is easily replaced by another if overheated.

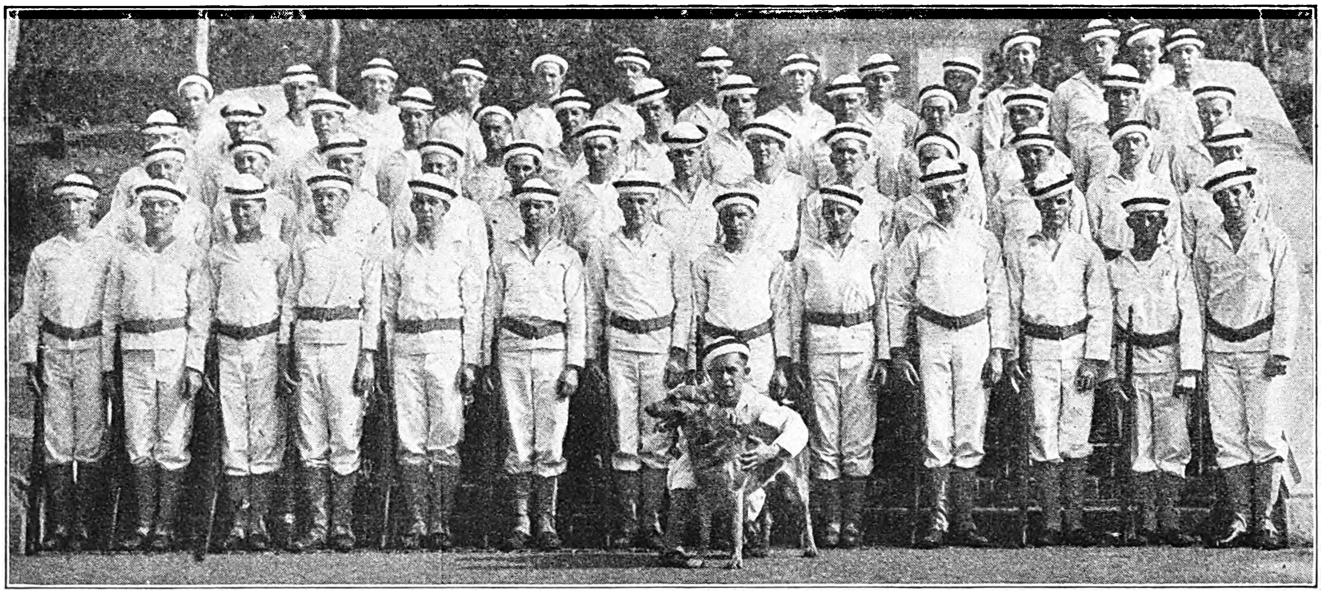


OLD TOOLS

These old tools are priceless. Here we have benches, vises, saws, clamps, and everything the old carver needed; a unique collection

PART OF THE MENAGERIE

No, this is not the "zoo," but a collection of the playmates of children during the last century. Some of them were worn out



PIONEERS OF THE CALIFORNIA UNIT

The 1930 class at the University of California, soon after their enrollment in 1926. The successful ones will receive with their diplomas this June commissions as Ensigns in the United States Naval Reserve. Much of their training has been aboard ship

Midshipmen at 'Landlubber' Colleges

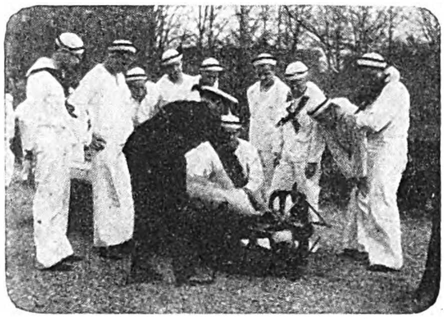
Six Great Institutions Co-operate With the Navy in Preparing Naval Reserve Officers for Sea Duty

By CAPTAIN W. D. PULESTON, U. S. N.

THE senior classes at Harvard, Yale, Georgia Institute of Technology, Northwestern University, University of Washington, and the University of California, now include for the first time a group of Reserve Midshipmen, who have completed their naval course. The successful ones will be tendered with their diplomas commissions as Ensigns in the United States Naval Reserve. In the event of war, these specially trained graduates will be qualified to take their places aboard ship as junior line officers of the Navy, carefully prepared for their specific duties aboard ship. Behind this pioneer class of 1930, there are already entered Reserve Midshipmen in the classes of 1931, 1932, and 1933, and it can now be safely stated that the Naval Reserve Officer Training Corps is fairly launched, and that each succeeding class in the years to come will graduate its quota of Ensigns of the Naval Reserve.

DURING the World War the commissioned line officers on the active list of our Navy were increased from about 2100 to about 21,000 — roughly ten-fold. The additional officers came from various sources. Many were former warrant officers and enlisted men of the regular service; others came from the Naval Militia and merchant marine; and still others came into the Navy directly from civil life. Some of those from civil life, who were recent graduates or under-graduates of colleges or universities, were sent, soon after their enrollment in the service, to the United States Naval Academy at Annapolis where they were given an intensive course, lasting three to six months, in seamanship, naval ordnance, and navigation.

Graduates of this intensive course made unusually good junior officers, readily adapting themselves to life aboard ship, and quickly grasping the essentials of their various tasks. To indicate the Navy's dependence on its reserve officers, it is only necessary to recall that during 1918 the commissioned complement of a destroyer in the war zone usually consisted of three regular naval officers, the Captain, the Executive (who also navigated) and the Chief Engineer, while the Ordnance Officer, the Signal Officer, and all the watch officers were volunteers, most of whom were college men who had successfully taken the intensive course given at Annapolis. The Atlantic Fleet, based in home waters and engaged on a huge training program, carried an even larger proportion of volunteer officers.



PRACTICAL INSTRUCTION

Students at the Georgia Institute of Technology study torpedo mechanism

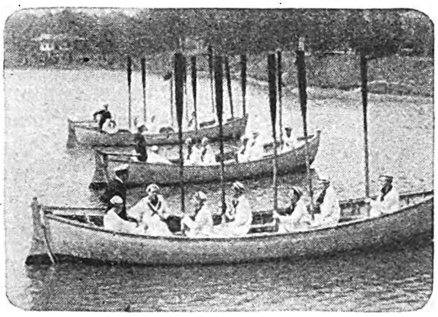
The United States Army during the World War was obliged to train and commission many more reserve officers than the Navy, and immediately after the war very wisely determined to establish a permanent system that would produce in time of peace an ample supply of trained reserve officers. The Army worked so effectively that in a very few years it had available in numerous colleges and universities in every part of our country, courses of instruction that, in addition to the usual courses taken by the undergraduates, would qualify these students for appointment as Second Lieutenants in the Army.

THE Navy, also, realized the necessity of training reserve officers in peace time, but it was 1925 before authority was obtained from Congress to establish Naval Reserve Officer Training Corps units similar to the existing Army units. The Navy's delay permitted it to profit by the Army's experiences, and much of the success of the Navy's effort is due to the cordial co-operation and assistance it has received from its sister service.

The Navy's need for officers in the event of a major war, will never be as great as the Army's, so, at the start, naval units were established in only six institutions, with the intention that, as experience was gained in the operation of these units, a few additional units would be established in other institutions. In order that these courses might be readily available to American students in all parts of the United States, it was necessary to distribute them in educational institutions regionally; it was also necessary to establish them in institutions with a sufficiently large student body to insure obtaining enough students to justify the maintenance of a naval unit; and most important of all, it was essential that the standards of scholarship at the selected institutions be so high that the Navy could be sure that the students would be well grounded in all the regular university courses. Another important factor in the selection of the six institutions was the attitude of the president, faculty, and student body towards the naval unit, and it is a pleasure to record that, in all of those chosen, a warm welcome has been given naval units by the entire personnel.

HARVARD has always been conspicuous for its willingness to cooperate with the government in any endeavor, and from the beginning, President Lowell gave the new naval unit his powerful assistance. The headquarters of the First Naval District and one of our largest navy yards are in Charlestown; and their proximity to Cambridge also facilitates the administration of the naval unit, and enables the students to familiarize themselves with the operation of a navy yard and to inspect visiting ships. Much of the Navy's early history centers around Boston and vicinity, Harvard treasures many traditions of our early days, and an intangible but powerful bond between Harvard and the Navy results.

Yale, located on Long Island Sound, is no less favorably situated for a naval unit. During the World War it almost converted itself into a naval academy, and President Hadley in one of his annual reports calls attention to the ease with which Yale could be made into an emergency naval academy. Finally, the famous Yale spirit assures a fine morale among the members of the naval unit.


STUDENTS AFLOAT

Part of the unit at Georgia Tech takes a turn at the oars on Lake Piedmont

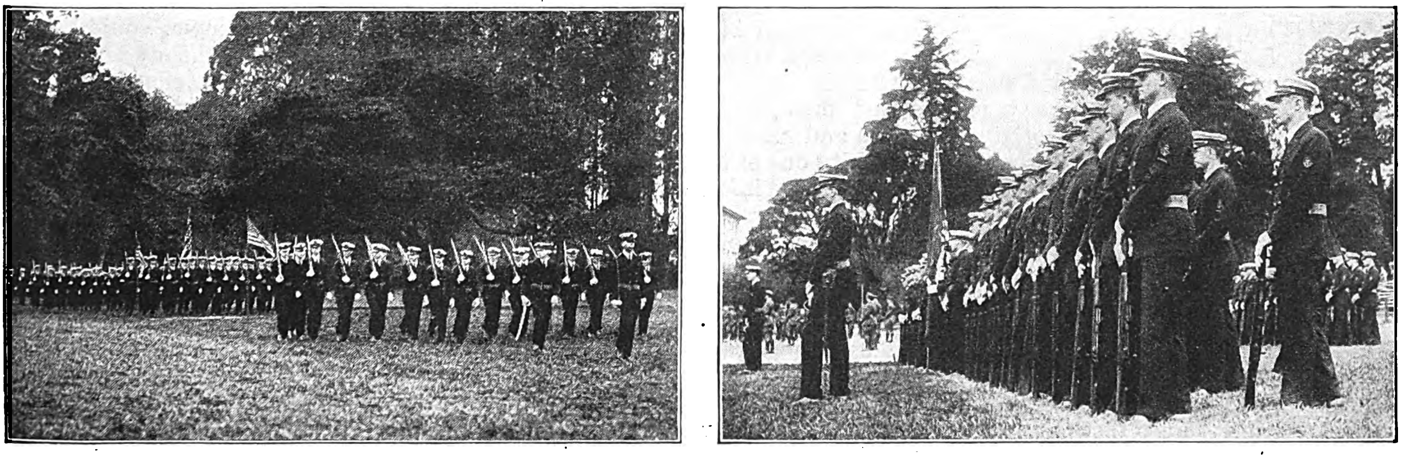
Situated inland at Atlanta, the Georgia Institute of Technology may not, at first thought, seem adapted for a naval unit, but the enthusiasm of President Brittain and the loyal support of the faculty and students have overcome the geographical difficulties. On Lake Piedmont, in the heart of Atlanta, the naval students are trained in navy cutters, to pull an oar and to handle boats under sail; while on the campus an ingeniously designed bridge, fitted with a standard compass and wheel, permits instruction in compass correction and steering. The Tech unit is very enthusiastic and always sends a large contingent on the summer cruise. The standard of scholarship at Tech is very high, and athletics and physical training are encouraged, so the student body furnishes plenty of excellent officer material.

Northwestern University, at Evanston, on the shores of Lake Michigan, lies about half way between Chicago and the Great Lakes Training Station. Like Yale, in an emergency, it could readily be converted into a naval academy. President Scott served in the Army during the World War and is still in the Reserve Officer Corps. Through his interest, a handsome boat house has been built on the campus for the use of the naval unit. Northwestern offers the young men of the middle west an opportunity to fit themselves to serve their country in the Naval Reserve.

The Ninth Naval District includes the heart of the country and embraces the populous states that border the Great Lakes, the navigable portion of the Missouri, and the Mississippi north of Cairo. It will surprise many readers to hear that this inland naval district contains more Naval Reserve officers than any other. It is expected that the graduates of the unit at Northwestern will be the future source of supply of junior officers to these mariners of our inland seas and waterways.

WASHINGTON University, on Lake Washington, on the outskirts of Seattle, is perhaps best known in the east for the superb crews it sends each year to Poughkeepsie. Dr. Suzzalo was President when the Navy Department asked if the University would be interested in a naval unit. In reply he telegraphed that the University of Washington wanted a unit and would comply with all conditions prescribed by the Navy. His fine enthusiasm evoked a similar spirit on the part of the Navy, which accepted his offer by despatch, so that Washington has the honor of being the first institution formally selected by the Navy for an R. O. T. C.

Dr. Suzzalo's patriotic interest in the Navy is a natural consequence of his enthusiasm for sea-going and the American merchant marine. During his presidency he was fond of calling the University of Washington a "sea-going university," and among its many courses is one devoted to the merchant marine and cognate subjects. Shortly after the naval unit was established at Washington, Dr. Suzzalo was succeeded as President by Dr. Spencer,


FOURTH YEAR EFFICIENCY ON PARADE

The two photographs above show the California unit in 1929 after three years of training. Comparison with the photograph at the top of the opposite page will indicate the progress in numbers and efficiency. Other institutions show a corresponding improvement who has continued his loyal support of the naval unit.

The University of California, located on San Francisco Bay, with one of the largest student bodies in the United States and a varied curriculum that could easily furnish a course practically identical with the one given at the United States Naval Academy, was an inevitable choice for a unit. President Campbell, a firm believer in national defense, from the beginning has been stalwart in the support of the naval unit. Among California's faculty are several reserve officers, all of whom have helped in the establishment of the unit.

NAVIGATION AT YALE

Above: a group of students of the Yale naval unit receiving instruction in compass correction. *At right:* members of the Yale unit are shown plotting ship's position

Vessels of the Battle Fleet frequently visit San Francisco harbor, and the Naval Reserve Midshipmen are cordially welcomed aboard and are thus afforded ample opportunity to combine practical work with their naval studies. The proximity of the Navy Yard at Mare Island and the dry dock at Hunter's Point permit the students to see the material side of the Navy.

There is a zestful spirit on California's campus which its students bring with them to their practical work on board ship.

THE purpose of the Naval Course offered to students at these six institutions, as stated in the original regulations prescribed by the Bureau of Navigation, is to supplement the regular courses taken by the naval students so that successful graduates of both courses will possess:

(a) A good general education.

(b) Sufficient knowledge of such subjects as seamanship, navigation, ordnance, military and international law, naval engineering, naval strategy and tactics, and naval communications, to fit them to perform their duties as Junior Officers of the Naval Reserve.

(c) A well disciplined mind and body.

(d) The quality of self-reliant leadership.

The naval courses are conducted by regular naval officers, who are chosen with care for this particular and exacting duty. They come to the campus directly from sea duty or from some important shore duty, and bring to the classroom the prestige of a successful career in the profession they are detailed to teach. The Navy Department is careful to send only successful officers to represent the Navy in the life of these populous educational centers, and to personify the naval service to the numerous undergraduates.

In some of the institutions, the regular professors assist in the instruction of the Reserve Midshipmen and, in return, naval officers are sometimes permitted to assist in other departments. Thus at Harvard, which for years has maintained an excellent Department of Navigation, the regular and naval classes in this subject are combined, and the instruction is carried out jointly by civilian professors and naval officers. At another university one of the naval officers was unusually well informed on combustion engines so his services were utilized in the regular aeronautical engineering course at the university. This cooperation directly adds to the effectiveness of the naval course and promotes a friendly understanding between the regular faculty and their naval colleagues.

Some difficulties were encountered in establishing these units, and while they have been overcome, it is well to note them. At every educational institution there is a positive lack of space because the demand for higher education in our country is actually much greater than our higher institutions of learning can supply; practically every department could advantageously use larger offices, more class rooms, and more extensive laboratories; so when the Navy appeared asking for its share of space it was crowding into an already over-populated region. Similarly the advent of a new course added somewhat to the complications already existing in the various schedules of study, but these difficulties were faced and gradually surmounted. The question of credits towards the regular degree for the successful completion of the naval course was one that required careful handling: the Navy Department required sufficient hours in the classroom and of outside preparation to enable naval students to master its course properly; the students could not give this time to the naval course unless they obtained sufficient credit towards their regular degree; the deans could not give the credit until they were satisfied of the intellectual content of the naval course and its cultural value to the student.

THE situation created a neat triangular problem between the Navy Department, the institutions, and the students, but it was solved when the deans realized that there was nothing easy about the naval course, and that the naval instructors would insist upon high standards of scholarship and in many cases would bring to their tasks the experience of an instructor or even of a head of a department at the Naval Academy.

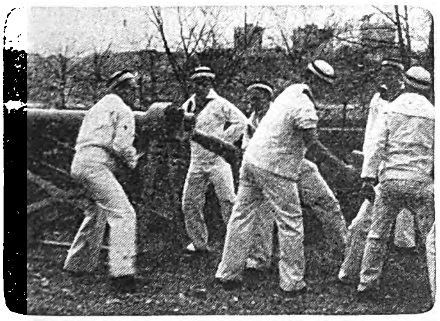
But it should be added further that there are compensating factors. Responsible university authorities realized that the presence of a well-conducted naval unit on the campus would have a stabilizing effect on the student body, that a group of naval students who had learned from practical experience aboard ship the absolute necessity of discipline and who had unconsciously imbibed a respect for constituted authority would have a steadying effect on the other students that would be helpful to the university. And it was generally acknowledged that the quality of self-reliant leadership resulting from naval training would be of great value to the students after graduation.

Even the best universities can not produce junior naval officers without giving them actual sea duty, so the Navy Department provides that no student will be commissioned as an Ensign unless he has successfully completed one practice cruise on a battleship and all are encouraged to take practice cruises every summer during their school vacation. Students from California and Washington cruise in the Pacific and usually visit Victoria and Vancouver in addition to their home ports on the coast; students from Harvard, Yale, Northwestern, and Georgia Tech cruise in the Atlantic and usually call at Halifax, Bermuda, or Havana in addition to some of our east coast ports.

On these cruises, which last about two weeks, the Reserve Midshipmen obtain a practical knowledge of their duties at sea; they work navigation, carry out gun drills and target practice, stand junior officer watch, familiarize themselves with the routine of a man-of-war, and at a receptive age unconsciously absorb our naval traditions and habituate themselves to the customs of the sea.

In addition to becoming acquainted with Navy personnel on these practice cruises, members of reserve units get well acquainted with each other, and while they are encouraged to retain the spirit of their own institution, their surroundings influence them to join together in one body, to develop a Naval Reserve spirit, and, finally, to merge themselves entirely with the naval service.

Besides the regular summer cruises, the Navy Department has authorized these students to embark on the regular week-end cruises given reserve officers and crews, to take passage on vessels of the fleet whenever convenient for them, provided their presence aboard does not interfere with the ship's schedule of work, and on special occasions students have been allowed to take passage on a man-of-war going from one coast to the other.


IN WORKING CLOTHES

Gun practice at Georgia Tech. Such work reflects the completeness of the course

Aboard ship, the Reserve Midshipmen are treated exactly as regular Midshipmen. Their service uniforms are identically like those worn by the regular Midshipmen except for a device on the sleeve; they mess together in junior officers' quarters usually referred to as the "steerage"; and are furnished white working clothes in which they can pull an oar, load a turret gun, crawl through a boiler, or inspect a double bottom. From the moment they are accepted as Reserve Midshipmen they are treated as junior officers and in return are expected to bear themselves at all times in an officer-like manner.

A requisite for enrollment in the naval unit is a deep interest in the Navy, which the Department hopes to make abiding, and a sincere determination to enroll in the Naval Reserve after graduation. Obviously, the government can not afford to give this training to students who at the end of four years will turn their backs on the service. There has been no difficulty in securing sufficient students who are fond of the sea and interested in naval affairs to enroll.

Wherever these young reserve officers go in the United States after graduation they will find fairly close to them some Naval Reserve unit or some regular naval activity to keep them in touch with the service. Generally speaking, it is probable that a majority of the graduates will eventually settle in or near the region of their alma mater. Consequently it is a reasonable hope that in time the Naval Reserve of the various naval districts will come to regard the institution within their district as their Naval Academy from whence they can annually expect their quota of reserve ensigns to replace those who for any reason have disenrolled or have retired.

Fortunately for the success of this new Navy undertaking, Secretary Wilbur realized its importance from its inception and never failed to give it his strong support; amid the press of other duties he would find time on his inspection tours to visit units adjacent to his route and took pains to inspect the units embarked on board ship for the summer cruise.

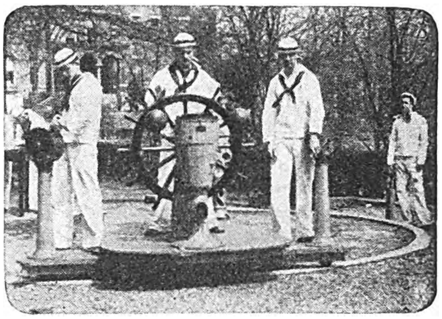
Secretary Adams, whose long association with Harvard has familiarized him with modern university life, also takes a keen interest in these naval units, as is indicated by the following extract from his letter to Mr. Richard Chamberlin, Commander American Post Number 42, American Legion, Evanston, Illinois, expressing the Department's appreciation of a medal awarded annually to the honor student of the naval unit at Northwestern University:

"The course in Naval Science and Tactics is intended to fit students to perform duties as junior officers in the Naval Reserve. But it does more than that. It brings out and ripens the qualities of self-reliance and leadership which are not only required in young officers but are essential in promoting the highest type of American citizenship. It is fitting, therefore, that recognition of merit among students of the unit at Northwestern should have been given by the American Legion.

Very truly yours,

(Signed) C. F. Adams."

In the spring of 1917 after the United States had severed diplomatic relations with Germany, and when it became increasingly evident that hostilities could not be avoided, the Navy began to enroll for active duty some volunteer reserve officers. The first enrolled were some young yachtsmen in the Second Naval District who, on their own initiative in the summer of 1915, had organized a volunteer patrol squadron of their own yachts and trained themselves under the direction of regular officers to operate against submarines. From this very small beginning, the Navy continued throughout the war to carry on simultaneously its training program and its operations against Germany.


SHIP'S BRIDGE ON LAND

Compass correction and a trick at the wheel on the campus of Georgia Tech

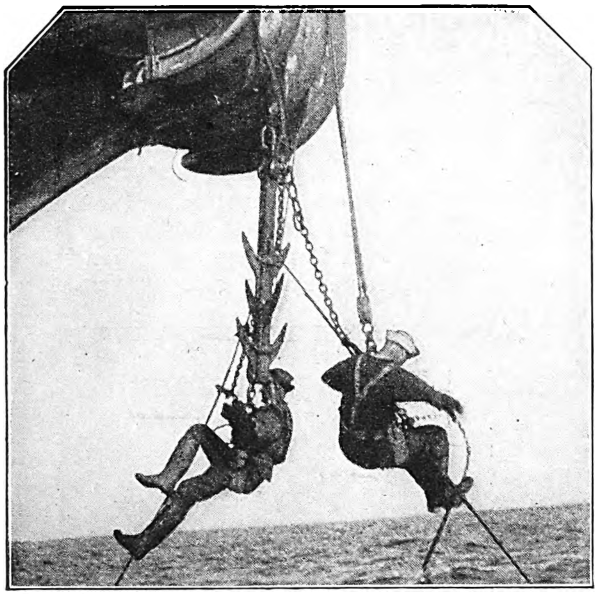
But our just pride in their abilities and the Navy's war achievements should not blind us to the fact that even such fine raw material required at least a year, with all the stimulus of a war atmosphere, to become useful naval officers. Manifestly, in future wars we should not depend upon the enemy giving us a year after hostilities begin to prepare our commissioned personnel.

Reserve officers who served in the Navy during the World War should regard members of these Naval Reserve Officers Training Corps units as their natural professional descendants, and aid and encourage them in every way; and the members of these units should familiarize themselves with the achievements of the reserve officers in the last war so they will realize fully their future duties and responsibilities. As these reserve officers grow in numbers and efficiency, it is not too much to hope that their existence only may prevent a possible enemy from attacking us as did Germany on the assumption, happily erroneous, that the United States could be defeated before it could develop its latent military power.

Linemen of the Sea

When Transatlantic Cables Are Broken, Men Must Be Sent to Splice Them

By JOSEF W. VON STEIN



Courtesy Commercial Cable Company

THE CABLE IS UP

Workmen lowered in bosun's chairs attaching stoppers to cable. After cutting, both ends are hoisted on board

An epic of the sea was enacted during the past winter in the icy, gale-torn reaches of the cold North Atlantic. A continuous struggle was staged by storm and elemental forces pitted against Man and his aides: highly developed scientific equipment and organized industry. Little did many of us realize at the time, that resolute "linemen of the sea" were fighting against overwhelming odds—midwinter cold and terrific storms—to maintain electrical communication service between two continents.

The earthquake* which upheaved the bed of the Atlantic and which seismographs registered November 18 and 19, caused havoc among the spider-like webs comprising the transatlantic cables. "About half past three on the afternoon of November 18," we were informed by Mr. A. E. Powell, Vice President and Chief Plant Engineer of the Commercial Cable Company, "we had the first intimation of the tasks confronting us, when a 'phone message from the main operating room in New York informed us that they had 'lost London' on all circuits.

"A few minutes later other messages began to come in from relay stations that their circuits were upset. The Canso, Nova Scotia, station reported a severe earthquake. Their instruments were badly shaken, and they believed that breaks in the cables had occurred. Routine repair work was begun, and three circuits were patched up to get the most important messages across. Within 15 minutes after the earthquake disturbance, reports came through from the Far Rockaway, Long Island, station to the effect that their tests showed that both cables from New York to St. Johns had been broken at approximately the same geographical position.

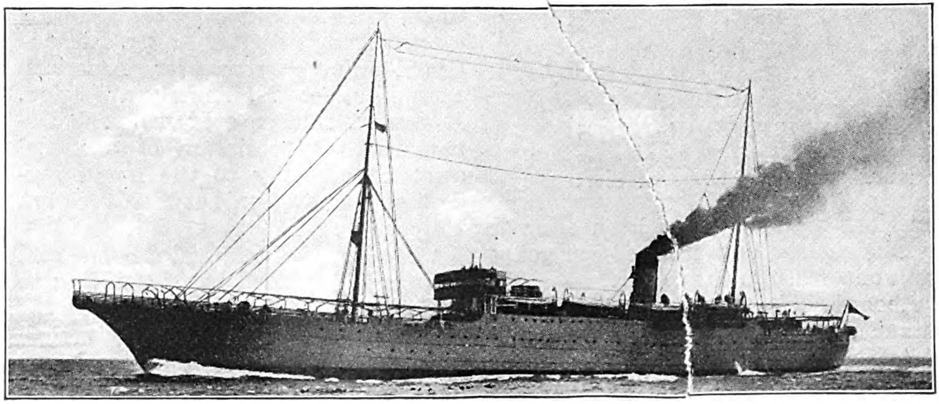
"Communicating with Mr. G. H. Ridge, Chief Cable Engineer, Western Union Telegraph Company, we learned that their tests showed breaks in both of their New York to Bay Roberts cables running through the same geographically situated sector. Meanwhile, Canso had effected temporary repair of their shaken instruments; but their tests showed the loss of the two Canso to Fayal cables which also passed through this apparently disturbed center."

The final tabulation showed that a total of 12 of the 21 cables connecting North America with Europe had been silenced. The powerful machinery of the highly organized cable industry began to function. The Commercial Cable Company's repair ship, *John W. Mackay*, was off Cape Cod repairing a feeder cable. Orders were issued to stop these repairs and rush to Halifax. Two days later this ship was well under way on its trying task in the earthquake zone.

The *All America* was in the Canal Zone. Word was flashed to this vessel and it raced northward. The *Faraday* was dispatched on November 24 from England. Meanwhile, the Western Union Telegraph Company's cable ships were also put to work. The *Cyrus Field* was dispatched to work on the 1926 fast, loaded cable, which was broken in two places. The *Lord Kelvin*, working at the time with the *Dominia* to repair the 1924 New York to Azores cable, which was broken in two places, later went to complete the work begun by the *Cyrus Field*.

The first indication that a cable is broken or faulty is the failure of the receiving instruments in the cable stations to record incoming signals properly. When a conductor is completely broken, there is an absolute loss of electrical continuity; but in the case of a leakage in the insulation, there is an escape of current without complete loss of continuity. These leakage faults are the most difficult to localize for repair.

When the receiving instruments indicate something wrong in the line, a test is immediately made from each end of the line by means of extremely sensitive apparatus using a mirror galvanometer. Several methods of testing are used, the most general being the Wheatstone bridge balance. In this, the galvanometer, or a similar sensitive instrument, is joined up between the arms of the bridge. Since the resistance of each mile of cable was tested and charted as it was laid, accurate location of the breaks is determined by altering the resistance of the resistance box that is used, until the beam of light in the mirror galvanometer remains stationary at the neutral point. Assuming, therefore, that the known resistance per mile of cable is two ohms, and the measuring apparatus indicates a total resistance in the cable of 800 ohms, the break would be ascertained by dividing the 800 ohms by



Courtesy Commercial Cable Company

THE "JOHN W. MACKAY"

One of the largest cable ships which took an active part in the repairing of the Commerical Cable Company's broken cable. She can remain at sea for about three months if necessary

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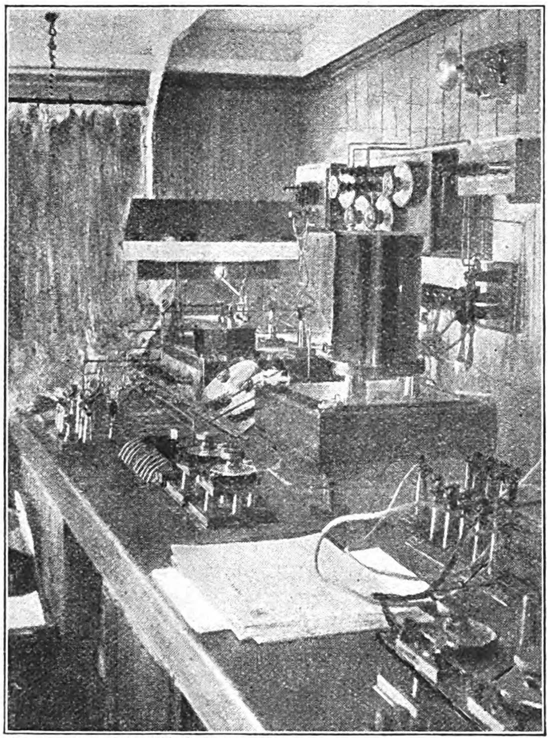
* See page 184, March, 1930, Scientific American for comprehensive map of earthquake region and cable lines.

2, which would place the rupture 400 miles from the shore.

With such information, the captains of the cable-ships were able to determine, on charts showing the positions of the cables, the latitude and longitude of their projected activities.

The ship is aided in locating the supposed position of the cable by electrically driven deep-sea sounding machines which indicate the depth, nature of bottom, and temperature at the ocean bed. Knowledge of the depth aids in finding the location by comparison with known, charted soundings; the character of the bottom determines the type of grapnel to be used; and the temperature indicates what allowances should be made for this factor in repairing the cable. The sonic depth finder is also generally employed.

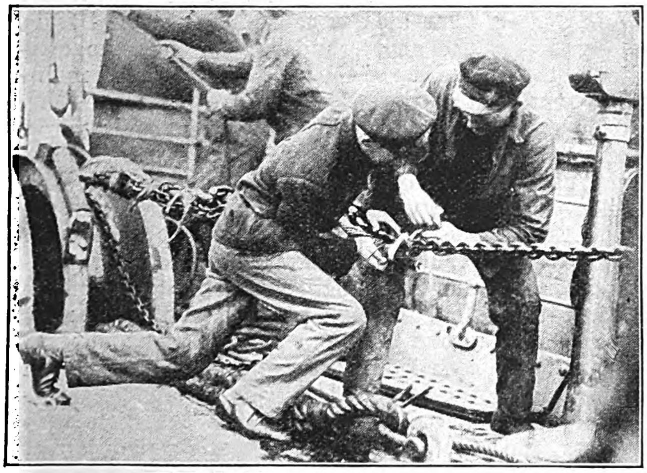
HAVING arrived at the apparent location, a marking buoy is moored by mushroom anchor and line. If weather conditions are satisfactory, the actual work of grappling for the cable, reposing in the soft ooze below, can begin. Inasmuch as it may take fully an hour before the heavy grapnel reaches the ocean bottom, the ship steams to a suitable distance from the line of the cable. Should there be a strong current, the grappling is done against the current. There are different kinds of grapnels, but all have similar general features. The ordinary kind for general use has a shank about four feet long with five prongs and weighs about 250 pounds. For very deep water work, a special type of grapnel is employed, which cuts one side of the cable and clutches and holds the other. This is done to avoid excessive strain on the cable, and this type was often used during the repair work of the past winter.



Courtesy Commercial Cable Company

▲ THE INSTRUMENT ROOM

Some of the delicate instruments aboard the *John W. Mackay*. When the cables are brought up from below, they are tested to determine the location of the fault. Cable is also tested mile by mile as it is being laid



◄ HARD WORK

Fastening cable to grapnel chains after pulling on board, to facilitate the testing and splicing operations

As the ship proceeds across the line of the cable at a speed of one knot per hour, the iron fingers of the grapnel rake the bed. The hooking of the cable is indicated on deck by a dynamometer, which registers a steadily increasing strain on the grapnel rope, or one of the crew "sits on the cable." If rocks or other obstructions are encountered by the grapnel, the fact is shown by the irregularity of the strain on the dynamometer. In grappling for a cable only an inch in diameter far below, the cable ship must be maneuvered and handled with the greatest delicacy. It is no simple problem to move a 4000-ton ship just a few yards one way or another, especially when there is a current or heavy, wintry seas. Frequently ships had to grapple for days this past winter before the telltale strain began to register on the dynamometer.

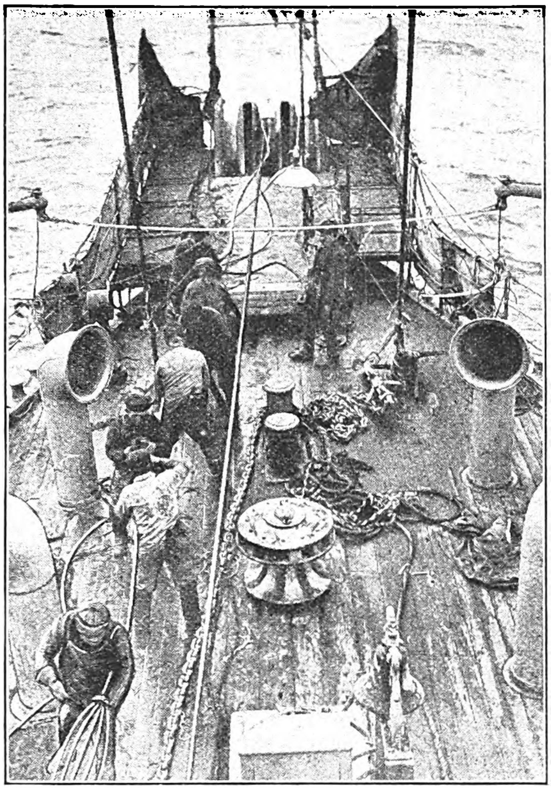
"When, at last, it appears that the grapnel has hooked the cable," related Mr. Higginson, who saw service as Chief Electrician on the *John W. Mackay*, "the engines are momentarily stopped to ease the strain on the cable, and orders are issued for 'full speed astern,' to keep the ship in this position. The dynamometer is carefully watched. Practical experience has taught us to know if the cable is hooked. If this is the case, word is passed to 'stand by to pick up.' There is a tense expectancy all over the ship.

"If the visibility is low, 'lights on' are ordered. The boatswain calls the watch. The ship is brought up to keep the long, heavy grapnel line leading away now from the bow sheaves. The captain stands on the foc'sle head, alternately watching the line coming slowly aboard and turning around to watch the strain registering on the dynamometer. Between times he shouts orders to the crew or to the quartermaster nearby, who stands by a duplicate engine-room telegraph. There is great danger of stretching the cable too tightly or allowing too much slack. The rise and fall of the vessel may snap the cable. The ship, barely making headway, is steered by her engines. At her slow speed, she will not answer the helm satisfactorily.

"THE 'skipper' tries to get his ship directly above the cable at the moment the cable begins to get free of the bottom. In this way, the cable will have the shortest distance to travel to the ship. The long line continues to come slowly in. It passes along the big bow sheave and over another wheel and in turn over and under the various other wheels and braking gears. At last! The beginning of the 15 fathoms of grapnel chain, polished to a bright silver by the chalky sea bottom, breaks water!"

Men are then lowered over the bow, strapped in "bosun's chairs," and "stoppers" are placed on the picked-up cable. This means that the cable is secured by chains passing over sheaves on each side of the sheave holding the grapnel line. The cable is then cut and both ends hauled on board and connected with the ship's electrical testing room. Tests similar to those described in the land terminus are applied. The end of the cable which is found intact to the shore, is then chained to a mooring anchor with a massive seven-ton buoy attached and dropped overboard temporarily. The short end to the point of fracture is either abandoned or picked up and stowed away. When the cutting type of grapnel is used, there is, of course, no short end.

The ship then proceeds on her way to grapple for the other end. The above grappling process is then repeated. This end is then spliced onto a length of spare cable on board. A skilled jointer and his assistants clean and solder together the ends of the



Courtesy Commercial Cable Company

THE FINAL SPLICE

Scene aboard a cable ship while the splice is being made between grappled cable and the new section

central copper wire or conductor. In the newest types of cables the copper wire is wound around with flexible copper tapes. Thus, should the central wire break, these flexible copper conductors will carry the current around the gap. Around this conductor is wound a single continuous strip of Numetal one eighth of an inch wide and six thousandths of an inch thick.

The total diameter of the conductor and its Numetal wrapping is just a fraction short of a fifth of an inch. Over this central core, the jointer then draws the gutta-percha covering from each side and applies two or three more coats of the same material.

Oddly enough, at this point the health of the men who work the hot gutta percha is important. If the jointer's perspiration is acid, this would cause the gutta percha to harden soon and develop a fault. Also, an imprisoned air bubble will later cause trouble since the pressure at a depth of 18,000 feet is 8000 pounds per square inch.

WHEN the jointer has finally completed his task, the joint is placed in cold water for about 20 minutes to harden. The splicer then places a serving of jute yarn around the core as a cushion for the armor wires. These wires are put back as nearly as possible in their original lay, and a heavily tarred jute yarn is put on tightly over a distance of 15 to 20 feet. The splice is complete and the cable is dropped overboard.

The ship then begins to pay out toward the end which was originally left buoyed. This is again located and taken on board. The two ends are tested in the electrical testing room by the chief electrician. If the results are satisfactory, the ends are then spliced, dropped overboard, and another cable has been put back in service.

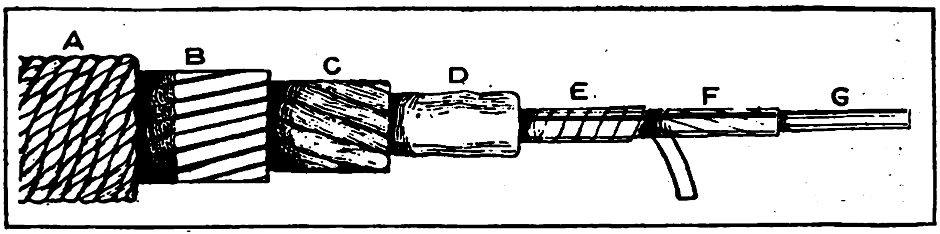
It is interesting to note that this laying of a new length of cable is not an easy matter even in calm seas. It is of utmost importance to know the topography of the ocean bed before the cable is laid, to avoid suspending the cable between submarine hills. Unless it rests on the bottom all the way across, it would be only a matter of time before it would break under the strain. Since it was feared that the earthquake had changed the contour of the ocean bottom, new surveys were necessitated. These surveys, as mentioned before, consist of deep-sea soundings which determine the depth of water, produce specimens of the bottom, and give the temperature of the water. If, by chemical analysis, it is learned that there is any mineral deposit on the bottom which would seriously affect the cable, or if the temperature should show that there is volcanic action at certain places, these places have to be avoided.

THE sounder invented by Rear Admiral Sigsbee, United States Navy, probably possesses the essential features of the others and may be taken as a typical one. It consists of a central tube fitted with valves at top and bottom, and three smaller tubes fixed beneath the central one. As the sounder descends, the valves open upward and the water rushes through. When the bottom is reached, the valves close, and a sample of the bottom water is retained. The three smaller tubes sink into the ooze, and bring specimens of it to the surface for analysis.

A low temperature increases the conductivity of the copper wire and the insulating qualities of the gutta percha covering, and is therefore desirable for cables. It is known that a conductor when normal gives a certain resistance per nautical mile at a given temperature. Thus a knowledge of the temperature of the bottom is indispensable for accurate results should the cable require testing for some future break, and in taking soundings a thermometer is always attached to the wire a short distance above the sounder. As we know, an ordinary thermometer cannot be used in great depths as the pressure causes an error of 8 to 10 degrees, Fahrenheit, and has been known to cause implosion of the bulb. Thus, for deep sounding, a special thermometer, the Miller-Casella, is used. The bulb of this instrument is enclosed in an outer bulb three-quarters full of alcohol. Before this outer bulb was sealed, the alcohol was warmed to expel some of the air. Between the two bulbs there is formed a cushion which takes up the pressure, and the inner bulb remains unaffected.

ONE of the most interesting spots on board a cable ship during the laying of new lengths of cable is the testing room. In front of a table covered with various testing devices, sits an electrician, watching a spot of light as it sways to and fro on a graduated scale. This spot is the reflection from the galvanometer mirror, and the swaying movement is caused by the induced currents set up in the coiled cable by the rolling of the ship. At the end of every fifth minute the spot gives a kick sideways on the scale, and the electrician duly notes its magnitude. This kick is caused by a signal from the shore, and proves that the continuity of the conductor is being maintained.

During this phase of repair work, careful nautical records are kept. When the length of cable has been laid, a copy of these records and charts are filed for future reference, together with results of tests and electrical measurements by engineers at both ends of the line. These records and data may prove useful at some distant date in case trouble is again experienced with the cable. It is safe to assume, however, that not one of the men who took part in the gigantic repair job of the past winter, is anxious for this time to come; for the work is infinitely hazardous and difficult.

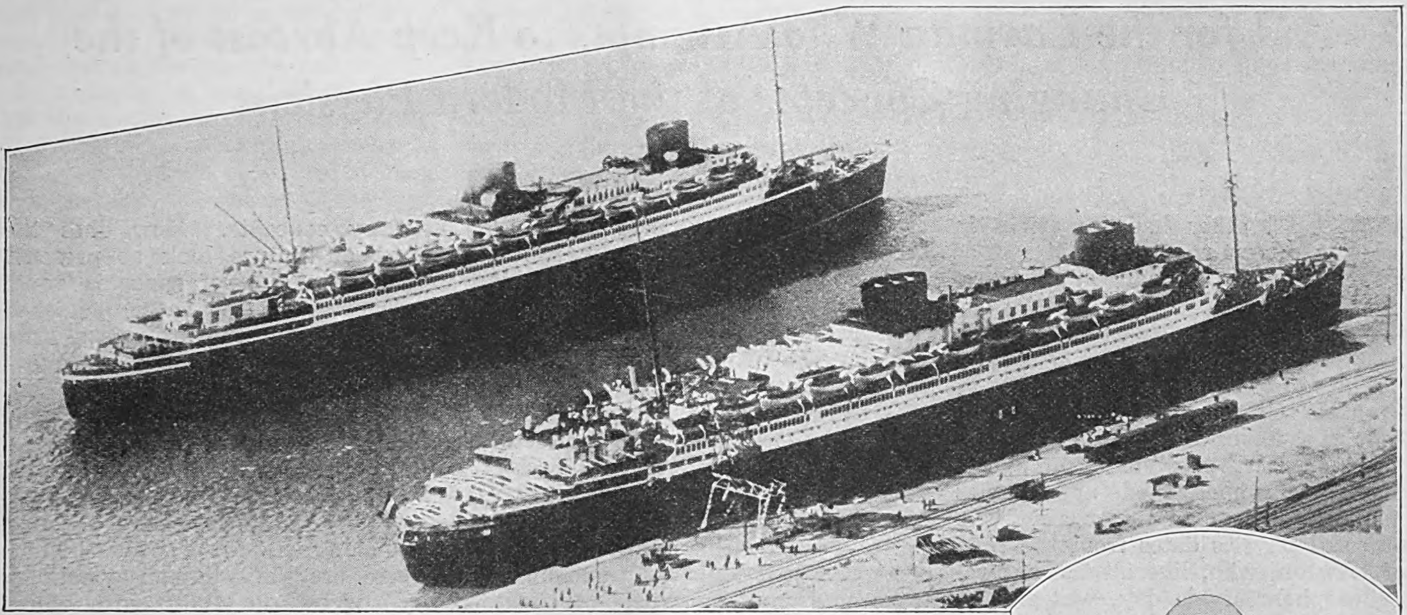


Courtesy Western Union Telegraph Company

THE MAKE-UP OF THE CABLE

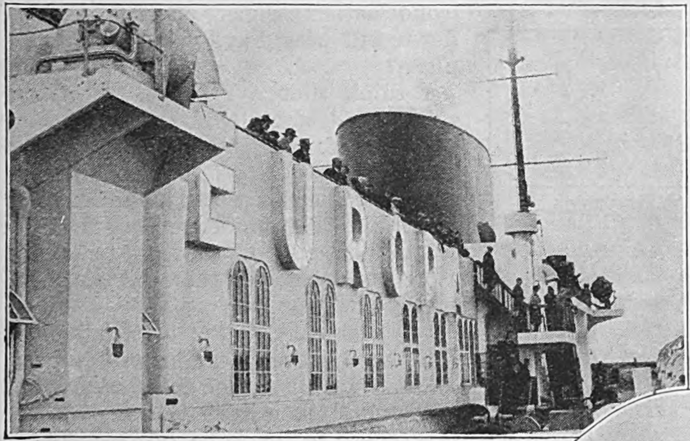
New fast cables are made as follows: A, tarred hemp cord wrapping; B, steel armor wires; C, jute cushion; D, gutta-percha insulation; E, Numetal; F, copper tape; G, copper conductor

Speed Queen Smashes Sister's Record

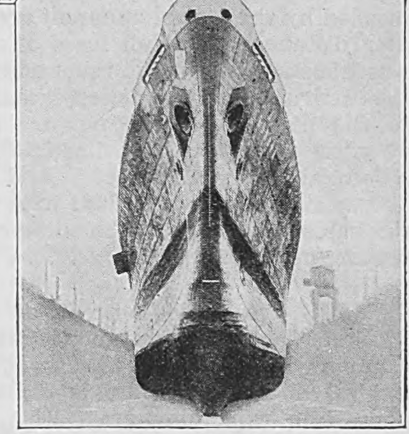


"EUROPA"

Above: The *Europa* at the dock, with her sister ship the *Bremen* alongside. The *Europa's* time from Cherbourg to Ambrose Lightship was 4 days, 17 hours, and 6 minutes, beating the *Bremen's* time by 18 minutes. Note the smoke stacks in the funnels and (*left*) the illuminated sign



All photographs courtesy North German Lloyd

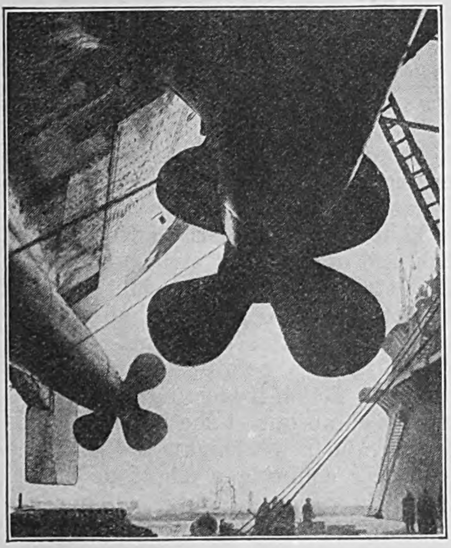


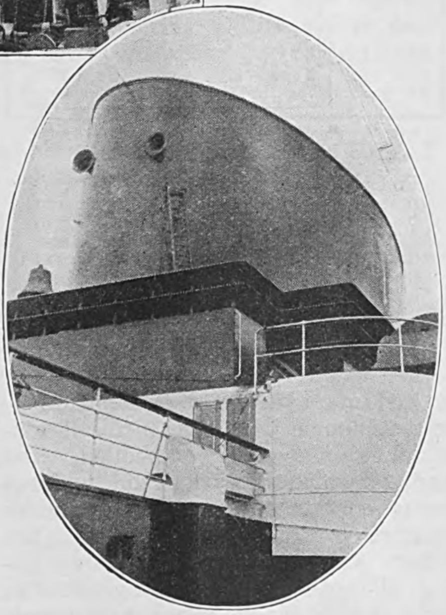
"SLIGHTLY BULBOUS"

The rounded bow was forecast after the World War, when sharp-bowed liners held the record. It creates dead water for the propellers, as against the outward push from a sharp bow

FOURTEEN-TON PROPELLERS ▼

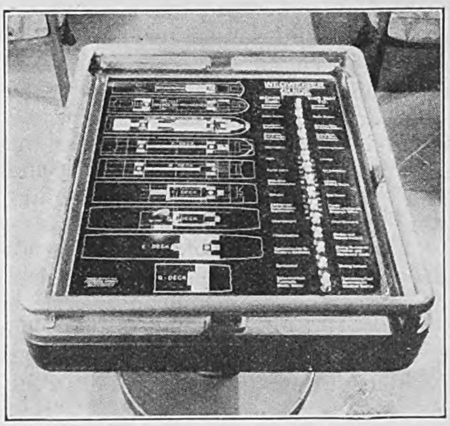
The *Europa's* propellers are smaller than those of the *Bremen* and make more revolutions per minute. Two of them churn the water outward, and two inward. The huge turbines are of 138,000 horsepower





SIRENS

The funnels, instead of being pear-shaped, as in the case of the *Bremen*, are of elliptical shape, measuring 50 feet long diameter, and 21 short diameter. The products of combustion of the oil fuel are thrown upward by a blower system. Note the semi-concealed sirens forward



THE "WEGWEISER"

These indicators, to direct passengers, are in many locations on the boat. If you want to go to the shooting gallery or the swimming pool, just press the button opposite the name and an electric light flashes up under the part of the proper deck plan and directs you understandingly

Is There An Ether?*

Aid for the Layman Who Attempts to Keep Abreast of the Changing Concepts of the Modern Physicist

By PAUL R. HEYL, Ph.D.†

Physicist, United States Bureau of Standards

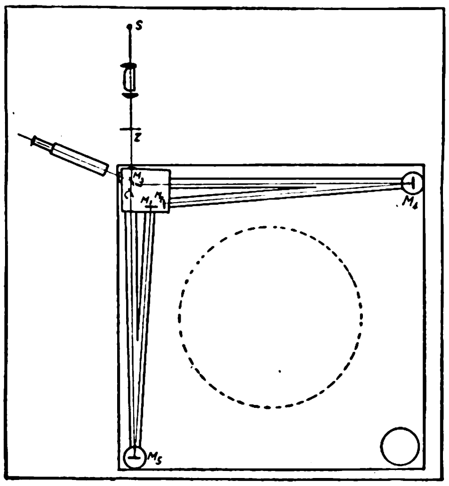
THE ether had its origin in human need and will last as long as human thinking requires it. Not always in the same form, perhaps, but unchanged in function.

The word "ether" comes down to us from the Greeks, but with their concept we have little interest. The "divine ether" to which Prometheus made his impassioned appeal was merely the rarefied upper air. The ether of physics dates from the time of Newton, who, like all the natural philosophers of his day, was greatly puzzled by the fact of apparent action at a distance. The full force of this was first felt when Newton showed that the earth's gravitative action extended to the distance of the moon. The question then presented itself: "Can a body act where it is not?" And the universal answer was: "No; it is unthinkable. There must be some connecting medium."

THUS arose the concept of the ether, at first a substance of rather vague physical properties. This hypothetical substance, while it did not succeed in explaining gravitation, at least furnished a medium by means of which it might be shown some day that gravitation could act.

In Newton's day the ether was not generally regarded as a carrier of light, for the corpuscular theory of light was then in favor. The early part of the 19th Century saw the establishment of the undulatory theory for which a medium of some kind was a necessity, and the luminiferous ether, as it then came to be called, was soon considered an indispensable part of physical theory. Later in the century Maxwell added to the duties of the ether the explanation of electro-magnetism, and with this additional responsibility came an increased measure of authority. In the eighties and early nineties the ether was everything in physical theory, and while it had not yet been shown capable of explaining gravitation it was confidently expected that this would also come to pass, perhaps in the near future.

The 19th Century felt very well acquainted with the ether, almost as well as with matter. Said the physicists of that time: "We know the ether just as well as we know iron or coal, and by the same evidence—its properties. True, it is transparent and invisible, but so is air. The ear can perceive air vibrations, and the eye those of the ether. Though it is not so simple a matter to weigh air as water, yet it can be done indirectly; likewise we can determine indirectly that the ether has a density of 10^{-18}. Moreover it must possess the properties of a solid rather than of a liquid or a gas, else it could not transmit the transverse waves which constitute light. The ether may be thought of as a vast mass of transparent, frictionless, tenuous jelly in which all material things are embedded, and through which we slip and slide without being conscious of it. Nay, matter itself may be only a kink or twist in the ether. One continuous substance filling all space, which can vibrate as light, which can be sheared into positive and negative electricity, which in whirls constitutes matter, and which transmits by continuity and not by impact every action and reaction of which matter is capable. This is the modern view of the ether and its functions."[1]



From Proceedings National Academy of Sciences. Vol. 12. p. 622

THE KENNEDY EXPERIMENT

Professor Kennedy stated that air currents and temperature effects sufficient to change the optical path one part in 1,000,000,000 would produce the ether-drift effect Miller obtained, so he sealed up his apparatus in a closed atmosphere of helium. Otherwise the set-up was the same in principle as that of the Michelson-Morley and Miller experiments. It was compact—about one yard square

But with the 20th Century there came the new physics with its revolutionary concepts. How does the picture of Nature look at present?

The jelly-filling of space is gone; matter can no longer be distinguished from electricity; the atom is a little bunch of waves traveling like a moving corpuscle; space is curved, and this causes gravitation; energy is atomized into quanta—

But stop! Let us catch our breath! Where is the ether? Is there anything left of it? And how are we ever going to get along without it?

These are very human questions. They suggest the alarm with which inherited tradition has ever viewed the iconoclast. It is easy enough to break down, but what have you to put in its place?

I think that a little study of the subject will show that the 20th Century has changed the form rather than the function of the ether; that action at a distance is as great a challenge as ever, and that modern physics binds every particle of matter to every other no less closely than did the older theory.

IN common opinion Einstein perhaps bears the blame for doing away with the ether. It is true that he asserts that there is no force of gravitation between the earth and the sun, and therefore it would seem that there need be no medium to serve as the physical basis for such an attraction; but the circular orbit of the earth must be accounted for, and this is how he does it.

Gravitation is not a pull, but a push. The earth is not drawn toward the sun by some mysterious force, but pushed out of what would otherwise be a straight course by—space itself!

Sink a large shallow bowl into smooth ice with the upper edge flush with the frozen surface. Stand off a little distance and send a golf ball rolling over the ice toward the bowl. What will happen?

That depends on the speed of the ball and on where it strikes the bowl. If it strikes well to one side and if it be not going too fast the ball may be captured by the bowl and describe several circles before settling to the bottom. But if it is going fast enough it may climb out of the bowl and proceed again in a straight line over the ice, after suffering a slight deflection from its original course. This deflection, or circular motion, as the case may be, does not mean that there is any force of attraction originating at the center of the bowl; the curved path is caused not by a pull but by a push of the curved surface of the bowl against the moving ball.

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*Publication approved by the Director of the Bureau of Standards of the United States Department of Commerce

†See "Among Our Contributors," page 421

[1] Composite of Kelvin and Lodge (1882)

In a similar manner Einstein says that the motion of the earth in a circular orbit is due to a push from curved space, and that this curvature of space is caused by the mass of the sun. According to Einstein, space is not mere emptiness, but a sufficiently robust entity to be curved and to deflect the earth. It is this very resistent space itself that forms the bond of union between the sun and the earth and relieves us of the necessity of assuming action at a distance.

RATHER a neat substitute for the ether, is it not? We need no medium filling all space if space itself is capable of doing the trick. And after all, whether we spell the connecting medium E-T-H-E-R or S-P-A-C-E—what does it matter?

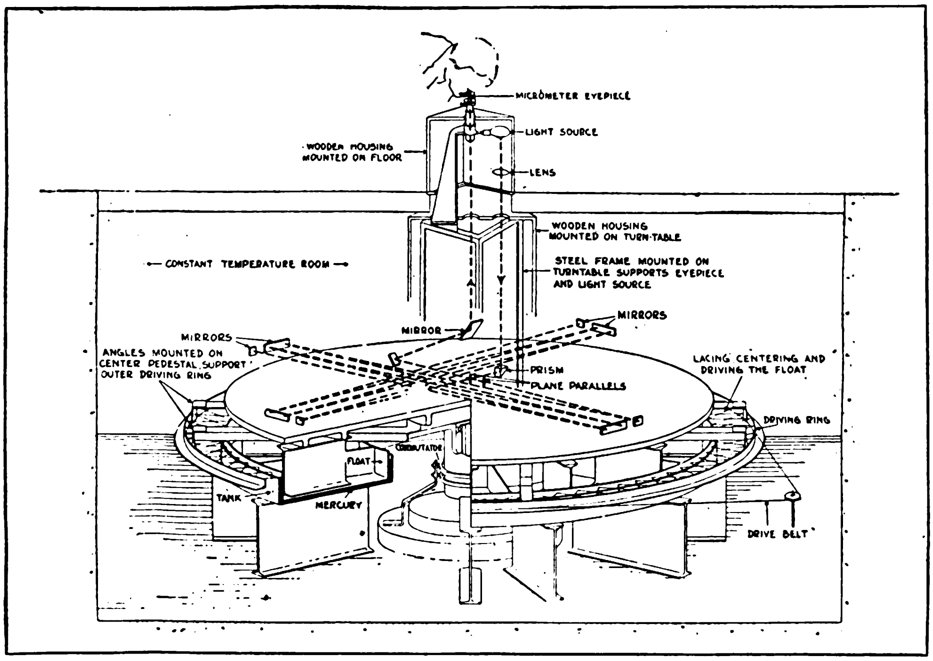
Let us now look at the latest concept of the atom. I do not mean the Bohr atom, though to many this attractive planetary concept still represents the 20th Century idea. The readers of the SCIENTIFIC AMERICAN know that the Bohr atom has for some time been superseded by a more powerful and plastic form—the wave atom of Schrödinger. According to this concept an atom is a little bunch of vibrant energy, spreading out in all directions and thinning as it goes, so that all atoms are connected, though rather tenuously, into one great vibrating system. And what is it that vibrates? Electricity.

Schrödinger assumes a filling material in space, a universal electric plenum which in vibration constitutes matter. Here we see again our old friend the ether in a new disguise. There is no escaping it. Scientific thought demands it and inventiveness supplies the demand under a different form suitable to the changed times. The ether is indeed protean in its properties, all things to all men. From the vague, imponderable medium of Newton's day we have come by way of the tenuous jelly of the 19th Century to the curved space of Einstein and the universal electric plenum of Schrödinger. In one form or another the ether will last as long as human thinking requires it.

But, then, is the ether nothing more than a logical proposition? What does experiment say? Can it give us no evidence of the ether as a physical reality?

Apart from the ever present evidence of our sense of sight and the stars of heaven there is no evidence available. Many times has the attempt been made to detect the ether by our motion through it, but to no avail. Not one but several independent lines of evidence concur in this negative answer.

But, you may say, is there not at least one positive result—that of Miller? And does not the evidence of one skilled observer who has seen an elusive phenomenon count for more than the negative testimony of the many who have failed to notice it? This is often true, but it happens that in this case the presumption is exactly the other way. The well known Michelson-Morley experiment is carried out by means of interfering light waves. The adjustment is one of extreme delicacy, difficult to obtain and to maintain. It is a very easy thing to get an apparent positive result and a very difficult thing to avoid it. It is a matter of wonder and admiration on the part of those who know the ropes that Michelson and others should have been able to reach their negative conclusions.


MICROMETER EYEPIECE
LIGHT SOURCE
WOODEN HOUSING MOUNTED ON FLOOR
LENS
WOODEN HOUSING MOUNTED ON TURN-TABLE
CONSTANT TEMPERATURE ROOM
STEEL FRAME MOUNTED ON TURNTABLE SUPPORTS EYEPIECE AND LIGHT SOURCE
MIRRORS
MIRROR
MIRRORS
ANGLES MOUNTED ON CENTER PEDESTAL SUPPORT OUTER DRIVING RING
LACING CENTERING AND DRIVING THE FLOAT
PRISM
PLANE PARALLELS
DRIVING RING
COMMUTATOR
FLOAT
TANK
MERCURY
DRIVE BELT

Courtesy of *Nature* (London)

REPETITION OF THE MICHELSON-MORLEY EXPERIMENT

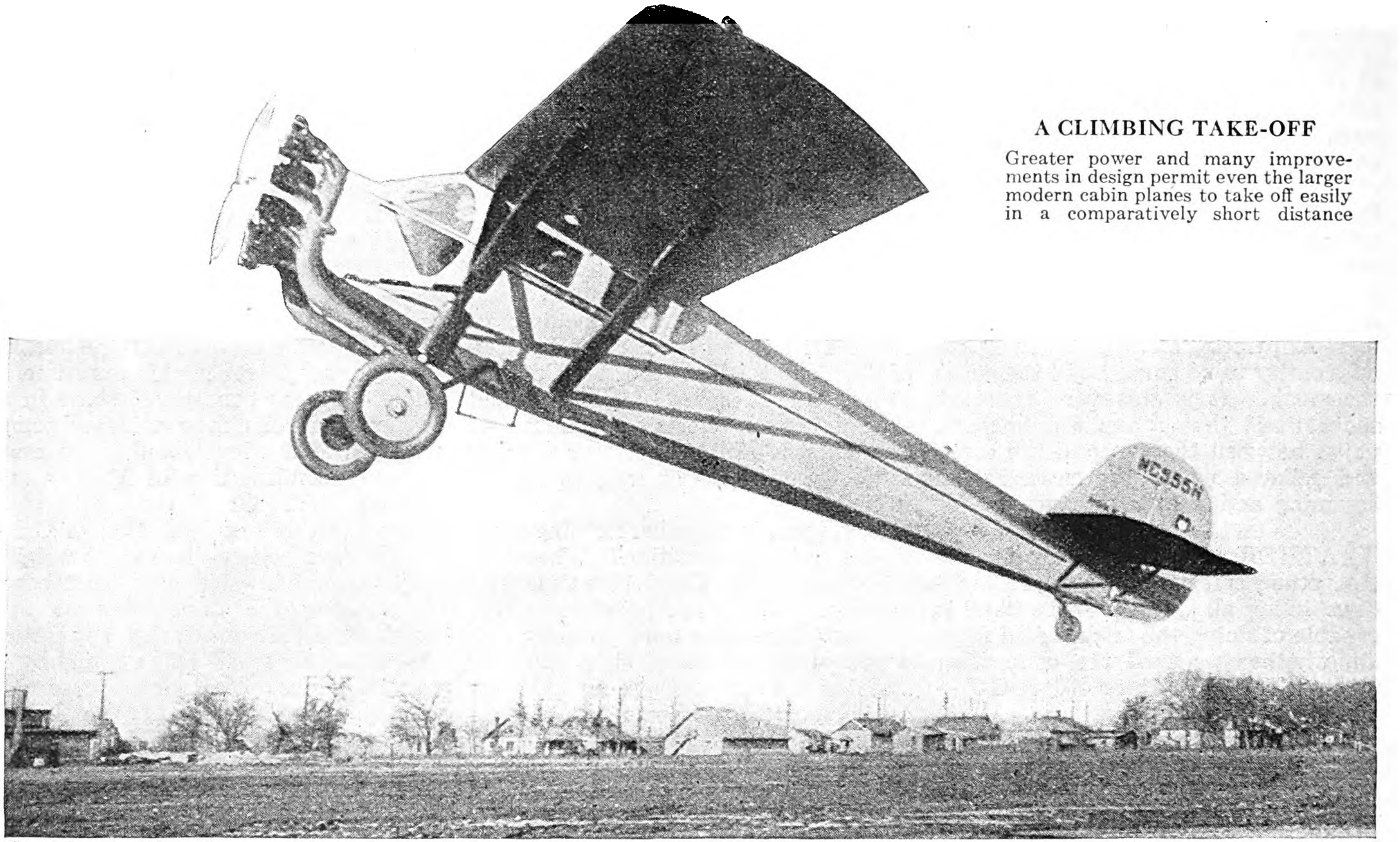
In 1926-'28 Michelson, Pease, and Pearson re-performed at Mount Wilson Laboratory the original Michelson-Morley experiment on the basis of which Einstein dispensed with the ether, in order to check Miller's findings—i.e., of an ether drift, hence the existence of an ether. Their results did not support Miller's findings, which connote the existence of an ether

For there have been others. Miller's first announcement stimulated a number of experimenters in Europe and in this country to repeat his experiment under different conditions, some in a balloon, some on a mountain, and some on earth at sea level, and in no case was any confirmation of Miller's result reported. Of all these other experiments those of Kennedy, of California, have perhaps had most weight with physicists. Kennedy succeeded in reducing the dimensions of the classical Michelson-Morley apparatus to a relatively small volume, and by a very ingenious optical device preserved all the sensitiveness of the larger form. He was therefore able to enclose his apparatus in a case filled with helium, thus obtaining unquestioned control of pressure and temperature. And his result was negative.

EXPERIMENTERS of the first rank have more than once been self deceived. There will be recalled the case of Ramsay, one of the best chemists of England, and a co-discoverer of argon. Soon after the discovery of radium it was found that radium emanation gradually turned into helium. This was the first recognized case of transmutation among the elements, and aroused great interest. Ramsay, as a result of some very carefully conducted experiments, came to the conclusion that not only helium but neon could thus be produced, and that even copper could be changed into lithium. Other experimenters failed to confirm Ramsay's results, and it took five years to settle the question. Finally J. J. Thomson developed the unexpected fact that certain gases were retained by glass under the most severe treatment, such as heating to the softening point. Ramsay's alleged results are now of historical interest only.

And so it is with the supposed "anti-Einstein" evidence today. Miller's results stand alone. Without independent confirmation they can not gain acceptance. Half a dozen attempts at confirmation have failed, and their very failure is the best proof of their claim to recognition.

¶ *"Waves and Particles" is the title of a thought-provoking article written by Professor G. P. Thomson of Scotland, and soon to be published. Professor Thomson helped prove the new wave-atom theory.*



A CLIMBING TAKE-OFF

Greater power and many improvements in design permit even the larger modern cabin planes to take off easily in a comparatively short distance

Courtesy Ryan Aircraft Corporation

Better Days for Aviation

Present Safe, Dependable Airplanes Will Be Further Improved and the Industry Placed on a Sound Business Basis

By EDWARD S. EVANS*

President, Detroit Aircraft Corporation

AT a Chamber of Commerce dinner which I attended recently, two men were talking about the future of the aviation industry.

"Five years from now we shall all have our air flivvers parked in our garages, and regulating traffic in the skies will be as much of a problem as street traffic is now in downtown business sections," one of them said to me. "I have half of my investments in aviation securities, and I expect to see these make a small fortune for me in the next five years."

"You are wrong," said my neighbor on the left. "Air transportation offers few practical advantages over other means of travel. It has yet to be developed to a safe practical basis. Aviation offers a thrill to the young man and woman, and airplanes are useful for carrying mail, but they cannot compete with other means of transportation. One hundred years from now our successors in business may travel by airplane regularly, but our generation will never see aviation developed so that it is of much value to the public."

Both of these men had entirely the wrong picture of aviation, but their opinions are held by many business executives, so that it may be of interest to consider some of the questions that are confronting the industry, as well as some of the past and probable future developments. In the next few years, every executive of a large corporation, who has not already done so, will have to give consideration to the place of air travel in his organization.

IN order that present conditions may be understood, it is necessary that we review briefly the development of popular interest in aviation. Colonel Lindbergh's historic flight may be said to have marked the beginning of commercial aviation in this country. Immediately after this flight, every airplane manufacturing company was flooded with orders for new planes.

In 1925 the writer made a record-breaking trip around the world in 28 days, using airplanes for a large part of the trip. Many of my friends at this time thought I was writing my death warrant every time I stepped into a plane. And yet these same men and women and millions of others all seemed to want to get into the air in 1927, and there were not planes enough to accommodate them. Commercial operators were making small fortunes from taxi hops and cross-country flights; and scores of planes were purchased for various advertising and other commercial services.

At the old San Diego plant of the Ryan Aircraft Corporation which built the *Spirit of St. Louis*, it was not unusual for purchasers to offer from 1000 to 3000 dollars over the advertised price of a ship for immediate delivery. Not one of the companies then in business was equipped for anything like quantity production, and by the fall of 1927, the company that could make delivery within two months after receipt of an order was unusual. Many purchasers were willing to buy anything that would fly, regardless of the plane's reputation or design. This surplus of orders caused the formation of a large number of new manufacturing concerns, many of which were not making planes based on sound engineering design. The crashes in which such planes figured did much to shake the public's confidence in flying. Fortunately this situation has now been corrected by the strict Department of Commerce regulations requiring engineering approval and flight inspection of every new plane, and periodic inspections of all planes used in inter-state travel.

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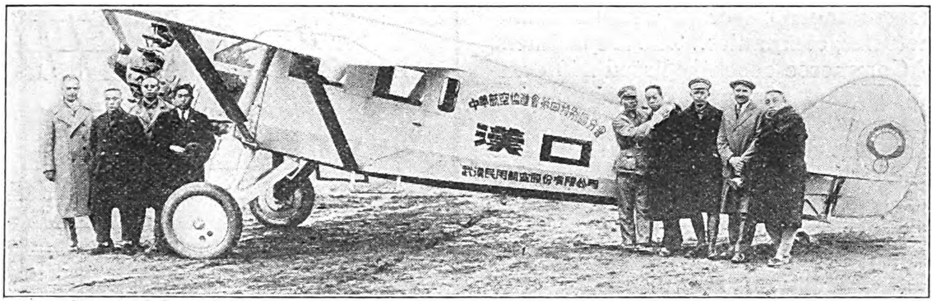
*See "Among Our Contributors," page 421.

Although there was undoubtedly far more business than the existing plants could take care of, the fact that many purchasers tried to obtain planes from two or three companies before finally placing their orders gave rise to the belief that there were more purchasers than was actually the case. Many plants were doubled and tripled in size; scores of new ones were built; and everything possible was done to speed up production.

LINDBERGH'S plane was one of the few cabin ships on the market, and the demand for that type was so great that many companies were forced to design entirely new ships. All materials entering into aircraft construction were difficult to obtain, competent men in all departments were scarce, and the industry was suddenly confronted with the new problem of quantity production. Selling planes was the least of the worries of aircraft company executives.

In view of these conditions, it is little wonder that the industry has made many mistakes. It was to be expected that certain promoters would seize upon the public's desire to invest in aviation enterprises as an opportunity to organize companies having no economic reason for existence. The history of the aviation industry has been no different from that of other new industries in this respect.

It has been only recently that aviation companies could offer high enough remuneration to attract men of broad and successful business experience. Originally, the pioneer work was done either by engineers or pilots. The country owes a debt of gratitude to these men who carried on through nine years of almost insurmountable obstacles, bringing the airplane to its present stage of reliability. It was only after this tedious pioneer work had been accomplished that the country's purse strings were opened and the necessary money provided for establishment of air transport lines and aviation schools, and for the development of improved airplane designs and manufacturing facilities.

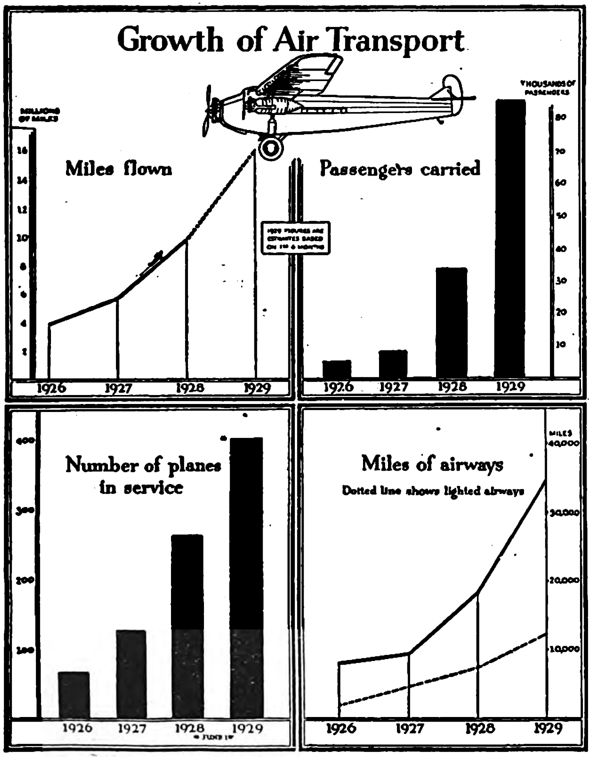


Courtesy Ryan Aircraft Corporation

THE AIRPLANE IN CHINA

The awakening interest in aviation of oriental and South American businesses and governments is expected to open a rapidly increasing foreign market for American-made aircraft

We have heard much in recent months about overproduction in the aircraft industry, and many unfounded rumors as to the general condition of the industry have given rise to opinions in some quarters that the aviation industry is in anything but a strong position. Despite the fact that aviation has just had the most successful year in its history, production did fail to come up to certain over-optimistic predictions made early in 1929. In 1928, approximately 5000 planes of all types were built in this country. Some aviation enthusiasts predicted that the 1929 production would be over 10,000. Figures for 1929 recently released by the Aeronautical Chamber of Commerce give the airplane production at 6034 planes and the value of motors and planes manufactured at 98,000,000 dollars.



PROGRESS TO DATE, FROM 1926

A self-explanatory series of graphs which strikingly show the increasing use of airplanes in this country

In 1929 the production of planes for commercial use increased 51 percent by number and 93 percent over the preceding year in value. There is nothing phenomenal in this increase, but it is a record which few industries could point to last year, and one of the best indications of the increasing air-mindedness of the American public and business man.

The Army and Navy are taking a rapidly decreasing proportion of the total production. Seven years ago, all airplanes produced were intended for military purposes, while last year this market absorbed less than 25 percent of the production.

The greatest problem now confronting the industry is that of educating business executives to the practical value of air transportation. It is true that the industry has been somewhat backward in adopting a sound merchandising policy. From 1918 up to the present time aviation has been presented the greatest amount of publicity ever given a new industry. In some ways this has hurt rather than helped in educating potential users as to the value of this modern mode of transportation. Far too much emphasis has been placed on the romantic appeal of flying, the danger of traveling by plane, and the thrilling experiences encountered by pilots and passengers.

THE whole American business structure is based upon speed. Small inventories require fast deliveries, the many recent mergers have placed a great premium on the time of business executives, the necessity for frequent changes in the design of products requires many consultations with high salaried consulting specialists, and present conditions require frequent personal contacts between salesmen and the home office.

A survey recently conducted by the Detroit Aircraft Corporation showed that approximately 180 companies now own one or more planes. At least 20 of these own two or more ships, and it is believed that this list will be increased to many hundred by the end of 1930.

During the recent scramble to increase production in an attempt to meet the sudden demand for planes, many plants were expanded more rapidly than future economic conditions warranted. Certain companies now find themselves with uneconomical manufacturing facilities on their hands, and this will result in a certain amount of new plant construction in the near future.

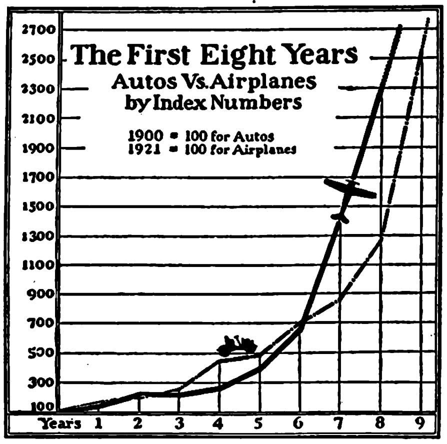
Airplane buyers today are most discriminating, and usually carefully compare the performance, reputation, and price of all ships that might fulfill their requirements. This has placed certain of the smaller companies, whose planes are not soundly engineered, in a serious position, and will undoubtedly result in a great reduction in the number of aircraft manufacturing companies. The Department of Commerce recently listed 240 companies that claimed to manufacture airplanes. The great majority of these were not equipped for anything like production, and many were founded purely as a basis for stock promotion. The production of 20 of these companies accounted for 85 percent of the 1929 production. By the end of 1930, it is probable that the number of companies engaged in all phases of aviation will be greatly reduced.

The prospective investor will do well to limit his investments in aviation enterprises to those companies which have a long record of achievement behind them, or holding companies controlling a well rounded group of organizations the permanency of which is assured by past accomplishments.

THE most significant factor of the industry for 1929 was the vast amount of new money that was poured into aviation, and the many mergers which were consummated. In the last 18 months, some 60 formerly independent companies have been merged into the "Big Four," composed of the Curtiss-Wright Corporation, the Aviation Corporation of America, the United Aircraft and Transport Company, and the Detroit Aircraft Corporation. Each of these companies controls a well rounded group of from 10 to 20 organizations specializing in various lines of manufacture and operation. There are still some 20 strong independent companies that have enough reputation and financial backing to meet the larger groups in any period of competition. In view of the stock market situation, it is not probable that there will be much further consolidation during the present year except possibly in the accessory or raw material fields.

The industry is now going through the third stage of its development. From the time of the Wright brothers' first flight until Colonel Lindbergh's flight in 1927, aviation was going through an engineering development. During this period, the basic aerodynamic problems were solved; and the next 18 months were devoted to meeting problems of efficient production. The latter half of 1928 and 1929 saw nearly 500,000,000 dollars of new financing poured into various aviation enterprises, the merger of many companies, and the introduction of more highly efficient business management.

We now approach 1930, when the main emphasis will be laid on efficient merchandising and selling the public and the business man on the practical time and money-saving value of flying. Until the last six months, airplane sales took care of themselves, but now with more discriminating buyers and the ready market from commercial operators and transport lines well covered, the industry has had to branch out and seek new purchasers. Up to the last year, not more than five companies had developed anything like a nation-wide distributing organization. Now every company is making efforts to establish dealers and distributors in all parts of the country. Most of the companies are requiring that these distributors make arrangements for servicing and storing planes, and some are requiring that they carry a stock of replacement parts.



LAND VERSUS AIR

Progress of aviation compared with that of the automobile: first eight years of each

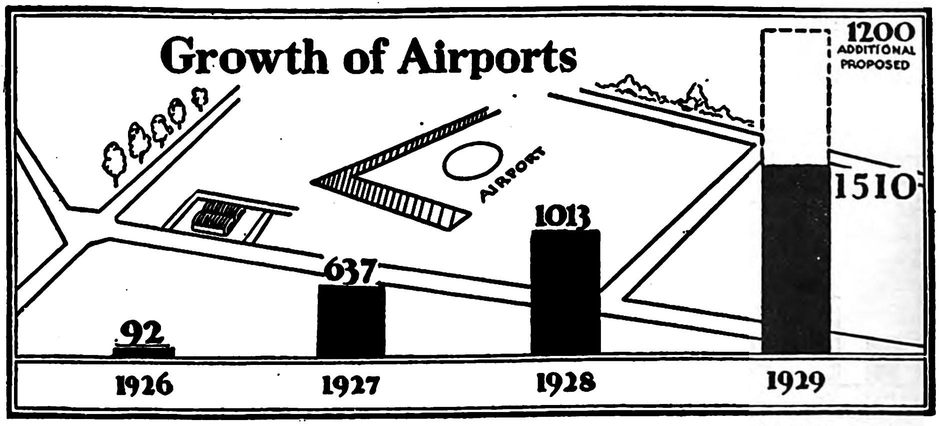
Showrooms have already been established in some of the larger cities, and the next few years will probably see even cabin planes on permanent exhibition in the business sections of every large community.

Financing plans have recently been put into effect by the better established companies, and it is now as easy to finance the purchase of an airplane as it is to buy an automobile out of income instead of capital.

Every few months we see some statement predicting that in the future we will all have "flivver" planes parked alongside our automobiles in our garages, that soon we will be flying directly to the roofs of our office buildings, and other startling developments. Such things may come in the next generation, but it is doubtful if the readers of this article will ever witness much change in design.

IT is a brave man indeed who is willing to make any predictions as to what the future holds in store for aviation, but there are some things that stand out as fairly certain. In spite of all the many new developments in the field of aeronautics, it is doubtful if we will see much basic change in airplane design in the next few years. Improvements and refinements, of course, will be made. These will increase the speed and carrying capacity, reduce the length of run required to land and take-off, give more comfort and even greater reliability. We will see many spectacular experiments in the next few years, but our present modern planes incorporate the features that make for safe, dependable operation. The engineering departments of several of the larger airplane manufacturing companies are working on radically different designs, but it will be many years before any of them will have gone through the engineering development necessary to bring them to the point of safe, practical application to air travel.

The present year will see the aviation industry settled on a definite stable business basis, with healthy increases in the value of products, and popular confidence in flying. Spectacular achievements will be less frequent, for there will be less need of them. The problem which is rapidly being solved will be to place dependable, economical aviation equipment at the convenient disposal of every individual and corporation in need of fast transportation.

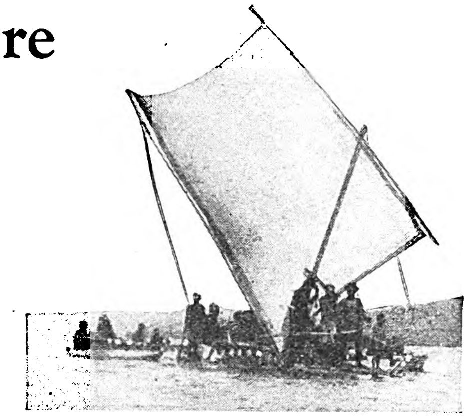


EVERY SIZABLE TOWN BOASTS ONE OR MORE AIRPORTS

In 1926 there were very few well-equipped airports but at the end of 1929 their number had multiplied over 15 times. Now many communities have several and others are being added

Tangled Commerce Abides Where Children Smoke and Swim

The Antipodean Manus Are the Pack Peddlers of the Pacific

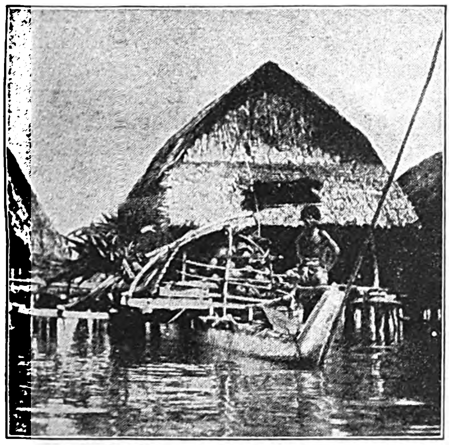


A CANOE FUNERAL

The Manus of the Admiralty Islands have curious death customs. It is necessary to bury the deceased on the land

DR. MARGARET MEAD, Assistant Curator of Ethnology in the American Museum of Natural History, recently returned from the Pacific where she had been investigating Melanesian tribes on the islands off the coast of New Guinea. Dr. Mead's presence in the Admiralty Islands was prompted by a desire to see how children and adolescents of a primitive people compare with children and adolescents in civilized society. The Admiralty Islands formed a part of what was German New Guinea, but they are now governed by Australia under a League of Nations mandate.

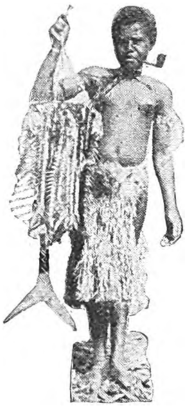
These islands were selected because they have been little studied. The Manus, while a primitive people, are highly developed commercially. The Manus number about 2000 and they live in several thatched Venices on stilts like Swiss lake villages. Why these people should have left the mainland for the reefs and tiny volcanic peaks where there is standing room only, is a mystery of the South Seas.



BUILT ON PILES

A South Sea Venice. Visiting and trading is done by water with the aid of canoes

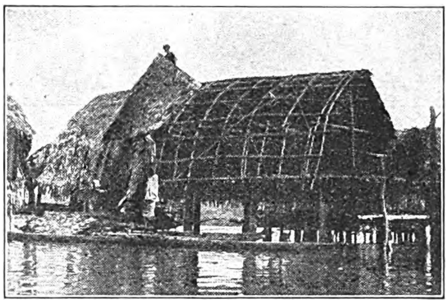
Dr. Mead learned the language of the Manus and made an excellent collection to illustrate their manners and customs. The Manus are born traders and they exchange anything at a profit. They bring sea water to the mainland and exchange it for fresh water with those who live on the mainland. The fresh water is transported to their island home. The legal tender is dog's teeth, but the currency was becoming debased because wily traders had been importing the teeth from China and Turkey. In trading with the whites, Louisiana tobacco twist is the standard of barter and as it passes from dirty hand to dirty hand it becomes mouldy and it has to be consumed in a pipe or rolled into cigarettes with the aid of old newspapers. Children of both sexes begin to smoke at the age of three and it apparently does them no harm, nor does it stunt their growth—but it surely looks extraordinary.



GIRLS MAY SMOKE

An adolescent girl holding up the skeletons of fish she has eaten. It looks like a perpetual Lent. Below is a war charm, one of the interesting specimens collected

The Manus developed the character of traders because they have a virtual monopoly on fish, while the mainlanders had virtual monopolies of everything else. The Manus catch fish, trade them to one mainland tribe for carved wood, trade the wood to another tribe for pigs, and trade the pigs to another tribe for dog's teeth, making a profit on each transaction.

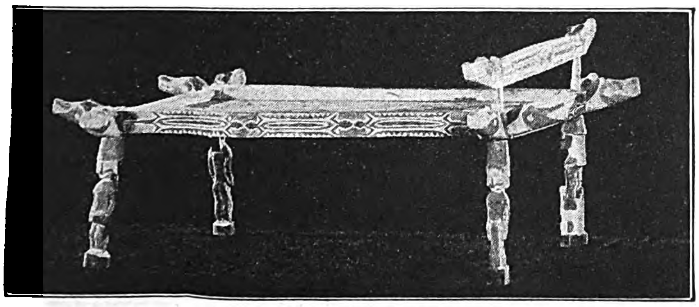


POST MORTEM HOUSE MOVING

After a death it is customary to remove a house to a new location, as is being done

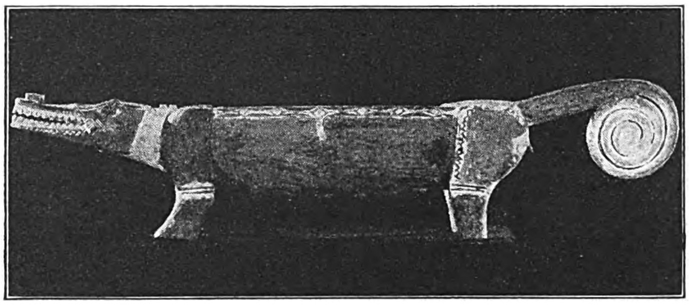
The Manus are so isolated that they must use canoes or swim. Even children three years old swim and are able to handle canoes. The oldest member of the tribe can remember only one case of drowning. Two children were out in a canoe which capsized and the younger, aged three, was drowned. The father wanted the other child, aged five, punished for murder, as any five-year-old child should be able to swim half a mile and tow another one. There is eternal wrangling about nothing among the tribesmen, and they like nothing so well as to foregather at the sound of a native drum.

Their religion is based on worship of the spirits of ancestors and the community laws are maintained by religion and shame rather than by civil punishments.



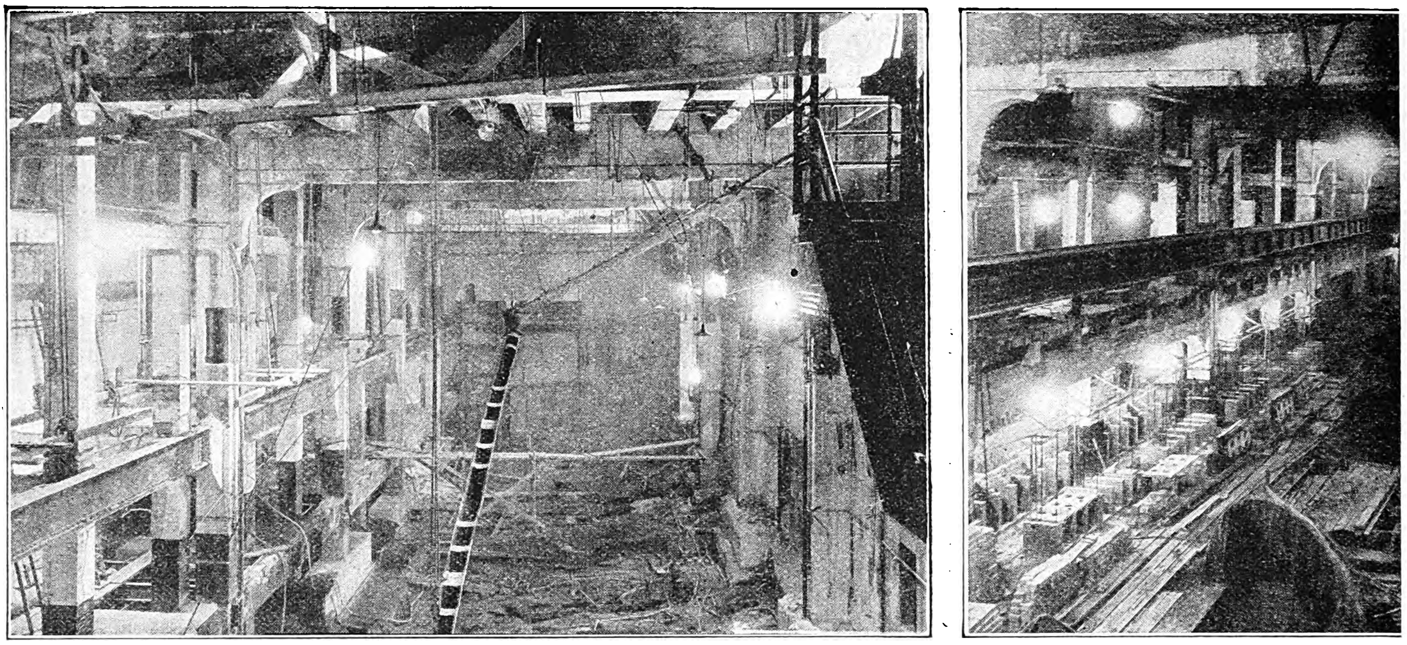
BED MODEL

The Manus are the only South Sea people that sleep in regular beds. This bed certainly looks hard, especially the pillow



NATIVE ART

Here we have a wooden bowl with a crocodile's head and a pig's tail. This is probably the South Sea Islander's conception of art



THREE VIEWS OF PROGRESS IN THE DYNAMO ROOM OF GRAND CENTRAL

Moving a Substation Underground

Without Interruption of Service, Substation Is Moved Seven City Blocks to New Underground Location

By F. B. FREEMAN
Chief Engineer, New York Central Railroad

WITH the co-operation of the General Electric Company and the Thompson-Starrett Company, the New York Central Railroad Company recently completed the unique engineering feat of dismantling and transposing the Grand Central Terminal power plant—a city block in area—from its former location on the surface at Lexington Avenue and 50th Street, New York City, to a site about 100 feet underground and seven blocks distant. The present installation constitutes the world's largest power substation.

Light, heat, and power is distributed by this plant to more than 60,000 persons occupying floor space exceeding 256 acres. This plant provides the electricity which illuminates 100,000 or more electric lights, moves more than 650 trains daily, operates 325 elevators in 28 buildings, and supplies these buildings—among the largest in the world—with the hot water which heats some, the steam that heats others, and hot water for general purposes. It also distributes steam to warm innumerable railroad cars, and it compresses air, not only for railroad purposes, but to open and close hundreds of elevator doors in the buildings, to assist in cleaning, and for other uses.

The magnitude of this moving job becomes apparent when one considers that the engineers were compelled to dismantle the plant, move much of it the distance of seven blocks, and add new apparatus, without interfering with the operation of the terminal or of the trains entering it, without hampering street traffic, which is quite heavy, and finish the job on a scheduled date which necessitated the work being placed on an emergency basis, all due to the former site being required for the construction of the new Waldorf-Astoria Hotel.

The economic necessity for a change in the location of the old plant was foreseen, due to the ever-rising midtown real estate values, some years ago, and careful studies showed the advisability of moving the power plant facilities underground. It was presupposed in all plans, however, that the major apparatus would remain at 50th Street.

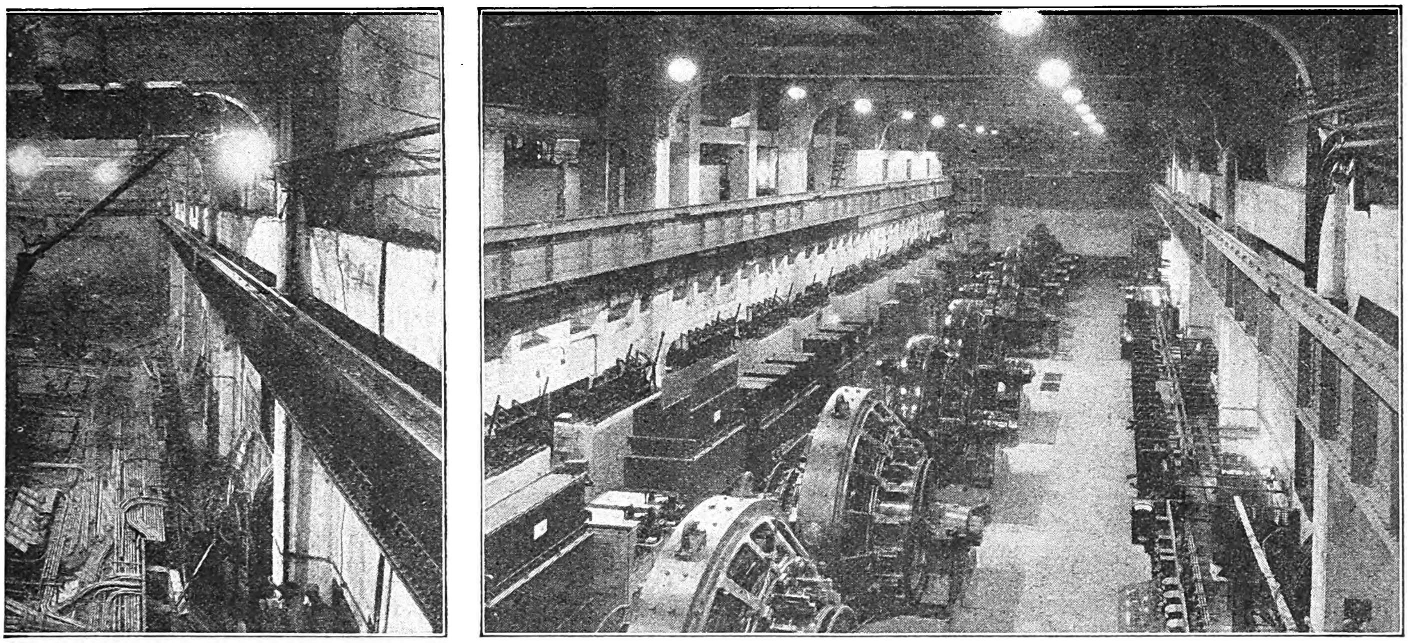
IN line with the company's general expansion program, the present site of the substation—an excavation about 90 feet deep and 225 feet long by 60 feet wide—had previously been made in the solid rock under 43rd Street, to accommodate a boiler plant. Two boilers were installed, with room for four more. This plant consisted of four floors: a basement, a boiler room, a meter room, and the coal bunkers. The stack extended to the top of the Commodore Hotel and was concealed in that structure.

Another vast cellar was also dug out under the southern end of the Graybar Building, adjoining this boiler plant excavation, for the accommodation of the mechanical facilities which, under the early plans alluded to, were not to be included among those to be placed underground at 50th Street at some future date. Calculations then established the fact that it would be possible to utilize the great stone vault, intended for the boiler plant, as the new site of the substation.

Ordinarily, six months would be required to draft the plans, and at least a year for the construction and removal. The lease was signed March 4, 1929, and dates set for the clearing of the various buildings for demolition. Although no drawings had been prepared, other than preliminary sketches, work was begun at once under verbal direction, followed by drawings as soon as possible. Despite these trying conditions, no change in any major plan was necessary during the course of this work.

Briefly, the following broad plans were carried out:

The steam generating plant was abolished and steam was purchased from the New York Steam Company system; and the space under the Graybar Building was turned into



TERMINAL'S NEW HEAT, LIGHT, AND POWER PLANT, 100 FEET UNDERGROUND

a heater and pump room to utilize this steam to heat the immense quantities of hot water needed, utilizing tanks of 20,000- and 50,000-gallon capacity. In this space were also placed the fire pumps, hot and cold water pumps, air compressors, and other auxiliary apparatus.

The two boilers were removed from the "boiler plant" excavation, the basement was enlarged, concrete foundations constructed for the 10 rotaries, an operating floor provided for conduits and with spaces for transformers, switchboards, oil switches, and other apparatus. Also, crane girders and a 30-ton electric crane were provided.

The meter room was made into an exhaust fan room, taking air from the top of the substation and exhausting it into the boiler breeching of the old arrangement and thence up the stack. The bunker space was converted into a stand-by battery room. Here was installed an 8000-ampere battery consisting of 150 cells, each weighing 4550 pounds.

The transfer of this battery was a major problem. A city ordinance prohibits the transportation of acid in open tanks through the streets, and use was made of an underground trucking passage. Time being at a premium, the battery could not be dismantled. Part of the acid was removed, the plates were clamped in place, and each cell was placed on wheels and lowered by tackle a distance of about 55 feet. They were hauled underground by an electric truck to 43rd Street, and raised by an elevator to their present site. During the moving not a drop of acid was spilled and not a cell was injured. The care that had to be exercised may be judged by the fact that the weight of each was sustained on glass plates.

Reliability of service was assured by connecting the lighting substation at 50th Street to the New York Central high-tension system and the lighting substation at 43rd Street to the New York Edison system. This stand-by battery was removed and re-assembled and placed in service in 53 days.

The total weight of the 10 rotaries installed, their transformers and other major electrical apparatus, was 850 tons. Much of this had to be lowered piece by piece a vertical distance of 50 feet from the unloading platform to the substation main floor. All materials were moved by flat cars from 50th Street on tracks which could be kept out of service only a few hours at a time. To remove 30-ton armatures in a limited number of minutes required exceptional skill.

THE traction system of third-rail feeders, 36 in number, extended through a complicated system of ducts from the substation at 50th Street to various third-rail sections on both levels of the terminal. To lead them all to the new substation would require an expensive duct system and miles of cable. Therefore, a circuit-breaker house was constructed at 49th Street and all these cables connected to switchboard panels therein, but under distant control from 43rd Street. Twelve cables were connected between the 43rd Street substation and this circuit-breaker house.

These cables carry the average current to this 49th Street house, where it is subdivided among the various third-rail feeders. The electrical effect is the same as though the 50th Street substation had not been moved; but the relaying by miles of wires was eliminated.

Since the piping system of the terminal was laid out in a square with one corner near 50th Street, where steam, water, and air were introduced, and another corner near 43rd Street, it was decided to open these pipes at 43rd Street as a new feeding point and to close them at 50th Street, thus using the same pipes.

Existing masonry conduits were used, as far as possible, to contain the electric cables and supplement these by an overhead metal conduit system in existing trucking subways. It was necessary to install and support in an elevated position throughout the terminal, approximately 20 miles of 3½-inch steel conduits. Into these conduits and the existing masonry conduits, 35 miles of cables of large size were drawn. These are the lighting and traction feeders. In addition, several miles of high tension and control cables were installed. The conduits concealed in the floor of the substation have a total length of 25,000 feet. In each conduit, from one to 16 wires are installed.

The high-tension masonry bus is 175 feet long and is divided into five sections. Connecting to it are 36 high-tension oil switches. More than 70 tons of bar copper was used in the buses. This all had to be drilled, bent, insulated, and supported.

All this work was accomplished without any interruption to, or interference with, the normal operation of buildings, in the lighting or signal power supply, or in the traction current for the movement of trains. No traffic delay occurred in connection with the loading or unloading of apparatus, although such work took place on tracks in daily rush-hour service. Each unit of the new plant started operation on or ahead of schedule. No damage was done to any piece of apparatus during transfer. And during the entire intricate operation, which was completed at a cost of more than 3,000,000 dollars, not a single man was injured.

Warmed By Satan

An Engineer's Discussion of the Familiar Proposal to Derive Power from the Earth's Hot Interior

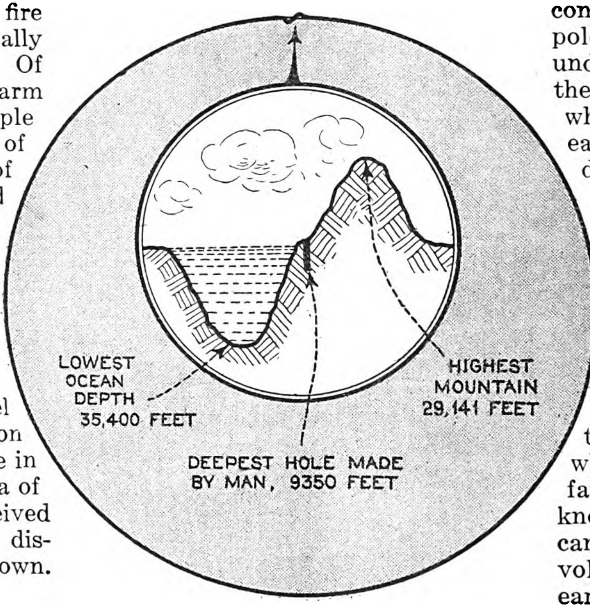
By THOMAS T. READ, E.M., Ph.D.*
Vinton Professor of Mining, Columbia University

THAT the interior of the earth is very hot is one of the things that people generally believe, without knowing anything about it. Primitive men needed no evidence other than volcanic outbreaks to convince them of it, but then the number of people who have ever seen a volcano at any time, much less one in eruption, must be very small indeed, and it is probable that the idea is one of those that the superstitious mind (and most of us are superstitious) has a natural tendency to believe. Millions of people believe that there is somewhere a place of everlasting fire where the wicked will be eternally punished for their sins on earth. Of course, such an idea originated in warm countries, where heat makes people uncomfortable. The primitives of the northland believed the place of eternal punishment was a cold place. The inside of the earth was a conveniently inaccessible place to assign as the locus of Sheol, Gehenna, Hades, or whatever the hot place was called.

Interest in Hell as a place of eternal punishment has generally waned and many people now feel that they catch enough Hell on earth, without expecting any more in the hereafter. Meanwhile the idea of a hot interior of the earth has received some scientific support from the discovery that the earth is cooling down.

OF recent years public attention has been stirred, every now and then, by someone's suggestion that since the interior of the earth is very hot, all we have to do is to find a way of bringing the heat to the surface and we will thereafter have a perpetual source of heat, without having to dig and burn coal. There is something peculiarly comforting in the thought that the presiding genius of the hot place, instead of being an evil spirit who will torture us forever, may really be a beneficient individual who will bless our descendants by freeing them from coal strikes and furnace tending, and it seems worth while to consider whether there is any more inherent probability in the new view than there was in the old one.

Why do we believe the interior of the earth is very hot? The distance from the outside of the earth to the center is about 21,000,000 feet and the deepest hole men have made into it is about 9350 feet or about 0.045 percent of the whole distance. But hold up, where is that measured from? From the top of the hole, of course. It does not require a very alert mind to see that a man who dug a hole in the bottom of a valley would be starting nearer the center of the earth than a man who dug a hole, starting on top of a hill. The deepest hole is Oscar Howard's No. 7 Hathaway well in the Sante Fe Spring Field in California, and it does not get as near the center of the earth as many "deeps" in the Pacific Ocean, for its reported depth in January was 9350 feet. The highest mountains stick up nearly six miles above mean sea level, and the deepest holes in the ocean bed are even deeper, so that the holes that men have been able to make are only about one quarter as deep as the holes Nature has made.


LOWEST OCEAN DEPTH 35,400 FEET
HIGHEST MOUNTAIN 29,141 FEET
DEEPEST HOLE MADE BY MAN, 9350 FEET

JUST A SCRATCH

The deepest place in the sea, exaggerated six times, is shown at the top of the outer circle representing the earth. In actual distance this place reaches only 1/620 of the distance to the earth's center

But men have made lots of holes several thousand feet deep; the total number of oil-wells in the world is somewhere near a half million, not to mention water wells and mines. I have myself been 6700 feet below the surface of the earth in the St. John del Rey mine in Brazil, which has since been deepened to over 7200 feet. Workings in South Africa are 7600 feet deep. As you go down in these holes you find the temperature rises as you descend. To make matters more difficult for us, the rate of increase is different in different places. In some it is as much as one degree Fahrenheit for every 60 feet in depth. In South Africa where there are many deep mines, the rate is only one degree for every 250 feet.

It is all very puzzling, for if the earth was uniformly hot all over hundreds of millions of years ago and has been cooling down ever since, it is evident that it ought to have cooled down faster near the poles, and the rate of increase as you go down there ought to be slower. No one has yet found it convenient to dig deep holes near the poles, so we do not know what it is like underground, but we do know that there are active volcanoes in Iceland where there ought not to be any if the earth has been cooling off for hundreds of millions of years. The only way to get around that is to suppose that relatively recent cracks in the earth's crust have let hot material come up from below, just as hot lava comes up in a volcanic outburst.

Explaining the mechanism of a volcano is much more difficult than explaining that of a radio set, for there are at least a thousand people who are interested in and somewhat familiar with radio, to every one who knows or cares anything about a volcano. The simplest way is to say that volcanoes are local hot spots on the earth's surface, much as a steam radiator is a local hot spot in a room. We know very well where the steam in a radiator comes from, but there are at least seven different hypotheses as to what makes lava melt. The one which nobody believes any longer is that the interior of the earth is molten, and that the lava comes up from below as steam does from the boiler in the cellar.

ALTOGETHER, figuring out that the interior of the earth is at a temperature of 7000 degrees, or 27,000 degrees, as various people have done, seems to me to be a good deal like the well known process by which a city dweller figures out, with pencil and paper, how he can get rich by raising chickens. The scientist calls the process extrapolation; you know the course of the line from A to B, and you simply prolong it to C. It is perfectly easy to prolong a straight line, but when the known points make a line that looks like the track made by a two-day old calf trying to get to the other side of the pasture, prolonging it is anybody's guess. Anyway, you always can say, if anybody denies your conclusions, that he can not prove it is not the way you say it is.

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*See "Among Our Contributors," page 421

After all, it doesn't matter just how hot the interior of the earth is, as long as it is a good deal hotter than the outside, and everybody who knows the evidence of observations made can at least agree on that much.

The next question is, what of it? Everybody knows that Palm Beach is considerably warmer than Kennebunkport in January, but the only practicable way for a Kennebunkporter to benefit by it is to buy a ticket to Florida. The people who dream of having Satan for a janitor are pleasantly vague about it. They propose to dig holes anywhere from five to 25 times as deep as the deepest artificial holes yet made and somehow bring the heat up the hole.

Maybe the digging of the hole can be done. It costs from 75,000 to 150,000 dollars to dig a deep oil well and the deeper you go the more expensive it gets. A hole five miles deep probably could not be made at all with present methods and equipment, and even if it could no one could guess whether it would cost 5,000,000 or 50,000,000 dollars. Obviously we would have to have two holes, for if the water to make the steam went down an inner or outer tube in the same hole that the steam was coming up, the heat in the steam would go into the water. In fact, it is a very puzzling problem how, starting with steam at the bottom of a hole five miles deep, you could get it to the top without having it cool down and condense to water again. But maybe it could be done if the steam passed through the hole fast enough, for the rate at which the heat would leak away is so many heat units per minute and if the quantity of steam passing through is multiplied by ten the percentage of heat lost is reduced to one tenth. So let's say it can perhaps be done, and that we will trust inventive genius to find the way.

ONE OF THE EARTH'S "HOT SPOTS," THE GEYSERS, CALIFORNIA

Wells drilled into the warm ground at The Geysers, 60 miles north of San Francisco, give steam at high pressure. This thermal region has been studied scientifically by Dr. Arthur L. Day, Director of the Geophysical Laboratory of the Carnegie Institution of Washington and Dr. E. T. Allen of that Laboratory. This photograph, showing escaping steam, was taken by Dr. Day, as was the one on the cover of our number for November. Through an inadvertence having to do with editorial routine that fact was not then mentioned

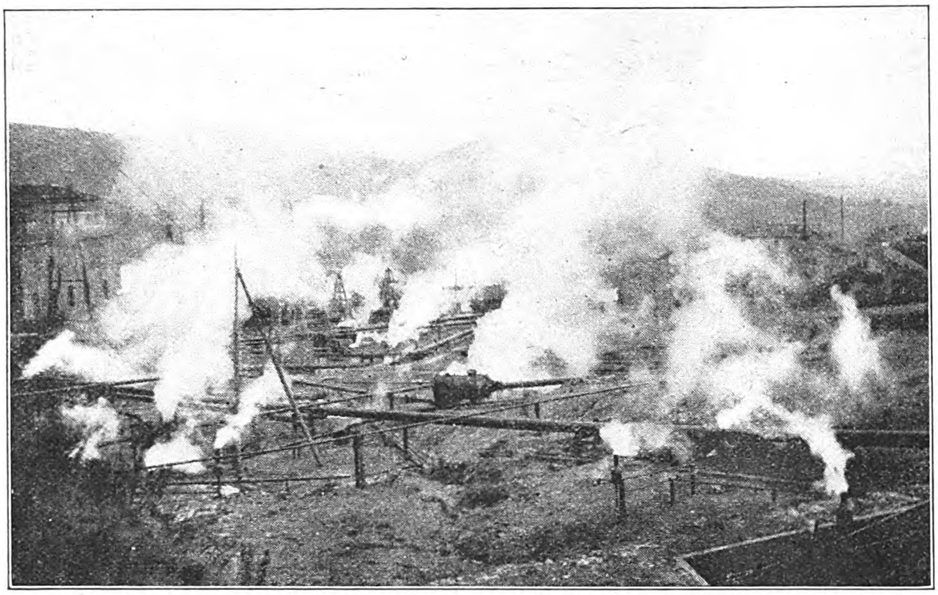
ASSUMING that we can make a hole for the water to go down and another for the water to come up, the next question is, how to connect them at the bottom. The only reasonable answer is, I do not know. The boring of oil wells is done from the surface, but to make a hole five times as deep as the present deepest would probably involve getting down inside it, and since we are being so generous let us concede that perhaps people could somehow get to the bottom of the hole and make a cross passage. It is only a few years since nearly everybody was quite sure that men could never fly through the air, and it is decidedly risky to say anything cannot be done, merely because no one now knows how to do it.

But here another question troubles us. How would we keep the hole open, even if we could make it? Everybody knows that in making the tunnels under the North and East Rivers, in New York, much engineering skill is required to guard against the pressure forcing the soft materials of the river bottom into the hole that is being made. At these shallow depths the pressures are such that compressed air, cast iron rings, and concrete are able to cope with them, but when we talk about depths of five miles, or 25 miles, we are in a region of immensely greater pressures. From laboratory experiments Professor Adams, of McGill University, concluded that holes could exist in solid granite at a depth of 11 miles. Whether they could exist at twice that depth is extremely doubtful; where the rock is not solid much difficulty is experienced in keeping the holes open in ordinary mines.

Finally, there are those inexorable things, the laws of thermodynamics. Lest the reader hastily turn over the page, let me say at once that I am not going to tell what they are. Everyone knows that you can not cook eggs on top of mountains, because the water boils at too low a temperature to cook the eggs. The reason is, that the lowered pressure lowers the boiling point. So it is easy to understand that raising the pressure raises the boiling point, but the interesting thing is that it finally gets to the point where you can not boil it at all. Perhaps it would be better to say that at such high pressures and temperatures no one can say whether you would have water or steam. If a hole five miles deep were filled with water flowing down it, to come up the other hole as steam, the pressure at the bottom would be about 11,500 pounds per square inch and the temperature, on the basis of one degree for every 200 feet, would be 130 degrees above what it started down at, or say 200 degrees. This is below the boiling point at surface pressure. The critical pressure of water is about 3000 pounds per square inch; at that pressure it boils at 690° Fahrenheit, and above that pressure no increase in temperature would make it boil. Since the pressure at the bottom of the hole would be nearly four times the critical pressure, even the heat of an oxy-acetylene blowpipe would not suffice to make it boil there. But this difficulty could be met by letting the water, after it had descended a limited distance, discharge into an open catch basin, and so go on down, arriving at the bottom at a pressure corresponding to the last drop, or 433 pounds to the square inch for a drop of 1000 feet. At this pressure a temperature of 450° Fahrenheit would suffice to make it boil.

Of course it is not necessary that the

water should boil at the bottom of the hole, but what we are after is heat, and a pound of water raised 130° Fahrenheit in temperature has taken on 130 heat units, while a pound of water that has been converted into steam 130° Fahrenheit above its initial temperature (whatever that was), has taken on 1102 units. Because of the greater heat-transporting power, therefore, we should much prefer to bring the heat up in steam. Let us see whether there is any chance that we could do this.



ANOTHER WELL KNOWN HOT SPOT—IN ITALY

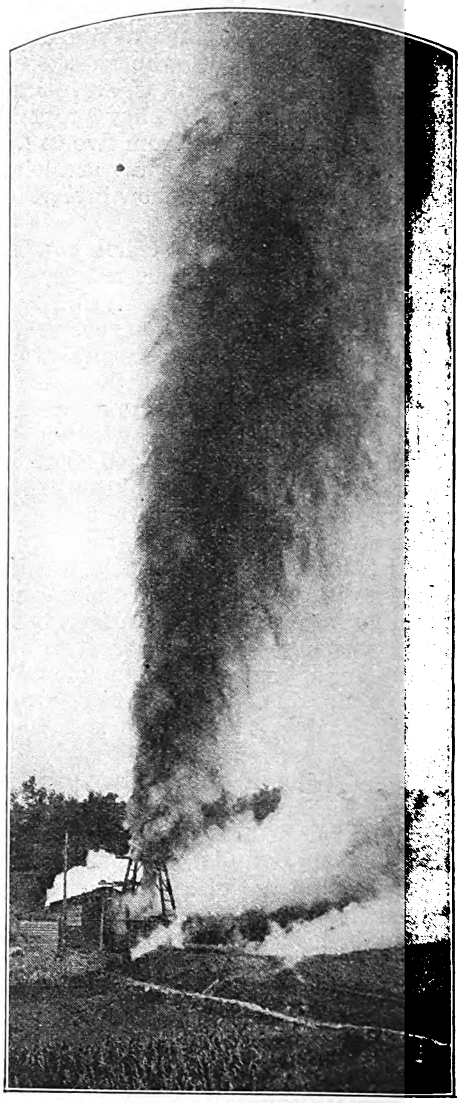
Steam escaping from thermal region at Lardarello in Tuscany. Here several thousand horsepower of energy have actually been developed but, as the author states, these thermal areas are not a promising source of vast energy such as the world needs to keep the wheels moving

Suppose that at the place where we are trying to get heat from the depths the rate of temperature is 1° Fahrenheit for every 100 feet; which certainly is the upper limit, according to the bore-hole records. At this rate the temperature at 26,000 feet would be 320° Fahrenheit, or that inside an ordinary steam boiler which is working at 75 pounds pressure per square inch. By cutting our last drop down to a little less than 200 feet we could reduce the water pressure to 75 pounds and, after all this trouble and expense, we would have——a set-up as practicable as an ordinary cheap coal-fired boiler; with the sole advantage that we would not use any coal in it, if—and there is a big "if"—we could get the heat out of the rock into the water.

The cause of that "if" is that rock is, as geologists know, not much better as a conductor of heat than the protective coverings that are put on steam pipes to keep them from losing their heat. The first few pounds of water would cool the surface of the rock, and the heat would have to pass through the rock by conduction and this rate is exceedingly slow even where considerable differences of temperature exist between T_1 and T_2—the respective temperatures of the two working substances. Perhaps a Jules Verne could imagine some way in which the water could be made to pass out through channels to great distances from the bottom of the hole, finally returning to the bottom of the other hole to emerge as steam, but my own fancy is unequal to the task. Engineers naturally hesitate to say that anything can not be done, but they may say they can not imagine any way of doing it, with present knowledge.

Someone will here say that there must be something wrong somewhere, because he has seen natural steam coming out of the ground in Yellowstone Park and has read that there are numerous other places where steam escapes, while hot springs are even more common. There are many of these local hot spots on the earth's surface and the scientists do not know how they get that way. Many explanations have been offered; such as that by earth movement molten rock has been brought up from below to near the surface and that the steam represents either surface water that has been heated by coming into contact with the hot mass, or else that it is water vapor that was in the molten material and is now escaping from it. There are difficulties in all these explanations, and we may here accept the two facts that over most of the earth's surface the rate of increase of temperature as we go down is too slow to offer hope of practically drawing heat from the interior of the earth, and that at some places there are local hot spots at which steam issues at the surface.

Suppose, then, that we forget about the rest of the earth and concentrate on the hot spots. There we have what Kipling would call "another story," one that I shall not attempt to outline here![1] Suffice it to say that the "steam" is not just steam, but contains a good deal of uncondensible gas and also, usually, chemicals that make it impracticable to use it directly in a steam engine, so some of the attempts that have been made to utilize it depend on using the "steam" to heat water and make ordinary steam that can be used in an engine. Add to this the fact that these hot spots are usually at places where there is nobody nearby who is a consumer of power and you arrive at something like the familiar water-power problem of having a source of power but the cost of harnessing it for utilization makes it cost more than power from coal.[2]



NOT AN OIL GUSHER

The eruption of a large steam well drilled in the thermal soil of a small area in Italy.

THE conclusion therefore is that coal producers need not lie awake nights worrying over the possibility of having their markets invaded by heat drawn from the interior of the earth.

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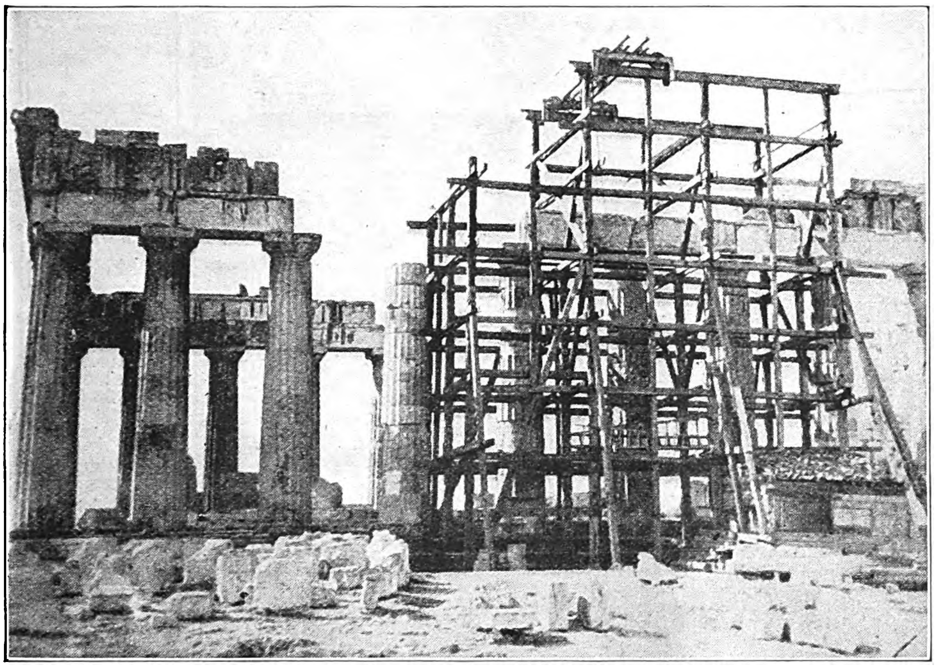
[1] See "Power from the Earth," describing one such development in Italy, SCIENTIFIC AMERICAN, November, 1929, pages 422-424—Ed.

[2] See discussion of various power sources of the future, SCIENTIFIC AMERICAN, February, 1930, pages 141-145—Ed.

From the Archeologists' Note Book



REPAIRING THE PARTHENON

The drums of the columns of the 5th Century B.C. Parthenon at Athens are being placed in their original position, having been thrown down in 1687 during the siege of that city

Digging up Athens' Broadway

AMERICAN scholarships and American dollars have combined to excavate the *Agora* or market-place and forum of ancient Athens. This might be likened to the Broadway or Fifth Avenue of the antique city of culture. The cost will run into millions and it will require ten years to make the excavation in an orderly manner. Prof. J. Leslie Shear of Princeton University will direct the work. The Greek Parliament has passed a special law by which the American archeologists may condemn the houses by properly compensating the owners. The scientific enterprise is backed by over 40 universities and colleges of the United States. The buildings which now occupy the site are squalid and unimportant.

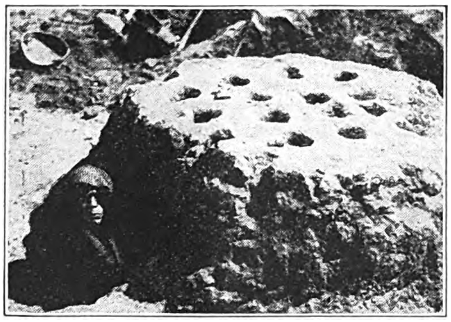
The *Agora* was the heart of Athens—commercially and socially. Here we had shops, markets, studios, and forums for discussions of all kinds. Here Apelles exhibited his paintings and here occurred the memorable meeting of Diogenes and Alexander the Great. Trading was carried on to a considerable extent, for Athens was a great center for luxurious merchandise. Trial by jury was also inaugurated here and we can almost see the reluctant potential jurors of yore trying to get excused from duty.

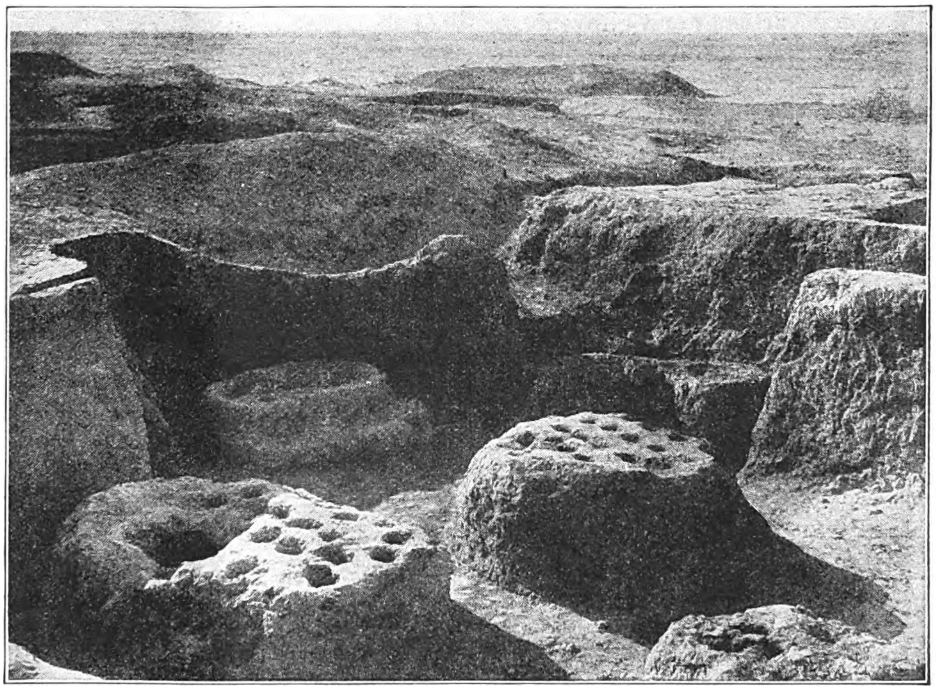
There are so many references to the *Agora* in classical literature that the task of the archeologists is much simplified. The excavated regions will be transformed into a park, as far as the maintenance of the antiquities permits. The site is the most promising in all Greece and the finds will probably be very important. When the excavations shall have been completed we can visualize the Athens of Socrates and Plato, as well as that of the dandies and revelers, for all sorts and conditions of men foregathered here.

Our illustration shows the repair rather than restoration of the Parthenon. This is not a part of the *Agora* plan but is a necessary although belated attempt to salvage one of the world's most precious structures.

An Ancient Bakery

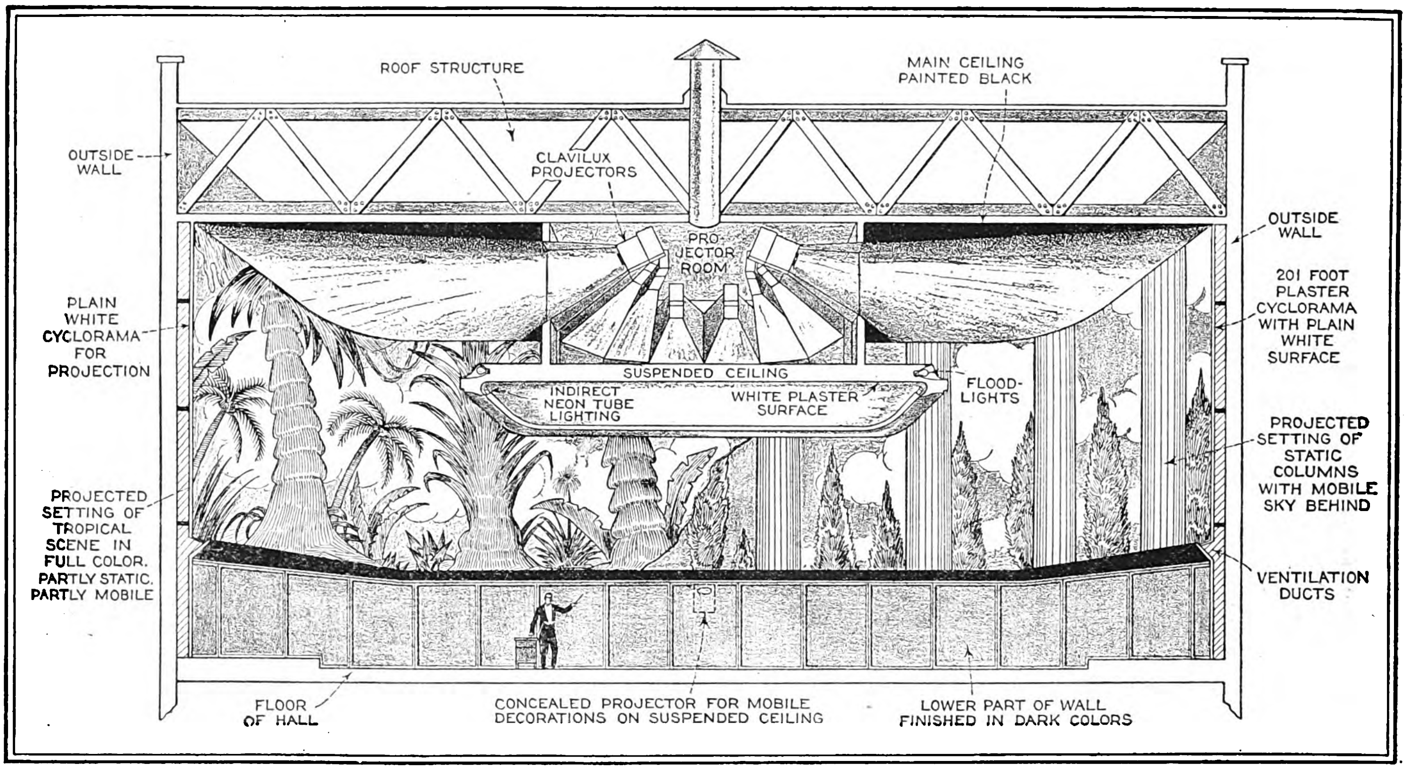
THE remains of what is believed to have been the earliest bakery established by any civilized people were found recently by the Field Museum-Oxford University Joint Expedition to Mesopotamia on the site of the ancient city of Jemdet Nasr. The bakery consists of a group of clay ovens, estimated to have been built about 4000 B.C., according to Mr. Henry Field, assistant curator of physical anthropology at the Field Museum of Natural History. The ovens consist of large clay mounds, hollowed out inside, and with holes through the top to permit the passage of heat. At their bases are fire holes large enough for a man to crawl into. Huge piles of cinders of ancient fires were found inside. Pots and pans containing the bread to be baked were placed on the tops of the ovens, where the heat reached them through the holes.





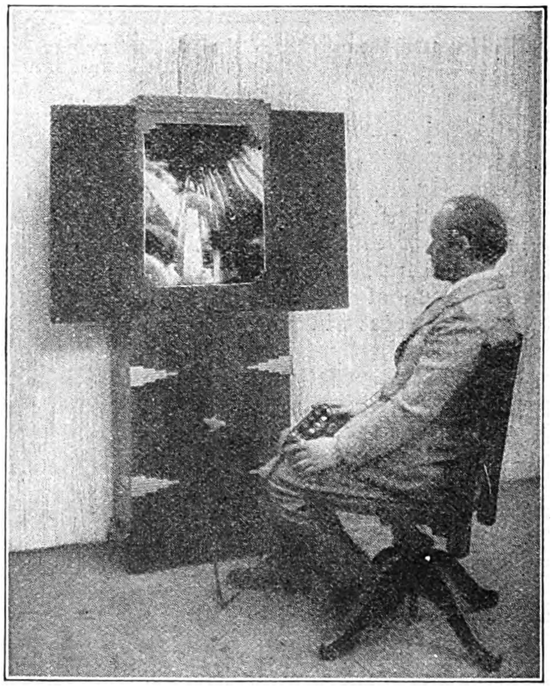
THE OLDEST BAKERY IN THE WORLD

Remains of clay ovens discovered in Mesopotamia at the ancient city of Jemdet Nasr by the Field Museum-Oxford University Joint Expedition. *Above:* an Arab in the fire hole


ROOF STRUCTURE
MAIN CEILING PAINTED BLACK
OUTSIDE WALL
CLAVILUX PROJECTORS
PRO-JECTOR ROOM
OUTSIDE WALL
201 FOOT PLASTER CYCLORAMA WITH PLAIN WHITE SURFACE
PLAIN WHITE CYCLORAMA FOR PROJECTION
SUSPENDED CEILING
INDIRECT NEON TUBE LIGHTING
WHITE PLASTER SURFACE
FLOOD-LIGHTS
PROJECTED SETTING OF STATIC COLUMNS WITH MOBILE SKY BEHIND
PROJECTED SETTING OF TROPICAL SCENE IN FULL COLOR. PARTLY STATIC. PARTLY MOBILE
VENTILATION DUCTS
FLOOR OF HALL
CONCEALED PROJECTOR FOR MOBILE DECORATIONS ON SUSPENDED CEILING
LOWER PART OF WALL FINISHED IN DARK COLORS

A HUNDRED HALLS IN ONE

In the ballroom of the Hotel Sherman at Chicago the new art of light has found one of its practical applications. Here all the decorations are projected from a suspended chamber



SUPERSEDING THE FIRE-PLACE

An instrument which plays form and color as a phonograph plays music. Colored disks are used

Light Furnishes Ballroom Decorations

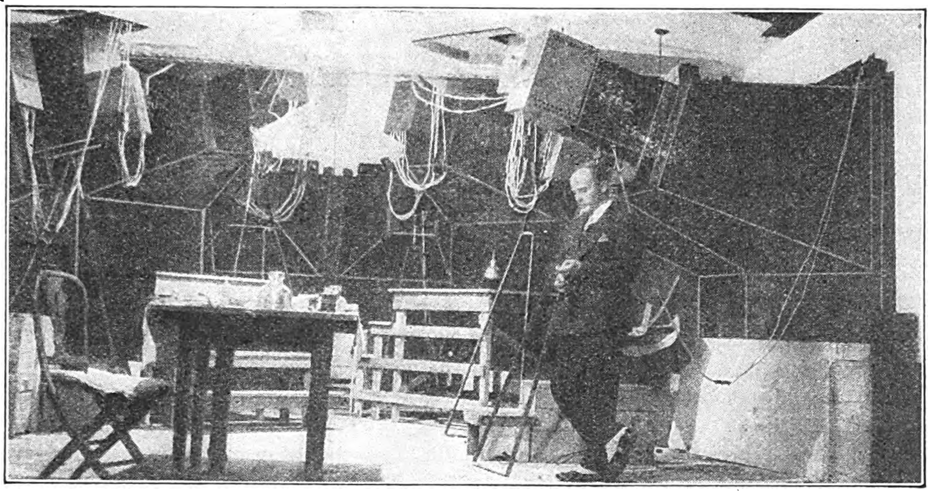
Color-Harmony Introduces a New Mode of Expression

SINCE Bainbridge Bishop patented his "color organ" in 1877, many artists and inventors have been at work on the creation of an art form of light somewhat similar to the age-old art form of sound-music. In its early stages this pioneer work was greatly hampered by the unfortunate and totally unfounded belief that each color corresponded definitely to a musical note. Now, however, the light artists of later years have come to look at light as an independent medium for esthetic expression no more related to music than to painting or sculpture. Form, color, and motion are the basic factors, according to the theory of Mr. Thomas Wilfred, an artist in light who has developed his dreams into the practical applications which we illustrate in this article. He has designed a clever keyboard from which lighting of any kind can be controlled with such delicacy as to enable an artist to express himself in form, color, and motion.

The Hotel Sherman in Chicago, wanted a mobile decoration for their ballroom—one that would be flexible enough to allow rapid changes to be made for varied functions. The hall may thus be used for a piano recital in the setting of a Grecian Court: For the Rotary Club luncheon the turning wheels, their well-known emblem, would be appropriate: For a woman's club tea in the afternoon, it can be decorated by diaphanous moving forms of a purely abstract nature: At night it can be turned into a Persian garden, slowly changing and opening vistas of enchanting beauty.

Our first illustration shows the means by which this is accomplished. The ballroom is finished in plain white plaster without a trace of decoration, which is all to be provided solely by means of light projection. The decorations are filed like phonograph records and are instantly available. The suspended projection chamber takes the place of a portion of the ceiling proper and carries its own ceiling below. This ceiling in turn is also decorated by projected mobile forms which issue from concealed wall instruments. Huge projection instruments in a semicircle are directed toward every point of the white walls. Below in a small chamber is the keyboard from which the operator commands a view of the entire hall. No operators are required in the projection chamber as the keyboard controls the light effects. The projection chamber is surrounded by a runway from which dancers can produce moving shadows of themselves on the walls.

To enhance further the projector images, a flood-lighting system is installed in the edge of the runway and an indirect neon-tube system furnishes



PROJECTORS

Twenty-three projectors in the suspended chamber cover the walls with unbroken images which are changeable at will

light on the suspended ceiling. The true ceiling is not seen, as it is painted black and no light is projected on it, which would differentiate it from the false or suspended ceiling. The effect is that of a vast cyclorama, but the true surface is entirely obliterated by means of the three-dimensional projecting system used. The illusion of three dimensions is achieved by utilizing a new principle of optics. One of the effects which can be obtained, for example, is a tropical forest. Through the spaces between huge tree trunks can be seen vistas of tropical undergrowth, flowers, sky, and water, constantly moving and changing in form and color. A cathedral with sunlight streaming in through a number of stained glass windows is another possibility. Using pure decoration, the entire hall may be covered with abstract forms apparently in three dimensions, rhythmically advancing and receding. Or there may be a modern city with a semi-abstract treatment of towers, cranes, girders, and bridges, swinging and moving. Or, at the operator's fancy, there can be an oriental fantasy suggesting the "thousand and one nights" with movements of festoons of large jewels among minarets and crystal towers.

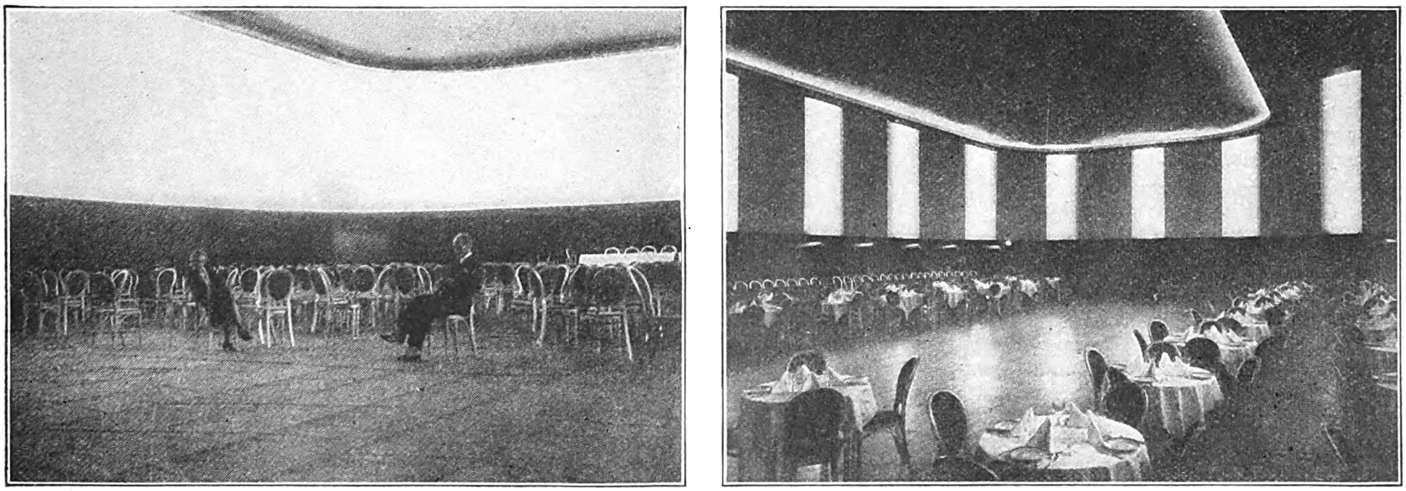
MUCH poetry has been inspired by the fire-place of yore, which has now been largely replaced by the uninspiring steam radiator or the unconvincing gas-log. The charms of story telling around the fire is as extinct as the dodo and the electric bulb has inspired no poetic muse. However, we may now take the very bulb and make it speak eloquently of the "stuff that dreams are made of" by a new instrument for home use. All one does is to open the doors which mask a curved screen, select a record from the drawer, take the tiny keyboard in his lap and the world of make-believe is his. Colored glass records rotating at different speeds are used to allow the lights to be projected onto a screen background lighted from above with the three primary colors from minature floodlights controlled by the player. Eleven buttons enable the player to modify the forms and colors projected through the slowly moving record to increase or decrease the tempo at will, or "freeze" any transitory form which appeals to the fancy, as long as desired.

THE LIGHT KEYBOARD

All projected images, colors, and movements are controlled by means of tiny keys sliding in grooves. This enables a recital to be given by a color artist

These cabinets can be designed to fit the architectural or decorative scheme of the room. They take up no more space than the modern phonograph or radio set. They are self-contained and all you need is to connect to an outlet, as with any other electrical device. The effect when seen for the first time is remarkable. You can give a home "color recital" with it.

With our noise-racked nerves, it would seem logical to seek recreation through silent beauty. We might even visualize, with Mr. Wilfred, large temples of light where people can find a place of silence with light as the only language of beauty.



"BEFORE AND AFTER"

At the left is seen the ballroom with light decoration omitted and all control keys at zero. Only a blank wall is seen. At the right the projectors are functioning and we have a Grecian court with three-dimensional fluted columns with night sky between

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Individual Hothouses for Plants

A NEWLY developed paper cover for plants, in effect a miniature hothouse for each plant, is coming into widespread use in some parts of the country. These paper covers, called "Hotkaps," are in the form of cones made of specially prepared waxed paper about 11 inches in diameter at the base. When placed over the plants, it is claimed that they protect fully against late frosts, wind, insects, and heavy rains.

Individual "hothouses" for plants being placed by means of the metal setter. The pre-formed paper caps fit snugly into this special device

The paper cones are inserted in a setter made of metal in the exact shape of the Hotkaps and the setter then placed on the ground over the seed or plant which is to be protected. Slight pressure on the handle of the setter forces the Hotkap into the ground a distance of ¼ to ½ inch. The edge of the paper cone which protrudes from under the edge of the setter is then heaped with soil, the setter is removed, and the paper is permanently in place. After the seeds have germinated and obtained a good start, a slit is cut in the side for ventilation; and later the top is cut out for the plant to grow through.

It is claimed that Hotkaps force a much earlier growth than would be possible under ordinary circumstances.

General Electric's Foreign Interests Gain

THAT the General Electric Company in the future will derive a greater proportion of its income from sources other than operations is evident from the substantial increase in its investments in associated companies, both in this country and abroad.

The greatest gain in such investments last year was in leading European companies, in some of which the General Electric Company, through International General Electric Company, previously had stock interests.

As a result of these acquisitions, investments of International General Electric Company at 74,665,063 dollars December 31, last, showed an increase of more than 100 percent over the total a year previously —35,418,307 dollars—funds for such investments being advanced by the General Electric Company.

General Electric retains intact its holdings of 1,240,530 shares of common of Radio Corporation of America, and these, too, are included, at conservative values, in the investments in associated companies, as well as additional capital supplied in 1929 to Electrical Securities Corporation and United Electric Securities Company to finance normal expansion of the latter's operations.

Income from investments in associated companies and miscellaneous securities, the latter being comparatively small, has been increasing each year for the General Electric Company and in 1929 represented 45 percent of all "other income." Against a total net of 67,289,880 dollars; including that from operations and other income, in 1929, total "other income" represented 31.8 percent.

The 9,681,387 dollars interest and dividends received from associated companies and miscellaneous securities in 1929 represented 6.6 percent of average value at which these investments were carried on the books of General Electric at the beginning and end of the year. It compares with a 7.6 percent return in 1928.

If the General Electric's proportion of undistributed earnings available for dividends of associated companies had been taken into income, the increase in total net would have been approximately $1.74 a share on the 7,211,482 no-par common shares outstanding at the close of 1929, bringing the per-share figure to $10.71, against the $8.97 that was reported.

Considering undistributed equities and various other items, the nearest calculation of share earnings would be around 13 dollars on the common, or an increase of more than 40 percent above reported figure. Total net, on this basis, would be in excess of 90,000,000 dollars, whereas actual reported income was 67,289,880 dollars.—*Barron's.*

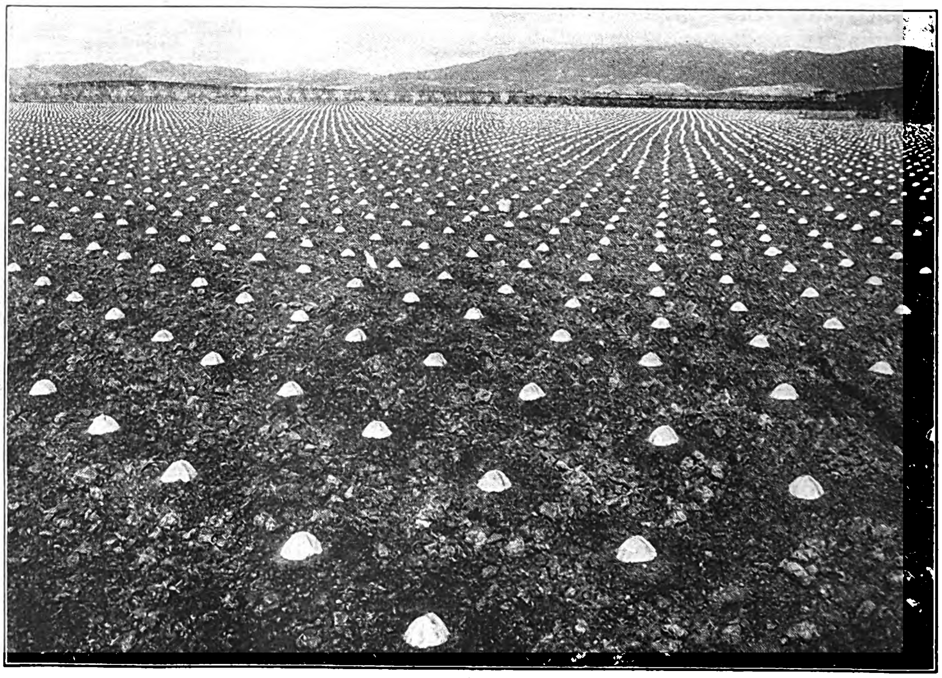
New Rubber Plants in the United States

RUBBER plants, of a species so productive that it has been exploited almost to the point of extinction in its native home in Madagascar, are now growing in southern California and Florida and have withstood the climate during the past winter with no apparent damage. So far only a few plants have been established but this number will be increased as rapidly as possible.

These rubber plants belong to the species *Euphorbia intisy*, and were brought to the United States more than a year ago by Dr. Charles F. Swingle, botanist of the United States Department of Agriculture, who spent several months on a plant exploration trip in Madagascar with Professor Henri Humbert of the University of Algiers.

Intisy is a shrub or small tree reported to reach a height of approximately 20 feet, although no specimens of this height are known to exist at this time. The trees are leafless, and present a scraggly appearance. Their ability to grow in the very dry regions of southern Madagascar is accounted for by an unusual root structure. The roots resemble links of sausage, and act as reservoirs for water.

With the discovery of this plant in



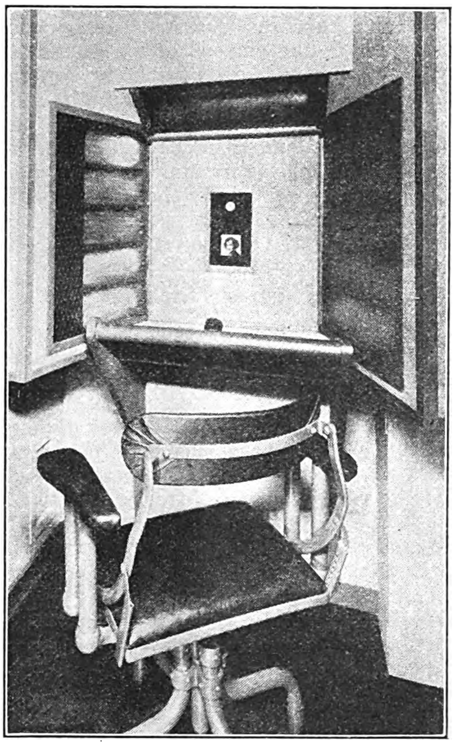
"Hotkaps" in place in a large field. They speed germination of the seeds beneath. The paper is stiff enough to resist the force of wind and rain

Madagascar in 1891, commercial exploitation followed at once, and annual rubber exportation jumped from less than 50,000 pounds to almost a million pounds. The ruthless exploitation soon showed its effect, reports Doctor Swingle, in an article in the *Journal of Agricultural Research,* and within a few years *intisy* had become so rare that observers reported it was very difficult to find specimens.

In some of the regions where Doctor Swingle found *intisy* growing there are periods of six years at a time when there is no rain.

"The manner of obtaining *intisy* rubber," Doctor Swingle says, "is very simple and is one of the factors that led to the commercial disappearance of this plant. The latex, which flows from any cut, coagulates in the air without further treatment. All that the native has to do is to make cuts in the stem, return in a few days and pull off bands of rubber of very high quality, especially desirable for the manufacture of automobile tires.

"The yield of rubber from stems less than one inch in diameter is so slight that it does not pay to tap them. However, during the time of commercial exploitation, spiral cuts were made all the way up the tree, and yields of 15 pounds or more of rubber would be obtained from a single tree. In many cases the first tapping was so severe that the tree died outright."

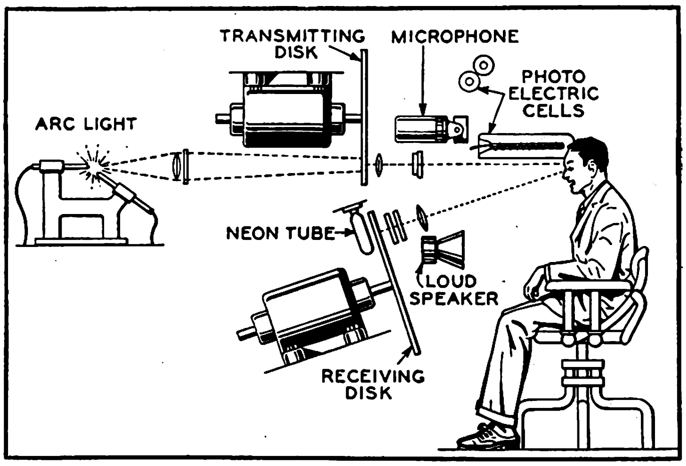

One of the two-way television cabinets. On the small "screen" in the center, one sees the person at the distant end; and above this is the scanning-beam hole

Two-Way Television Demonstrated

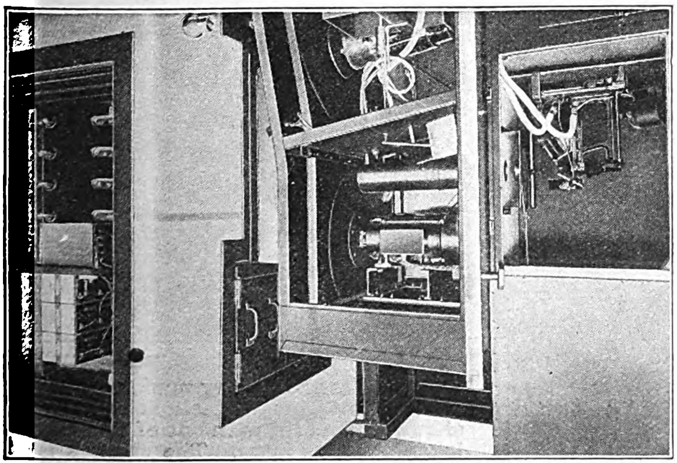
TELEVISION has taken another step in its development, with the production of an experimental system of two-way television supplemented by the usual two-way telephone, permitting the parties to a conversation to see as well as to hear each other.

An experimental service between the American Telephone and Telegraph Company's building at 195 Broadway and Bell Telephone Laboratories at 463 West Street, which has been in operation for some time, was disclosed recently to the editors of this magazine. Special telephone-television booths were installed at these two buildings.

In one of these booths a person seats himself before a frame in which he will see the face of the person with whom he is talking. His own face is rapidly scanned by a mild beam of blue light which reflects from his face to the photoelectric cells and gives rise to the current which transmits his image to the distant booth. There is no fierce glare to the scanning beam; and one is not annoyed by its presence and may even gaze directly at it without inconvenience.



At right: **Arrangement of apparatus in two-way television. As the incoming image is viewed through the lower scanning disk, the speaker's face is scanned by the upper disk. A microphone and loudspeaker complete the layout**


At left: **Opened doors of the three major cabinets of the television-telephone apparatus show photo-electric cells at right, scanning disks for receiving and sending in the center and the arc-light for sending at left**

The first thing which strikes the observer when he steps into the booth—which is lighted with a dim orange light to which the photo-electric cells are insensitive—is the absence of the usual telephone. Special telephone transmitters and receivers are concealed in the booths. One talks face to face to the distant person and a hidden receiver speaks the words which seem to issue from his mouth. The other party to the television-telephone conversation appears with sufficient detail for recognition of facial expression.

The television image is greatly improved over that originally demonstrated by Bell Telephone Laboratories in 1927, and is about twice as large with a corresponding increase in detail. The image, which has the detail of about five thousand discrete points of light, is formed 18 times a second. The photo-electric cells, used in picking up the face which is to be transmitted, have been much improved in sensitiveness and give rise to about 10 times the current for the same amount of light as did those developed for the earlier demonstration. This increased sensitivity and the use of the blue scanning beam have made possible the reduction of the dazzle and glare which occurred to a certain extent in the earlier forms of apparatus. The increased area and detail of the image necessitate the use of a transmitting band of 40 kilocycles.

New Inexpensive Eight-inch Fan

THE Westinghouse Electric and Manufacturing Company has recently announced a new eight-inch fan of the non-oscillating type in the price-range of five-inch fans now on the market. It is a portable type, the body being made of cast iron in an attractive black finish, the fan blades are heavy gage sheet steel, and the guard is of heavy steel wire. It is single speed and is controlled by an on-and-off switch in the base.

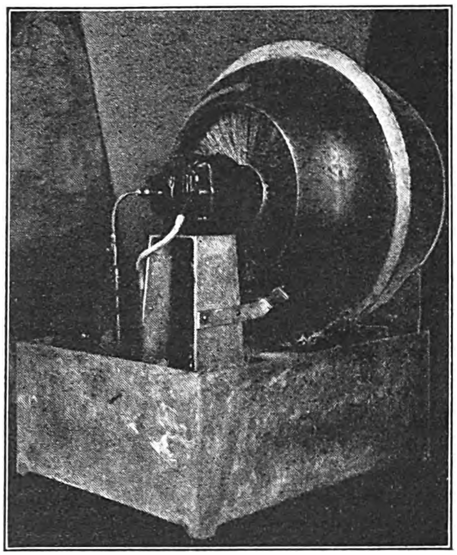
Wasteful America Saves Billion in Scrap Annually

EVEN if Americans are wasteful, as is often claimed, they salvage nearly a billion dollars' worth of their waste every year. This is according to figures of the United States Bureau of Mines on the amount of scrap and secondary metal recovered, which is increasing every year.

The waste trade industry is concentrating in large units. Even gold and silver is recovered in quantity from jewelry and dental waste. Photographic solutions contain half an ounce of silver to the gallon and 1,000,000 feet of waste movie film yield 800 ounces.

Of the 500,000 tons of secondary copper recovered annually, part comes from 300,000 burned out electric lamps collected by one company. About 40 percent of the annual supply of tin and lead has been used before.

The iron and steel saved in a year is worth 500,000,000 dollars. Other metals



Rear view of the small air conditioner showing all of its parts

salvaged in quantity from scrap, sweepings, skimmings, and dross are mercury, zinc, antimony, aluminum, and nickel.—*Science Service.*

A Home-Size Air Conditioner

FOR reasons of health and personal comfort, stress has recently been placed upon the necessity for purifying and cooling the air in which we live and work, in home, office, and factory, but most attempts to solve the problem have resulted in the production of the elaborate air washing and refrigerating equipment now commonly used in theaters and, in a few cases, in office buildings. Recently, however, a compact air washer-cooler-ventilator which can be used for small offices or even in the home was developed by John H. Fedeler, Building Superintendent of the New York Public Library.

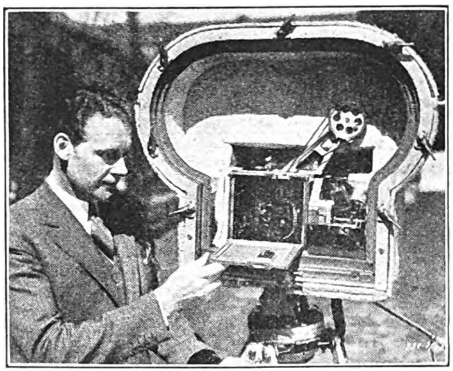
Mr. Fedeler first realized the necessity for such a device when he worked, in 1895, as a draftsman for Mr. Edison at the ore mines in Edison, New Jersey. When the crushing plants at the mines were in operation, he noticed that the whole countryside was enveloped with a dense dust cloud. He later conceived the idea for the unit which he finally developed, but many experiments lasting over a period of 30 years, and the expenditure of thousands of dollars were necessary before he attained his goal.

The complete machine is shown on this page. Its parts are: a circular brush, the "bristles" of which are of crimped Monel metal wire; a scientifically shaped casing of light-weight metal; an electric motor; a small water pump together with necessary tubing of metal and rubber; and a water box or tank on which the other equipment is mounted. As the motor rotates the brush at a speed of 1500 or 2000 revolutions per minute, the pump, which is also run by the motor, draws water from the tank and throws it into the brush. Due to the shape of the casing, air is drawn in and as it comes in contact with the wet brush, dust and dirt in the air are captured by the water and thrown by centrifugal force to the casing. The constant flow of water carries the dirt down into the tank where it settles out and may be removed periodically. The air also is thrown by centrifugal force to the casing and, because of the shape of the latter, is deflected through the unit into the room beyond. The rapid evaporation of water in the current of air causes the temperature to be appreciably lowered and a partial adjustment of humidity.

When desirable, a small amount of perfume may be added to the water used, so that the air will be perfumed. Also, when the air of any locality has been found to be acid, a neutralizing alkali such as ammonia may be dissolved in the water.

Feeding Helps Sick Trees

A RECENT development in the care of shade trees is the importance now given to "feeding" a sick tree before a lot of tree surgery work is attempted. Workers in the United States Department of Agriculture explain that this does not mean that pruning and other surgical work is not necessary, but if a tree is not vigorous, an application of plant food is likely to prove very helpful in restoring the tree to a healthy condition. Fertilizers which give immediate effect include nitrate of soda and sulfate of ammonia, applied broadcast in the spring or early summer at the rate of two to five pounds for a medium-sized tree.



Lane Chandler, movie operator, is shown with the "blimp" camera cell he has devised. By enclosing the camera in this padded cell, all clicking is kept from the microphones while making "talkies"

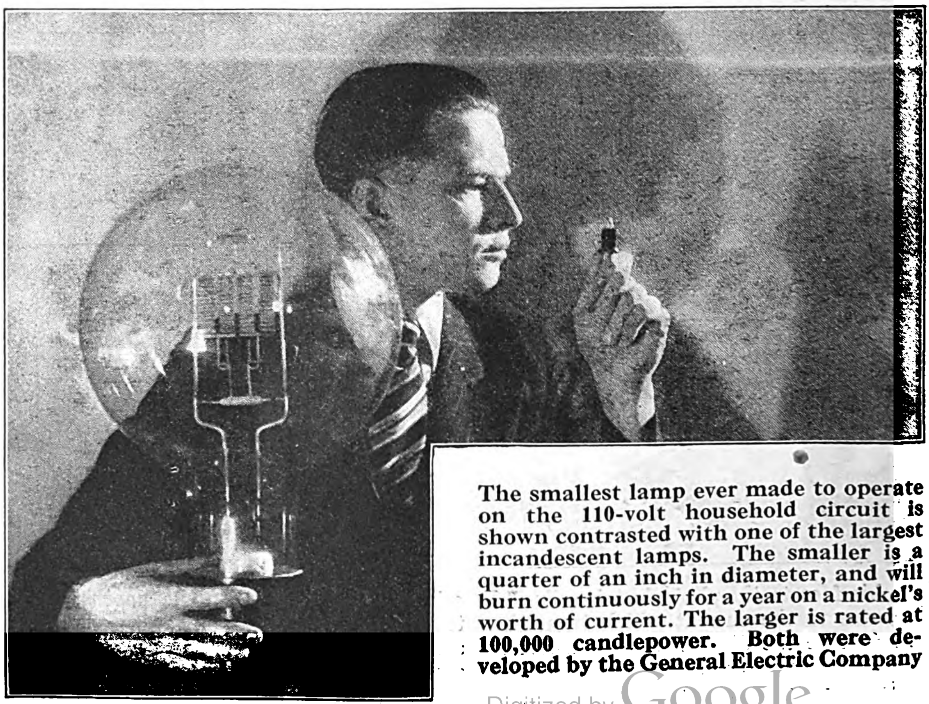
The direct effect of such an application usually lasts for only a year, but the indirect effect may be apparent the following year, as it usually stimulates the healing of wounds made by pruning or cavity work. An excess amount of fertilizer or an application late in the season may cause injury by stimulating excessive development of foliage and failure to mature the new wood properly before winter sets in.

Centennial of the Modern Scale

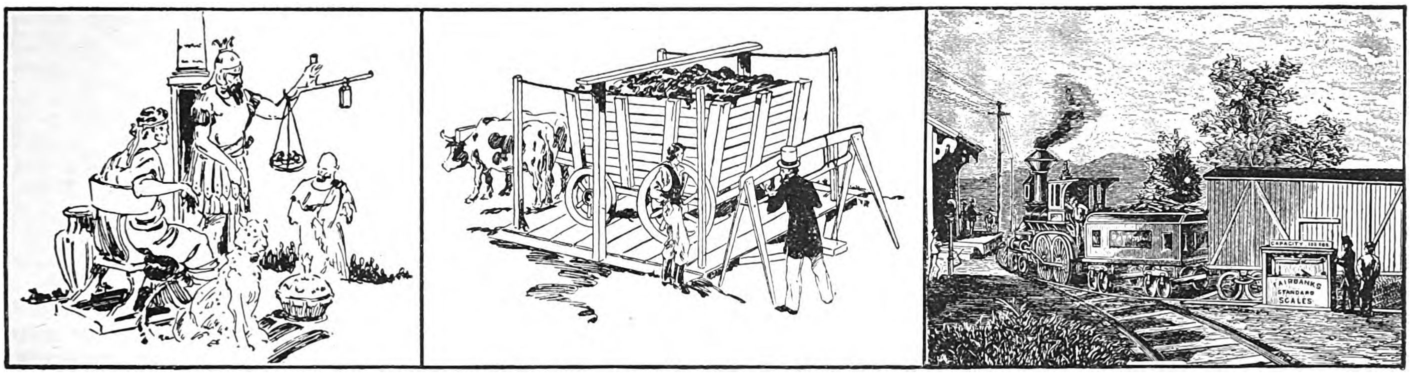
MANUFACTURING methods of today are concerned chiefly with mass production and the waste both of time and materials. It naturally follows that accurate weighing plays an important part in almost every phase of the production schedule. Thus it is that the year 1930, marking the centennial of the platform scale, is particularly interesting in that it shows what may come out of small beginnings.

From the steelyard of ancient days, there was no improvement in methods of weighing until, in 1830, Thaddeus Fairbanks invented the platform scale, the prototype of all modern scales.

It was in 1815 that Major Joseph Fairbanks moved from Brimfield, Mass., to St. Johnsbury, Vermont, and set up a grist mill and saw mill on the banks of a little creek that ran through this old Vermont town. His sons, Erastus and Thaddeus, had even broader visions and established a wheelwright and foundry business and then developed the manufacturing of saws, pitchforks, cast-iron plows, and stoves. In about the year 1830 the "hemp craze," as it was called, struck Vermont and the farmers expected to make substantial fortunes in raising hemp instead of corn. Contracts for making hemp-dressing machines were awarded to the Fairbanks brothers. The question now arose—How was the hemp to be weighed? The old steelyard was of little use for this service and so Thaddeus conceived the idea of constructing a huge steelyard beam suspended from a high frame with chains to grapple the axle of the cart. An approximate weight was thereby obtained by a process that was both slow and laborious.



The smallest lamp ever made to operate on the 110-volt household circuit is shown contrasted with one of the largest incandescent lamps. The smaller is a quarter of an inch in diameter, and will burn continuously for a year on a nickel's worth of current. The larger is rated at 100,000 candlepower. Both were developed by the General Electric Company



Evolution of the modern scale. At the left is shown the steelyard which was used by man from early times until Fairbanks invented the platform scale. Fairbanks' scale, in center, was the prototype of the one at right

Thaddeus studied the problem and finally conceived the idea of supporting the platform upon an A-shaped lever with the tip of the lever connected to the steelyard by a rod. Though not suspected by Thaddeus at the time, he had revolutionized all weighing methods and at that moment the steelyard of old Rome took its departure.

From this small beginning the platform scale in all of its ramifications was developed until today the same principle is in use, whether in a health scale, a laundry scale, or the ponderous ones used for weighing the largest railway locomotives.

Pump Dry Cement Across River

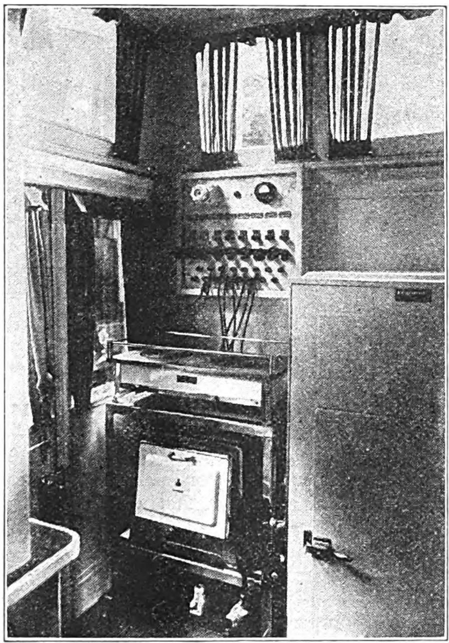
ALL the cement required for the recent construction of a 16-mile concrete highway along the Allegheny River in mountainous Warren County, Pennsylvania, was pumped across the river in dry bulk through a three-inch pipe.

Compressed air at 100 pounds pressure carried the cement in powdered form from freight cars a distance of 768 feet, the length of the pipe, to the batching plant. This unusual method of handling cement proved thoroughly practical and economical. The pipe was suspended across the river from a cable.—*Science Service.*

Ford Profits—81,797,861 Dollars

AFTER showing a deficit for 1927 in excess of 42,000,000 dollars due to the shut-down the latter half of the year for re-tooling incident to the production of the new model, and a deficit of over 72,000,000 dollars for 1928 due to large expenditures to bring up production, the Ford Motor Company showed a profit of 81,797,861 dollars for 1929, the second year of production of the Model A. These figures are given in the annual balance sheet filed recently with the State Commissioner of Corporations of Massachusetts.

Profits for last year were equal, according to *The New York Times*, to $473.79 a share on the 172,645 shares of stock, all of which are held by Henry Ford, Mrs. Henry Ford, and their son, Edsel Ford.



More evidence of the machine age in which we live. View of an electric range on one of the latest German motor buses. It was shown at a Berlin automobile show recently

Floodlight Units Help Prevent Liquor Smuggling

BY an odd twist of the illuminating engineer's mind, the Aqualux underwater floodlight, usually operated under water for the illumination of swimming pools and fountains, is now used to help keep the United States dry.

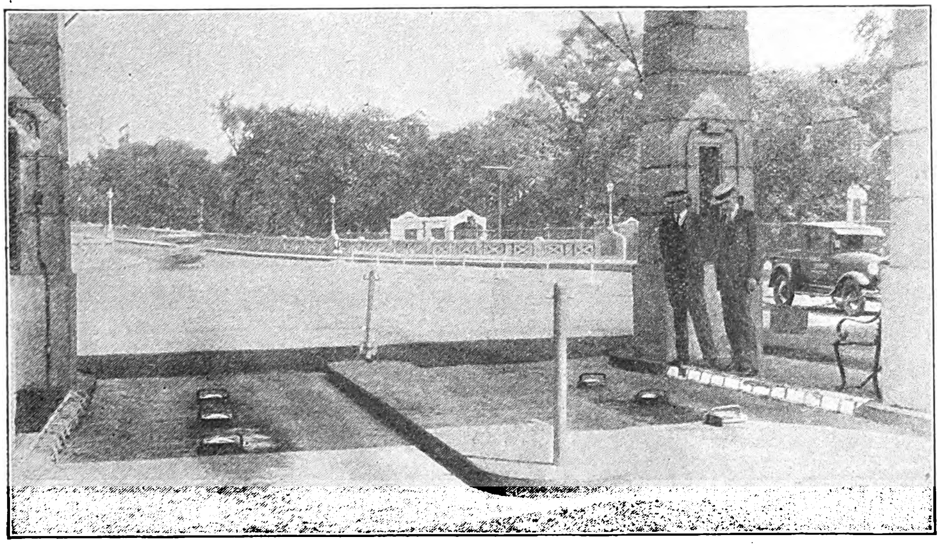
A unique method for enforcing the Volstead Act has been worked out with the United States customs and immigration officials. One of the installations has been made on four of the traffic lanes on the Buffalo end of the new 4,000,000-dollar Peace Bridge linking the United States with Canada.

It was found that a few of the cars returning to the United States over this bridge had hiding places constructed on the underside designed to contain quantities of contraband. Such hiding places, it was thought, could not be detected. It was a different story, however, after the floodlights were installed.

Three Westinghouse floodlights are buried in the concrete in the center of each traffic lane, and are equipped with 100-watt Mazda lamps which are completely enclosed by the waterproof housings. The spread lenses are protected by a heavy iron reinforcing rod embedded in the concrete over each light. The Aqualux floodlight is a cubical cast-aluminum box 8⅞ inches on a side with a gasketed cover containing an 8⅜-inch spread roundel. A chromium plated metal reflector is supplied in order to withstand the severe operating conditions.

With the car well illuminated on the underside, a view is obtained by merely looking downward into mirrors which are located for a distance of 10 feet along the curb, and set at an angle of about 45 degrees. These are five and one half inches high and are also protected by iron rods set in the concrete.

When a car stops in the lane for the usual inspection, the customs officer can see at a glance the details of the underside of all cars. If he sees the usual machinery and open spaces, there can be but little concealed. But, if the mirrors reflect large areas of sheet iron, or suspicious boxes or tanks, the car is ordered out of line for closer inspection of under-body parts.



One of the toll gates on the American approach to the Peace Bridge at Buffalo, showing the under-car lights and mirrors for detecting contraband in cars

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

Experiments in Fog Flying

EXPERIMENTS in blind flying, under the auspices of the Daniel Guggenheim Fund for the Promotion of Aeronautics, were recently related by Lieutenant James H. Doolittle before the Society of Automotive Engineers.

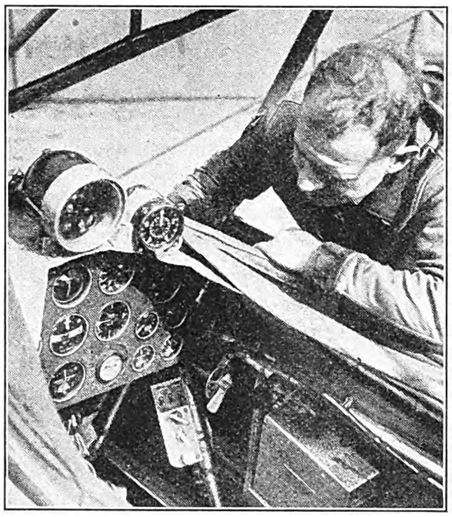
A number of flights including 180-degree turns were made with remarkable accuracy, with the pilot seated in an entirely covered cockpit, and an assistant in the rear cockpit to take charge in case of emergency.

Success was due as much to the remarkable instruments employed as to the skill and pluck of the pilot. The instrument board of the *N Y 2*, Consolidated training plane employed in these tests, is shown in one of our photographs. The instruments included standard tachometer; oil pressure gage; oil-temperature gage; airmeter; voltmeter; compass; bank-and-turn indicator; air-speed indicator; altimeter; and rate-of-climb indicator. In addition, a very sensitive Kollsman altimeter, graduated in 10-foot intervals, a Sperry artificial horizon, and a Sperry directional gyroscope are shown in the photograph.

The directional gyroscope is not truly a gyroscope compass because it does not seek the north, but once set in a given direction, it will maintain that direction without serious error for a two-hour period.

Another very useful instrument employed was the Sperry artificial horizon. Here again a gyroscope is employed (driven by a small air turbine which is connected to a Venturi placed in the airstream) in this case with its axis placed in a vertical position. The instrument is so constructed that a tiny airplane is seen by the pilot to be in normal attitude, climb, dive, left wing low, or right wing low, according to the position of the plane on which the instrument is mounted.

The ground radio equipment consisted of (a) an audible-type radio-beacon, the purpose of which was to direct the incoming airplane to the vicinity of the field or to keep the outgoing airplane on its course, (b) a visual type localizer-beacon, the function of which was to lead the pilot to the exact point where he should touch his wheels in landing; and (c) a ground receiving and transmitting set.



An airplane cockpit equipped for experimental flights under conditions simulating flying in fog

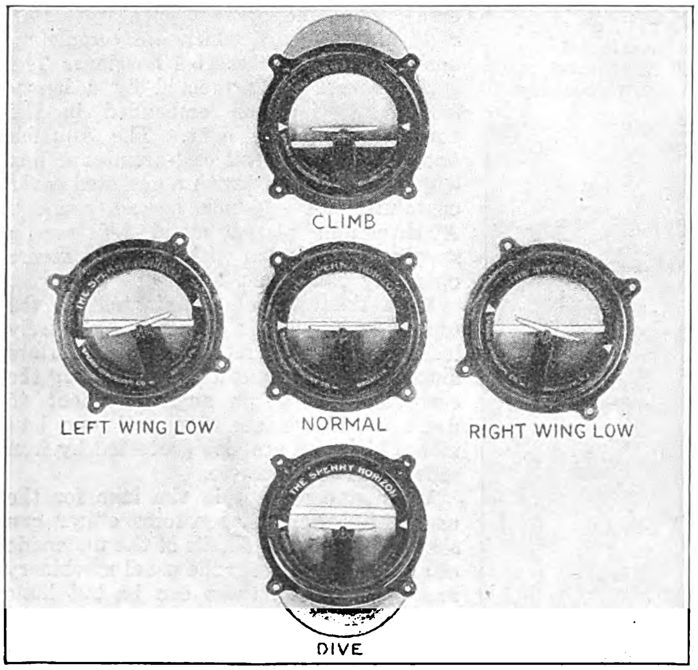
The visual-type indicator consisted of two vibrating reeds, indicating to the pilot his position with respect to the beam center. When to the right of the beam, the right reed vibrated through a greater amplitude. When to the left of the beam, the white streak caused by the vibration of the left reed became longer. When exactly over the center of the beam path, the reeds vibrated with equal amplitude. Upon approaching the beacon house, the intensity of the signal increased rapidly. At the exact moment of passing over the beacon house, the reeds stopped momentarily, and then started to vibrate again in the opposite direction.

The beacon employed was of the loop type entirely enclosed in a small building, with no wires on the outside. In the center was the goniometer which tunes the loop aerial, so that the correct guiding beam was transmitted to the pilot.

The airplane was taxied out onto the field in position for the take-off, and directly on the radio beam. The altimeter was set at zero, and the gyros speeded up. At take-off the pilot was able to hold the airplane straight by the gyro and the tail in the proper attitude by the artificial horizon.

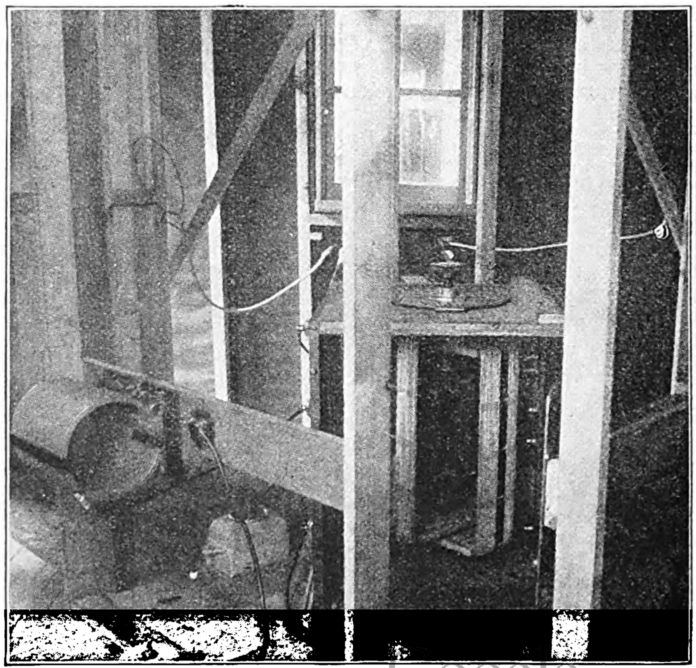
The localizer beam was followed for about four miles and the plane climbed to about 1000 feet. A 180-degree turn was made at this point and the beam followed to the beacon. As the beacon was approached the beam became narrower, and the course more exact.

Upon passing over the beacon house again, the reed stopped vibrating, the engine was throttled so that the plane came down to a speed of 60 miles per hour, the plane was kept absolutely level by the artificial horizon, and then flown directly to the ground without leveling off. The



Courtesy *S. A. E. Journal*

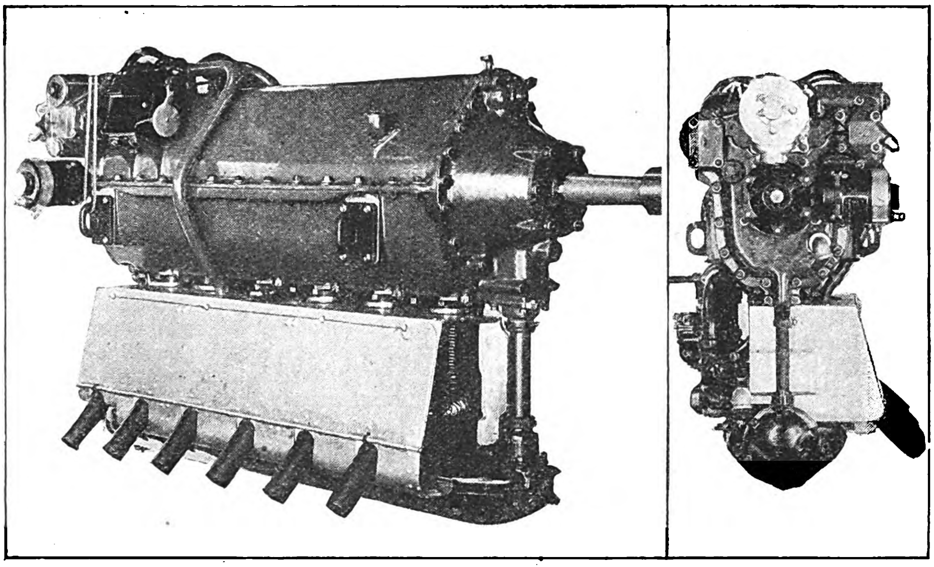
The Sperry artificial horizon. See text above



Goniometer in the ground radio transmitting station shock of landing was uncomfortable but could probably be eliminated by correctly designed landing gear.

"Had the airplane actually been coming into a fog-bound airport from a distant point," said Lieutenant Doolittle, "it would have come in along the audible-type beacon until it arrived at a point which indicated the intersection of the audible and visual-type beacon beams. At this point the pilot would radio in and request that the more powerful beacon be shut down to avoid interference. He would then follow on along the localizer-beacon beam, and at the same time request the ground barometric pressure, wind direction, ceiling, and visibility under the fog. Next the pilot would set off the correct ground pressure on his altimeter and put himself in the proper position to land into the wind."

These tests covered several months, and hundreds of landings were made without breakage. They are extremely encouraging, even if they cannot yet be considered commercially applicable.



Side and end views of the Fairchild 6-390 engine described below

Plumbing and Heating in the Air

IT is extraordinary how the airplane constructor has to reach out into every industry and trade to make his craft really comfortable for the passenger. In the matter of plumbing and heating, the aircraft designer has had to become his own plumber because the trade could not supply him with sufficiently light and compact equipment. John F. Hardecker, writing in *Domestic Engineering*, describes some of these very interesting developments.

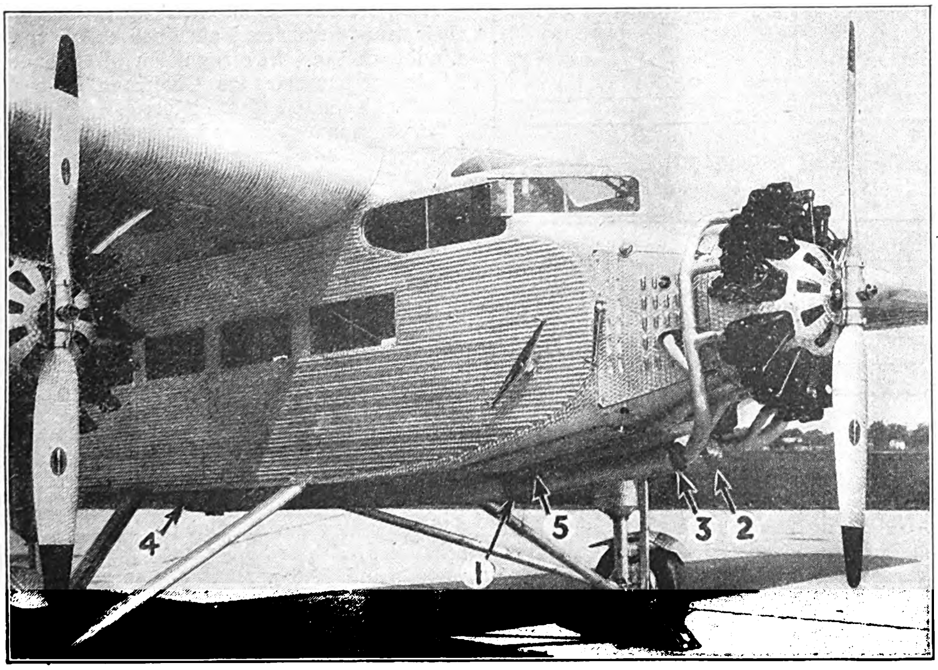
In the matter of plumbing, the limitations in the airplane are very severe. The fixtures must be light and small, because space is very valuable. Governmental regulations rigidly prohibit the discharge of any waste while in flight.

Designers have met these limitations by providing light combination water tanks and washstands of polished metal, weighing less than five pounds. Water tanks have been made of triangular and quarter-cylinder shapes so as to fit in corners and against cabin walls. A folding washstand has been developed which weighs only three pounds and fits snugly against the wall when not is use. Chemical hoppers have been provided, with sloping bottoms so as to fit sloping floors. Lavatory compartments on large passenger planes are fully equipped with washstands, closets, towel racks, small cupboards, and so on.

In the matter of heating, similar ingenuity has been displayed. Thanks to the courtesy of *Domestic Engineering*, we are able to show a special photograph indicating the heating arrangements on the Ford tri-motors now in use on the T. A. T. lines. The center motor exhaust pipe is installed along the under side of the plane. Over the exhaust pipe a large housing is placed with a clearance of approximately one inch on all sides. The bottom of the plane is protected by a heavy sheet of asbestos.

Fresh air is taken into the housing at the point 1 on the photograph. As the air passes through this housing it is warmed by contact with the hot exhaust pipe. The warm air is directed into the cabin by pipes of sufficient size, located in the floor at the center of the cabin. Registers may be opened or closed at the will of the passengers. The valve located at the end of the exhaust housing, at point 4, is operated by the last register in the cabin. When this register is closed, the valve is opened and allows the hot air to pass out to prevent overheating of the cabin. The funnel shaped opening, at point 2, and the register, at point 5, lead heated air into the cockpit. The opening at point 3 is for heating the air for the carbureter and operates in the same fashion as the cabin heater.

This simple and inexpensive method of heating has proved entirely satisfactory in practice, although temperatures under operating conditions vary from 35 degrees below zero, Fahrenheit, to 135 degrees above, and the flying ranges to 12,000 feet altitude.



Illustrating "Plumbing and Heating in the Air" above at left

A New Inverted Engine

THE in-line air-cooled inverted engine for small planes is still growing in popularity. This type offers somewhat less head resistance than the star or radial air-cooled engine and also less hindrance to the vision of the pilot. The pilot's vision is particularly satisfactory when the in-line air-cooled motor is inverted. The development of a six-cylinder in-line air-cooled engine by the Fairchild Engine Corporation is therefore of considerable interest to the aviation industry as a whole. The Model 6-390, as this new engine is called, has the following specifications:

Bore 4″
Stroke 5⅛″
Total displacement 386 cu. in.
Compression ratio 5.2 to 1
Weight dry 335 lbs.
115 h.p. at 2000 r.p.m.
Fuel consumption—.55 lbs. per BHP/hr at rated power and speed.

The engine has undergone a satisfactory 50-hour non-stop run at approximately full power.

The crankcase of the 6-390 is in two parts, and designed with special reference to ease of maintenance. A novel feature in the design is the use of four finished pads, two on each side, for mounting the engine. This makes for ready installation and removal of the engine from a plane.

The camshaft and rockers at the bottom of the engine are supported and enclosed by a housing, the cover of which serves as the engine oil sump. This makes for less noise and greater cleanliness.

The airplane pilot and mechanic should be particularly pleased with the grouping and location of the accessories on this engine, which are all placed towards the rear. Through a single opening about 12 inches by 16 inches in the cowl over the engine, it is possible to get at all the accessories as well as the starter and generator, oil pressure relief valve, and tachometer drive connections.

Glider Carnival Postponement

POSTPONEMENT of the New York Glider Carnival till late in June was announced by Edward P. Warner, chairman of the Carnival Committee. The event was originally scheduled for April 25 and 26 at Queens Borough Golf and Country Club, Bayside, L. I., N. Y.

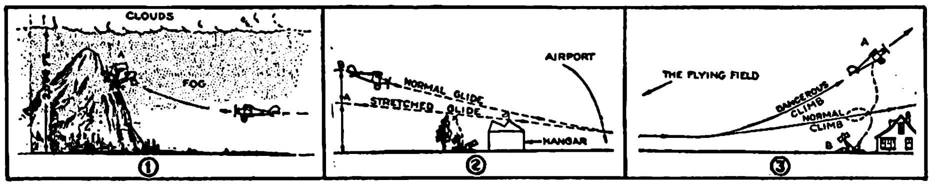
The Carnival was postponed in order to allow a number of organizations which had entered, sufficient time to complete the construction of gliders which they will fly. This action was taken following a meeting of the executive committee, which consists of Miss Amelia Earhart, Norman Siegel, C. T. Stork, and E. P. Warner.

Postponement to a date late in June also will enable a number of the collegiate glider organizations to take part in the event, Mr. Warner pointed out. The program of 14 events for novice, second, and first class glider pilots will remain the same as scheduled for the earlier date.

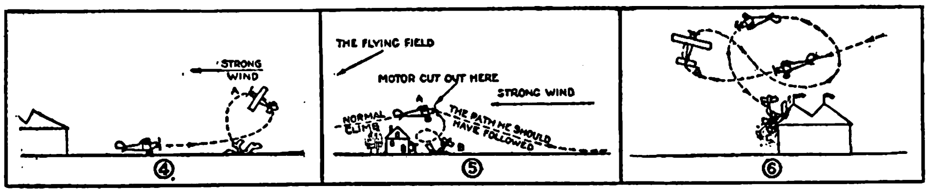
Avoidable Causes of Accident

A FORMER Bulgarian army pilot, A. Jordanoff, has graphically depicted some avoidable causes of airplane accidents in the *New York Times*. These sketches are reproduced below.

1, indicates a plane striking the side of a mountain in a fog. Some sensitive warning of the presence of the mountain is an invention still to be made. The present remedy is to land rather than to attempt to fly through fog at low altitude.



Above and below: Illustrations of six avoidable types of accidents



A misguided effort to stretch a glide by putting the plane at a large angle of incidence and so getting it out of control is illustrated in 2. The longest glide from a given altitude occurs at an angle of attack of about four degrees for the wings. Raising the nose slows down the speed of the glide, but actually diminishes the gliding radius.

The dangers of too steep a climb are shown in 3. If the climb is too steep, the engine may not provide enough power to maintain the climb, the wings may stall, and loss of lift and control lead to trouble.

Turning in a sharp climb may be dangerous, as shown in 4. We beg to differ with the author-artist here. Once the airplane is up aloft in a steady wind, the wind has no effect on its maneuver relative to the air—whatever may be its effects from the point of view of ground speed.

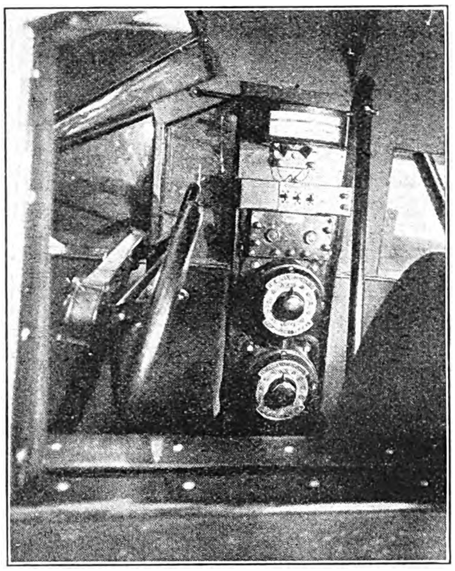
The golden rule is illustrated in 5. Never attempt to turn back when the engine quits. Turning without power may result in a stall, with consequent disaster.

Illustration 6 speaks for itself. Stunting at low altitudes is always dangerous.

Such diagrams published in the daily press may give the public an erroneous idea of the hazards of flying, but, on the other hand, if every pilot took such rules to heart the number of accidents would be greatly diminished.

Testing Gasoline in the Air

THE importance of using the best gasoline for aircraft is of course obvious and a great many of the large oil companies now have special aircraft gasoline departments with experienced aviation men at their heads, ready to supply pertinent information to aircraft engine builders and operators.



Equipment in cockpit for use in testing gasoline during flight

The Natural Gasoline Association of America, in collaboration with the Phillips Petroleum Company, has gone a step further by equipping a Wasp engined Travelair monoplane with a complete set of instruments for testing gasoline under conditions of actual flight.

The accompanying photograph shows the installation of the switch panel and recording instruments in the cabin of the plane, using delicate thermocouple and resistance thermometers. A most comprehensive survey of temperatures may be made at any one time; namely, temperature of the right wing, temperature of vapor space and gasoline in the tanks, temperature in the gasoline feed line, temperatures in the carbureter bowl, fuel pump, strainer, air intake, cylinder heads, and temperature in cylinder-head flanges.

If these temperature measurements are accompanied by the usual determination of altitude, air speed, and climbing and gliding angles, it is clear that a very thorough study of the motor's operation will be available. The temperature of the engine parts has an obvious bearing on the reliability of the motor.

Model Meet

A NEW YORK State model airplane meet will be held at Binghamton, New York, on May 30 and 31. Junior events will be for boys under 15 years of age, and senior events for young men from 16 to 21 years of age.

Outdoor models are to be twin pushers or tractors with 40-inch fuselages and a minimum wing surface of 125 square inches. Indoor models are to be somewhat smaller, with single tractor or pusher, propellers and with 15-inch fuselages and 24-inch wing spreads.

Nothing spreads interest in actual flying as much as the education of our youngsters in model work.

Radio "Flag Stops" in Air Transport

A MOST interesting development is the introduction of flag stops by the Transcontinental Air Transport. In order to serve more cities along its route, the T.A.T. has created three flag stops along its transcontinental line; one at Vandalia, Ohio, about nine miles north of Dayton; one at St. Elmo, Indiana; and one at Terre Haute, Indiana. Passengers will be able to board the planes at these points by simply notifying the company's representatives in time to have the pilot instructed. This will be done by radio while the plane is in the air.

Progress on the Lindbergh Line

WORKING in active co-operation with the Pennsylvania and Atchison Railroads, Transcontinental Air Transport Lines have issued interesting figures regarding the first six months' operations of their transcontinental air lines called the Lindbergh Line, in recognition of Colonel Lindbergh's service as Chairman of the T.A.T. Technical Committee.

Since its inauguration last July, T. A. T. has carried 4346 passengers for a total of slightly more than 2,000,000 passenger miles.

Its operating ratio, obtained by balancing the number of miles scheduled against the miles flown, has been 90.5 percent. There were 603,700 miles scheduled and 545,354 miles flown. Out of the 669 trips scheduled, 578, or 86.5 percent, were completed, and 70.6 percent of the plane arrivals were on time. These figures are quite encouraging and it is to be expected that, as confidence increases, a great many more passengers will be carried during 1930.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Dead Sea Becomes Center of Live Industry

THE Dead Sea, in Palestine, long known to contain potash and other valuable salts, is now being exploited by a chemical company which will recover potash from its historic waters. Palestine Potash, Ltd., has been formed in London with 2,000,000 dollars in capital to exploit the chemical resources of this body of water. Actual work will be begun immediately at the confluence of the River Jordan and the Dead Sea, where elaborate drying plants have been erected and 400 workers engaged.

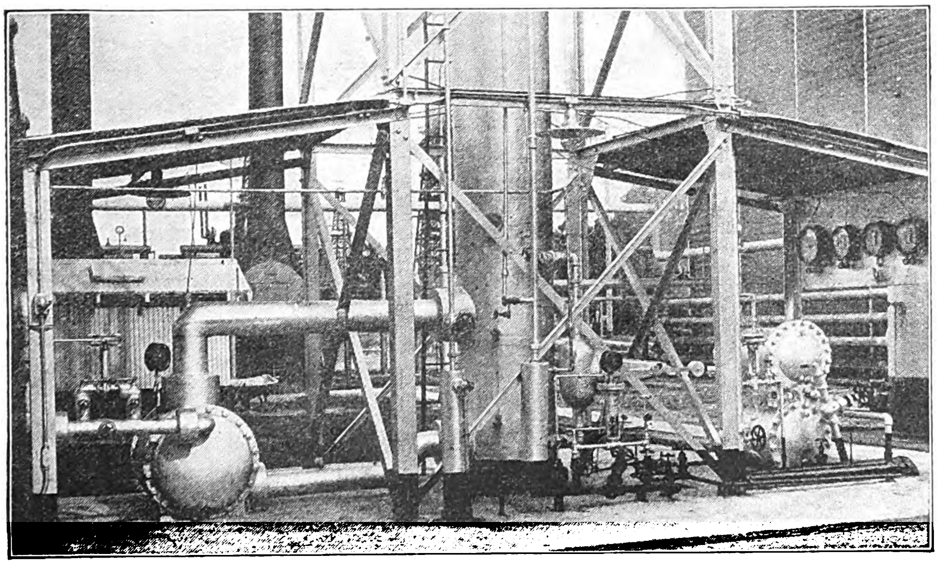
The Earl of Lytton, former Viceroy of India, is chairman of the new company, which intends to increase its capitalization as business warrants. Shares already have been subscribed by the British and American directors, but additional shares will be offered to the public in accordance with the terms of the concession. Among the American directors are Felix Warburg and Bernard Flexner of New York.

Although the start necessarily will be slow, the company is bound by its concession to produce at least 50,000 tons of potassium chloride annually after the tenth year. The work will be carried out by means of huge drying tanks built on the hills on each side of the mouth of the Jordan.

The water of the Dead Sea, which is 300 feet below sea level, is said to be among the world's richest repositories of valuable salts, and potash is expected to become one of Palestine's most important products. The potash will be taken by motor truck to Jerusalem and thence to Haifa by rail for export.

Automatic Control of Gasoline Plant

THE chemical engineer is not slow to adapt the ingenious devices of the electrical and mechanical engineer to his own problems, thus providing automatic control for the operations with which he is concerned. Often, a few degrees variation in temperature will make the difference between success and failure in a chemical reaction, so the automatic thermostat is called into use to keep its tireless vigil over many a vat, still, or digester. An equal degree of mechanization is now being realized in the control of pressure. Thus, for example, in the recovery of gasoline from natural gas, a very careful control of pressures in pipe lines and towers is essential. J. V. Thomas, in a recent issue of *Chemical and Metallurgical Engineering*, describes the almost human devices which take the place of manual control in plants of this kind.

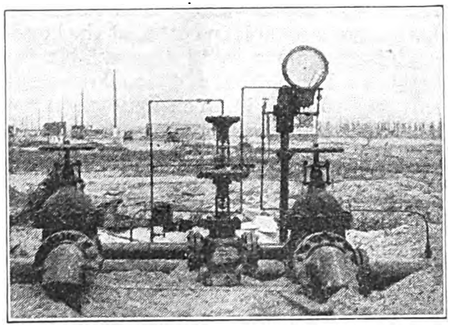


These pressure regulators, liquid level controllers, and temperature controllers are used in automatically maintaining a stabilizing column in a gas plant

Not only are pressures and temperatures controlled automatically, but liquid-level controllers maintain constant levels in tanks and absorption towers.

Mystery of Poison Island Solved

WHEN a large number of workmen, engaged in building a new power plant for the Duquesne Light Company, on Brunot Island in the Ohio River near Pittsburgh, were mysteriously overcome on the job, the engineers decided it was time to call in the chemists. A hurry call to the United States Bureau of Mines, Pittsburgh Experiment Station, brought a corps of specialists equipped with breathing apparatus, gas masks, and gas detecting devices. On arriving at the construction project, it was found that the employees affected by gas had been overcome or partially overcome while changing clothes in a change-house before going to work. Tests made by the Bureau of Mines safety engineers with a carbon monoxide detector showed that there was approximately 1 to 2 percent of carbon monoxide in the atmosphere of the building.



Automatic regulator used in gas line to reduce the pressure from 250 to 5 pounds, and maintain it

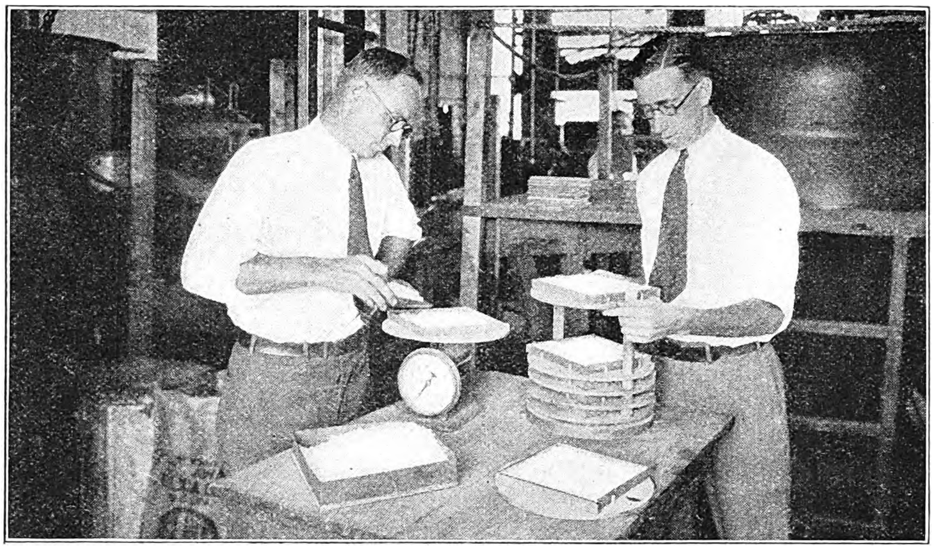
Investigation as to the source of carbon monoxide disclosed one of the most novel occurrences of the gas that has ever come to the attention of the Bureau of Mines specialists. The entire upper end of the island has been formed by the dumping of cinders from a boiler plant operated for a period of at least 20 years. This bed of cinders and ashes is at least 40 feet in depth in various places. Various sections of this cinder-ash field had been on fire as recently as two or three months previous. Thus a great area was giving off carbon monoxide, the formation of the deadly gas from the cinders being similar to the formation of water gas.

An intake tunnel was being constructed under the cinder-ash field, and the compressed air from the tunnel, under about 7½ pounds pressure, was being forced up through the cracks and the interstices similarly to the passage of air through a blacksmith's blower. This air movement increased the production of carbon monoxide, the formation of which was also considerably aided by the melting of a fairly heavy snow followed by rain, resulting in little or no air movement on the surface. The change-house in which the employees were overcome was located several feet from the site of the tunnel, illustrating the widespread distribution of the carbon monoxide.

Electrocute Methane to Form Acetylene

AT the Kaiser-Wilhelm Institute für Kohlenforschung, Germany, chemists have developed an "electrocuting" apparatus through which they pass a gas such as methane, whereupon it emerges as acetylene. Almost any of the hydrocarbons, when subjected as gases to the "shocking" effect of this electrical device are converted to something else, indicating that the effect of the discharge is to blow the molecules of gas into atoms which then rearrange themselves into new combinations, something like a game of electrochemical puss-in-the-corner.

Of the several kinds of electrical discharges which have been applied to chemical reactions, the most important from the practical standpoint are the arc, the silent discharge, and the low-pressure discharge. The arc process has been used, notably in Norway, for the conversion of the nitrogen in air into nitric acid. Another use of the arc discharge in chemistry is the production of carbon black and acetylene from



Weighing quartz crystals in the trays in which they will be melted to form window panes, and loading the trays on the holder for the electric furnace

hydrocarbon gases. The silent electric discharge is useful for its polymerizing effect and for activating gases. Its industrial use is limited by low yield and low current density. Low-pressure discharge gives a useful means of effecting endothermic and ionic reactions at relatively low temperatures.

The Germans have now found that not only methane but the higher hydro-carbons (naphthalene, anthracene, petroleum oils, and even pitch) can be converted into acetylene by a low-pressure discharge. In the presence of nitrogen, prussic acid can be obtained. Removal of products as formed makes possible excellent yields in the laboratory trials. Production on a commercial scale has not yet been accomplished, but energy relations and other considerations which affect costs do not indicate any fundamental obstacles.

Making Glass Which Passes Health-giving Rays

WHILE it is only recently that electrical manufacturers have developed lights which artificially produce the health-giving rays formerly available only in natural sunlight, nevertheless, the beneficial effects of these rays has been known for centuries. The ancient Egyptians were familiar with the benefits of sunlight.

The importance of ultra-violet rays of the sunlight to health and the fact that ordinary window glass cuts out nearly all of these beneficial rays has long been recognized. Several years ago Professor Elihu Thomson, director of the General Electric's great research laboratory at Lynn, Massachusetts, took up the work of developing a material which would transmit the health rays, to replace window glass. Fused quartz was known as the best medium for the purpose but to make window panes of it was a problem that required years to solve. The difficulties of making quartz windows can be appreciated when it is realized that the melting point of quartz approaches a temperature of 3200 degrees Fahrenheit, about three times that of glass. Moreover, it is extremely viscous, or thick. Many methods were investigated and special furnaces were developed before the engineers finally succeeded in making quartz in sheet form, and at a reasonable cost.

One of the first methods developed to produce a high quality quartz glass consisted in fusing, in a vacuum, specially selected and treated quartz crystals in a square fabricated graphite box, and pressing the fused mass of quartz at 1000 pounds per square inch while in the molten state. A block of quartz 8 by 5 by 5 inches was thus obtained. This block when cooled was sliced into sections one eighth inch thick and each pane was ground and polished by hand.

This method of manufacture was considered too expensive for common use, and further research was carried on to get a satisfactory quartz window that would be sufficiently reasonable in cost that the benefits of fused quartz could be available for more general use. This additional development work resulted in an entirely new process which cut the cost of manufacture to about one fifth of previous costs and made it feasible to use quartz in large solariums.

In the present process, quartz crystal, crushed to one quarter inch mesh, is fused in a vacuum on flat graphite disks between thin graphite slabs in the form of a 7½ inch square. A number of these trays are stacked in a form and placed in a high-temperature furnace. When the quartz is fused, nitrogen gas is admitted to the furnace at a pressure of 150 pounds per square inch to compress the bubbles. The resulting quartz plates, upon cooling, require only squaring of the edges by grinding. The plates themselves are 7½ inches square by one quarter inch thick. This new method does away with cutting, grinding, and polishing each pane, and the trays can be used a number of times.

United States Alcohol Consumption only Half Capacity

ETHYL alcohol ranks first in quantity and value of production of all organic chemicals. It is a basic raw material in the chemical and process industries and finds application in a multitude of products: An approximate distribution of denatured alcohol by uses is as follows:

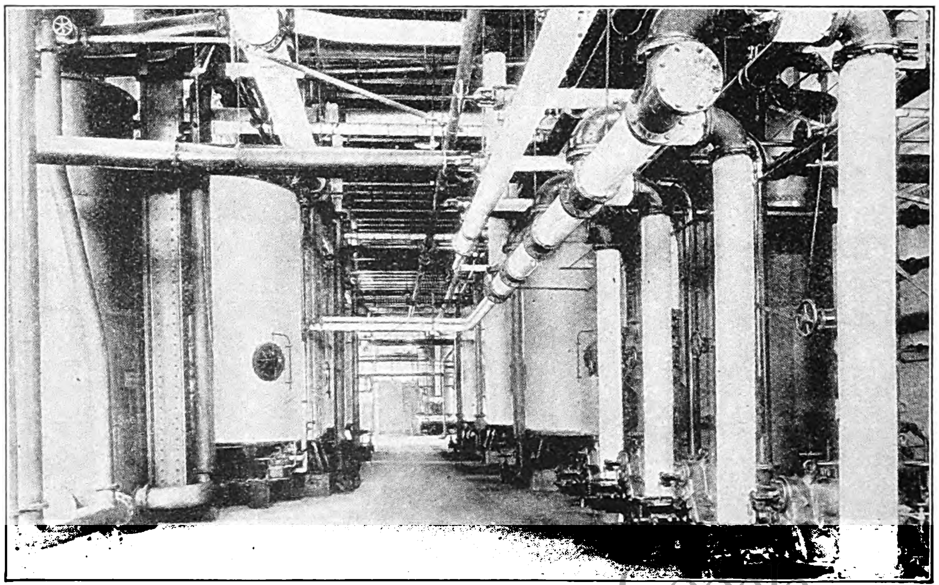
	Wine Gallons
Anti-freeze	40,000,000
Cellulose industries	25,000,000
Shellac and varnish	8,000,000
Toilet and perfume preparations	5,000,000
Miscellaneous	15,000,000

The total available capacity in the United States for producing alcohol, says W. N. Watson, of the United States Tariff Commission, writing in a recent issue of *Chemical and Metallurgical Engineering,* is about 220,000,000 wine gallons, of which about 15,000,000 wine gallons is for production from grain, and the balance, 205,000,000 wine gallons, from molasses. The annual consumption is about 100,000,000 wine gallons, or somewhat less than one half the present capacity. The capital invested in molasses alcohol plants is about 55,000,000 dollars and in grain alcohol plants about 5,000,000 dollars.

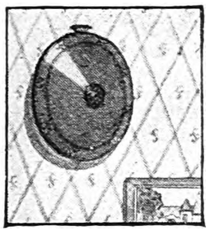
In the manufacture of alcohol from corn, the by-products consist of distillers' grains, a valuable cattle feed, which has sold in recent years for from 35 to 45 dollars per ton, or on an average of about 2 cents per pound. Each bushel of corn gives about 12½ pounds of distillers' grains. In addition, fusel oil is another by-product of small importance, and in certain cases, corn oil and corn-oil meal are obtained.

It is estimated that if all the alcohol produced in America were made from corn,

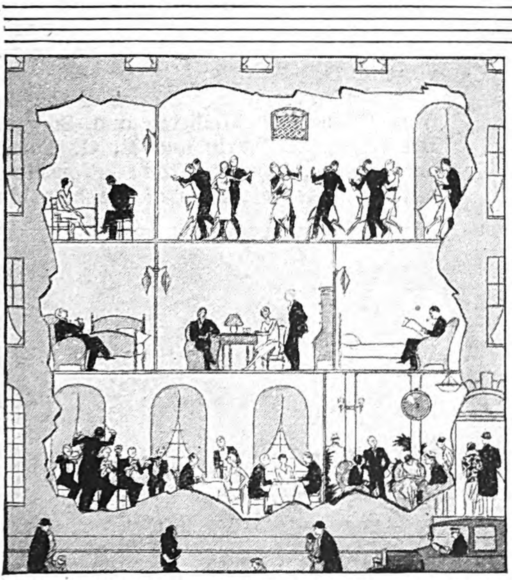
(*Please turn to page* 483)



Evaporators in a modern industrial alcohol plant



BUILT-IN-MUSIC



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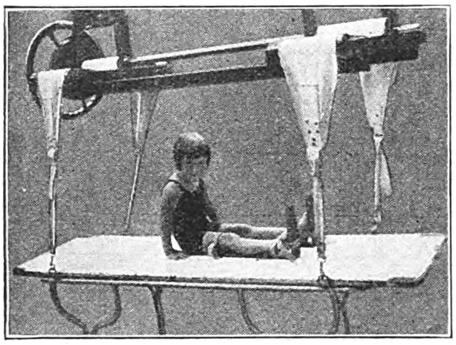
The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

The Care of the Crippled

WITHIN the last few years special attention has been paid throughout the world to the use of the swimming pool method for developing and educating tissue that has lost its function through infantile paralysis. Among the leaders has been the Orthopedic Hospital of Los Angeles. There a special pool was built in which all forms of paralysis are treated. The chief values of the pool treatment seem to be the greater ease and freedom of movement in painful conditions, the easier handling of painful joints and easier development of weakened muscles, the fact that the water bears the weight, the enjoyment and interest, and the special value of the baths on the general morale of the patient.



Traveling hoist with hand control. New apparatus for carrying patients will be electrically controlled

In developing a pool particularly for this purpose, arrangements have been made for carriers which deliver the patient at the pool and for special sprays to clean the patient before entering the pool and on leaving. Foot baths are provided and cleanliness is carefully controlled by chlorination, and by the use of copper salt for algae. Metal equipment is made of bronze, chrome nickel or enamel so that it will not be corroded by the chlorine in the water.

Special tables have been arranged which allow the head and shoulders of the patients to be supported out of the water, and permit the attendants to manipulate the tissues while the patient is in the water.

As may well be imagined, such special equipment is exceedingly costly, but it is of value in the relief of pain and the cure of defects, which makes cost a secondary consideration.

First-Aid for Motorists

APPARENTLY European countries are far beyond our country in anticipation of the difficulties associated with modern tourists and their safety. France has had established for some time a series of first-aid stations along many of the highways. The Red Cross Society of Belgium established its first-aid stations three years ago and now has a complete series of them in working order along the roads from Brussels to Ostend, Antwerp, Liege, and Namur.

Because of the tremendous number of roadside accidents in this country, the American Red Cross might give serious consideration to this work. Persons who are injured are usually carried by the first passerby to some hospital. Hospitals are dubious about taking care of such patients, particularly when they come from outside the state, and the whole problem of responsibility for the care of the patient is in doubt.

Operations on the Heart

IT is not so long ago that any operation on the human heart was considered invariably fatal. With gradual improvement in methods of operation and in the use of anesthetics attempts were made to do various surgical operations involving the vital organ. In this country men have had wounds of the heart sewed up, a bullet has been removed from the heart, and in one instance the heart was opened, a constricted valve cut, and the patient recovered.

In a recent meeting of the Vienna Medical Society several interesting cases were presented in which operations had been performed on the heart. In one case a man was stabbed and when the patient was opened the wound was found to have penetrated the outer covering of the heart and the heart itself. The heart had apparently stopped beating. The space between the outer covering of the heart and the heart itself was filled with blood clots. The sac was opened and the blood clots were removed, whereupon the heart began to beat. The heart was sewed, the outer covering was sewed, and the wound in the chest closed.

Another instance was reported in which a bullet had penetrated the heart. When the body was opened and the heart examined, an opening was found into the heart, but no exit opening was found. The opening was closed and during the operation the heart stopped. After massage it began beating again. The use of the X-ray some three months later showed the projectile buried in the tissue of the heart, but the patient up to that time had not suffered any unusual symptoms.

Hospitals of the United States

ONE of the most interesting phenomena of the last quarter century has been the rise of hospital care in this country. There are today 6665 reputable hospitals providing 907,133 beds and 47,939 bassinets. This is an increase of 486,068 beds or 115.4 percent since 1909. The average number of people constantly in hospitals in 1929 was 726,766. There are approximately 150,000 physicians in this country, of whom about 125,000 are in practice. It is almost impossible to realize that 98,491 doctors have connections with hospitals and indeed 84,579 are actually attending in such institutions.

Sinus Infection and Vitamins

IT has long been known that vitamin A deficiency produces an inflammation of the eyes. More recently it has been quite definitely shown that vitamin A is related to the resistance of the human body against infection. Following a deficiency of vitamin A in the diet, rats develop inflammations of the eyes, infections of the nasal passages and sinuses, of the ears, the tongue, and even of the lungs. Most investigators are now convinced that the value of cod-liver oil in preventing colds, if it has any such value, is due to the vitamin A in the cod-liver oil and not to the vitamin D.

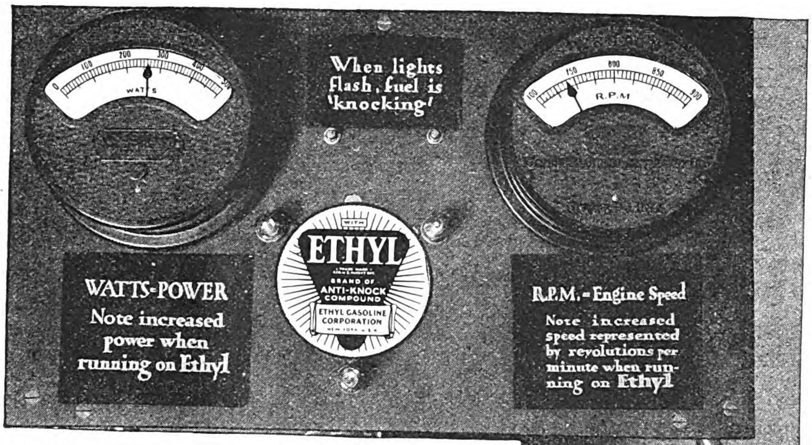
In the research laboratories of the Detroit College of Medicine and Surgery, Drs. Burt R. Shurly and R. G. Turner made a special study of the relationship of vitamin A to infections of the breathing tract, and particularly of the sinuses. They made a special study of the bacterial organisms found in animals which had been on vitamin deficient diets. They found certain organisms in such cases which were especially virulent.

Hoist for transporting patients between pool and dressing room

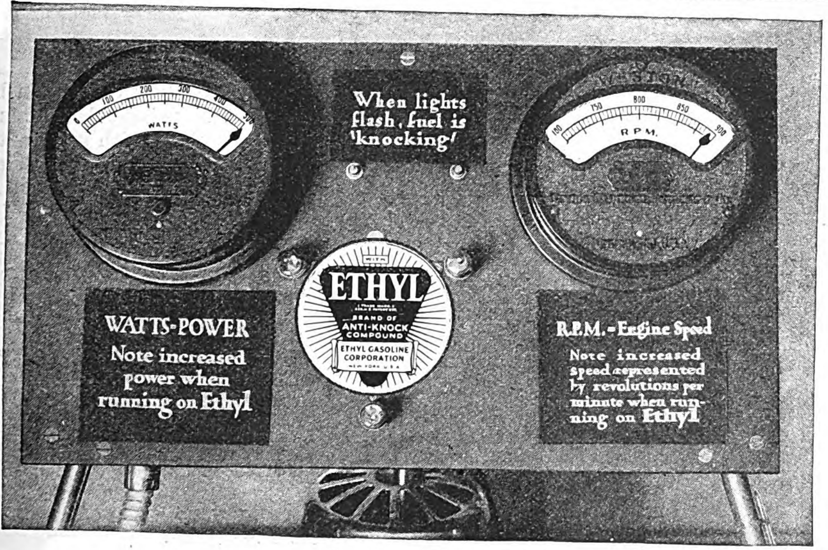
In the University of Iowa, in 1916, Doctors Daniels and Armstrong showed that deficiencies in diets encouraged infection of the sinuses as well as of the ear. There seems to be no doubt that deprivation of vitamin A permits germs to exercise extraordinarily virulent effects.

The *proof* that Ethyl develops more power

Right: This is the instrument board of a knock-demonstration machine. The wattmeter (at the left) registers power. The tachometer (at the right) records engine revolutions per minute. When this picture was made, the engine was running on ordinary fuel.


WATTS
R.P.M.
When lights flash, fuel is 'knocking'
ETHYL
BRAND OF ANTI-KNOCK COMPOUND
ETHYL GASOLINE CORPORATION
WATTS-POWER Note increased power when running on Ethyl
R.P.M.-Engine Speed Note increased speed represented by revolutions per minute when running on Ethyl

Below: When the lower picture was taken, Ethyl had been fed into the carbureter. The wattmeter shows that the power has risen to the maximum; the tachometer shows a corresponding increase in revolutions per minute.


WATTS
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When lights flash, fuel is 'knocking'
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BRAND OF ANTI-KNOCK COMPOUND
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WATTS-POWER Note increased power when running on Ethyl
R.P.M.-Engine Speed Note increased speed represented by revolutions per minute when running on Ethyl

GOOD GASOLINE plus ETHYL FLUID equals ETHYL GASOLINE

"Knocks out that 'knock'"

ETHYL
GASOLINE

"SEEING is believing." These pictures of a knock-demonstration machine let you *see* how Ethyl Gasoline will increase the speed and power of your motor.

A simple valve switches the fuel from ordinary gasoline to Ethyl and back again. When Ethyl goes in, "knock" goes out, R. P. M.'s (engine revolutions per minute) increase, power goes up. That is how Ethyl improves motor car performance.

The Ethyl anti-knock compound in Ethyl Gasoline makes the difference. This remarkable fluid was developed by General Motors Research Laboratories after years of experiment to find an ingredient which would make gasoline a better fuel. Make this convincing experiment in your own car. Use up the ordinary gasoline in the tank; then fill up with Ethyl. You'll see and feel the difference.

* * *

Wherever you drive—whatever the oil company's name or the brand associated with it—*any* pump bearing the Ethyl emblem represents quality gasoline of anti-knock rating sufficiently high to "knock out that 'knock'" in cars of average compression and bring out the additional power of the new high-compression cars. Ethyl Gasoline Corporation, Chrysler Building, New York City.

© E. G. C. 1930

The active ingredient used in Ethyl fluid is lead

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Axe Manual of Peter McLaren (America's champion chopper). Axemanship as sport and as an art; how to handle an ax expertly and how not to; how to conduct a chopping contest, a new outdoor sport; how to put an edge on an ax scientifically. 84 pages illustrated. *Fayette R. Plumb, Inc., Philadelphia, Pa.—25 cents.*

Tests of Large Timber Columns and Presentation of the Forest Products Laboratory Column Formula, by J. A. Newlin and J. M. Gahagan. (Technical Bulletin No. 167, Department of Agriculture). The authors have made a valuable contribution to timber mechanics. *Superintendent of Public Documents, Washington, D. C.—15 cents, coin.*

Indian Corn, by James B. McNair. A 33-page summary of information on our largest crop plant. Origin of corn; how Indians used it; modern industrial and experimental products such as starch; uses of corncobs (corncob flour, wood sugar) and of stalks (syrup, wall board, paper, artificial silk). *Field Museum of Natural History, Chicago.—Ten cents.*

Permissible Explosives — Information concerning their characteristics and their use in gassy and dusty coal mines. *E. I. du Pont de Nemours Co., Wilmington, Del.—Gratis.*

Sand and Gravel in 1928, by Estelle R. Phillips (Excerpt from Mineral Resources of the United States). Gives complete statistics of the industry. *Superintendent of Documents, Washington, D. C.—5 cents, coin.*

Pullman Progress 1859–1929. A very attractive folder giving eight pictures in color of sleeping cars at various periods. Valuable for schools. *The Pullman Company, Chicago, Ill.—Free to teachers.*

Alleghany Portage Railroad. Interesting pamphlets on the forerunner of the Pennsylvania Railroad. *Publicity Bureau, Pennsylvania Railroad, Broad Street Station, Philadelphia, Pa.—Gratis.*

Port of Hamburg (Foreign Port Series No. 1, Department of Commerce). Contains maps and 300 pages of information, bound in buckram. *Superintendentent of Documents, Washington, D. C. One dollar, money order.*

Port of Liverpool. (Foreign Port Series No. 2, Department of Commerce). Contains 300 pages giving full information. There are maps, and it is bound in buckram. *Superintendent of Documents, Washington, D. C.—One dollar, money order.*

Upper Colorado River and its Utilization. (Water Supply Paper No. 617 of the U. S. Geological Survey). It is of special interest to engineers and agriculturists concerned with projects in this district. *Superintendent of Documents, Washington, D. C.—65 cents, money order.*

Tobacco and Its Use in Africa by Berthold Laufer, Wilfrid D. Hambly, and Ralph Linton, is illustrated with drawings showing the many novel types of smoking equipment used by the natives in Africa. *Field Museum of Natural History, Chicago.—25 cents.*

Yukon: the Land of the Klondike is a 46-page illustrated booklet showing the great changes that have taken place in the Yukon Territory since the storied days of '98. Both scenic attractions and industrial development are covered in the booklet. *Department of the Interior, Ottawa, Canada.*

For Home Lovers is the title of a new booklet illustrating houses of a wide variety of types, with floor plans and sketches showing construction details. *National Lumber Manufacturers Association, Transportation Building, Washington, D. C.—Gratis.*

Roman Surveying Instruments, by Edward Noble Stone, is an illustrated short general description of the principal instruments used by Roman engineers in land-surveying and leveling, in laying out sites for camps and towns, and in the construction of roads and aqueducts. The descriptions and line drawings will prove interesting to present-day surveyors and engineers, as well as to students of Roman antiquities. *University of Washington Press, Seattle, Washington.—75 cents.*

The New News is a significant study of journalism and its place in the life of a great nation, particularly from the viewpoint of the advertiser. The publication is also interesting typographically, and presents some striking reproductions from line plates depicting modern America. *The United States Daily, Washington, D. C.—Gratis.*

Year Book for 1929. Carnegie Institution of Washington. Summary of a single year's research in archeology, biology, chemistry, genetics, history of science, mathematics, meteorology, nutrition, paleontology, physics, physiology, seismology and others, conducted at the subordinate laboratories of this vast institution, each piece of research being described in a technical abstract. *Carnegie Institution of Washington.—One dollar.*

Journal of the Society of Motion Picture Engineers; published monthly, contains many important engineering papers on various topics pertaining to the technical improvement of motion pictures. *Secretary, Society of Motion Picture Engineers, 5th and Sussex Streets, Harrison, N. J.—$1.50 per copy to non-members.*

How the 13-Period Calendar Works in Business, is a leaflet containing the views of executives of many prominent corporations which have adopted the use of the revised calendar. *National Committee on Calendar Simplification, 343 State Street, Rochester, New York.—Gratis.*

National Physical Laboratory Report for 1928. Detailed 270-page account of researches performed at Britain's institution corresponding to the United States Bureau of Standards. *His Majesty's Stationery Office, London, England.—9 shillings net.*

Great Britain and Ireland, Calendar of Historic and Important Events 1930 is a little booklet printed in black and red giving the principal events month by month together with information useful to travelers. *The Travel Association of Great Britain and Ireland, Kinnaird House, 1 Pall Mall East, London, S. W. 1, England.*

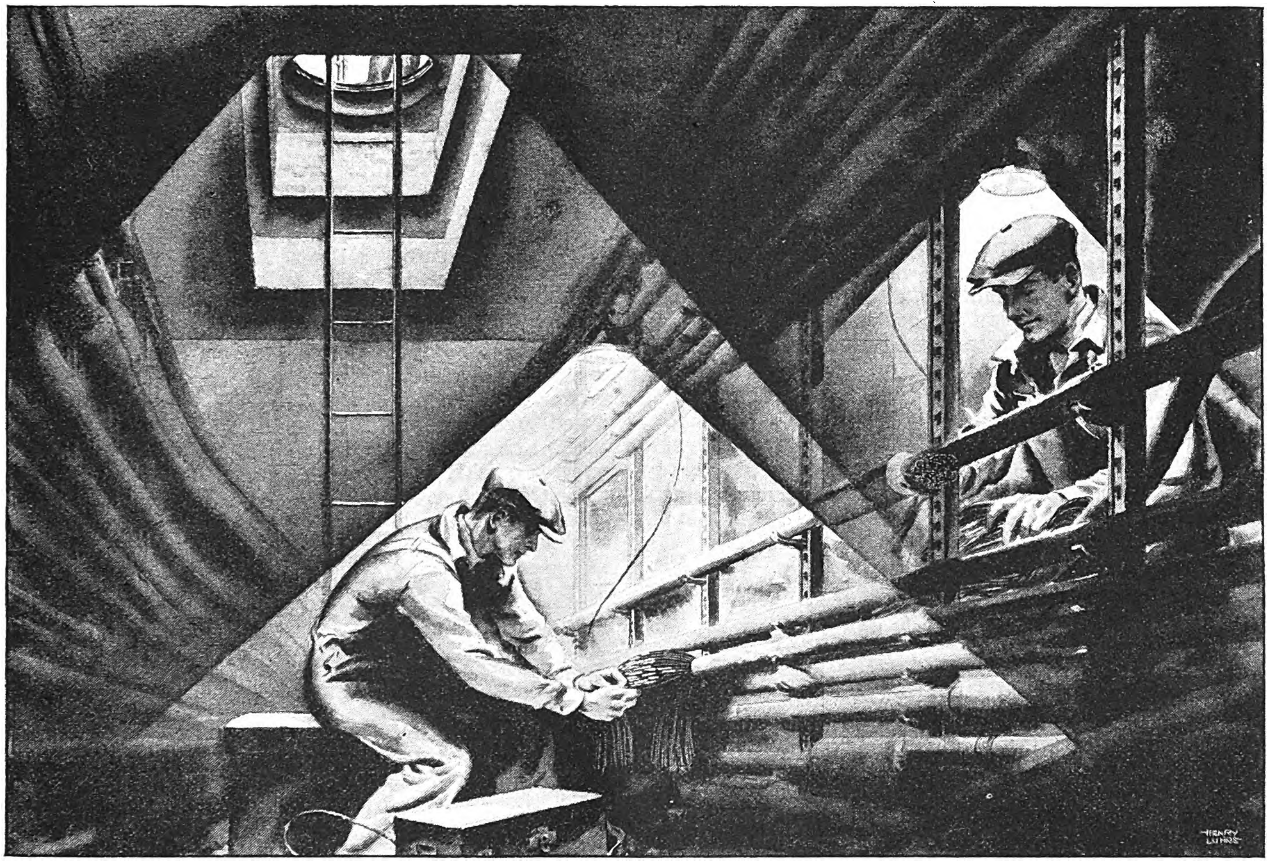
Nickel-Chromium Steels for High Temperature Service Valves and Bolts, by V. T. Malcolm. *The International Nickel Co., 67 Wall Street, New York City.—Gratis.*

Safety Rules, a pamphlet on safety in factories issued by the General Electric Co., Schenectady, New York. *Address G. E. Sanford, Chairman of the Safety Committee, 1 River Road, Schenectady, N. Y.—Gratis.*

Safety Precautions When Handling Acids, Alkalies and Poisons. General Electric Company, Schenectady, N. Y. *Address G. E. Sanford, Chairman of the Safety Committee, 1 River Road, Schenectady, N. Y.—Gratis.*

Safety Rules for Men Handling Electric Circuits or Apparatus. General Electric Company, Schenectady, N. Y. *Address G. E. Sanford, Chairman of the Safety Committee, 1 River Road, Schenectady, N. Y.*

Rayon as a Paper-Making Material, by Merle B. Shaw and George W. Becking, (Research Paper No. 143) is a reprint from Bureau of Standards Journal of Research. The test data indicates that rayon is valueless in the rag stock for high-grade papers and may actually be detrimental to their quality.—*Superintendent of Documents, Washington, D. C.—5cents, coin.*



THE INCREASING USE OF THE TELEPHONE REQUIRES THE EXPENDITURE OF HUNDREDS OF MILLIONS ANNUALLY FOR EXTENSIONS AND IMPROVEMENTS

It keeps faith with your needs

An Advertisement of the American Telephone and Telegraph Company

You have found a constantly growing use for the telephone. You have learned its value in business. You have found it helpful in keeping contact with family and friends. Its increasing use has given the telephone its humanly important place in modern life and requires the expenditure of hundreds of millions annually for extensions and improvements.

In 1929 the Bell System's additions, betterments and replacements, with new manufacturing facilities, meant an expenditure of 633 million dollars. During 1930 this total will be more than 700 millions.

Definite improvements in your service result from a program of this size and kind. They start with the average time required to put in your telephone—which in five years has been cut nearly in half. They range through the other branches of your service, even to calls for distant points—so that all but a very few of them are now completed while you remain at the telephone.

In order to give the most effective, as well as the most economical service, the operation of the Bell System is carried on by 24 Associated Companies, each attuned to the part of the country it serves.

The Bell Laboratories are constantly engaged in telephone research. The Western Electric Company is manufacturing the precision equipment needed by the System. The staff of the American Telephone and Telegraph Company is developing better methods for the use of the operating companies. It is the aim of the Bell System continually to furnish a better telephone service for the nation.

The Amateur Astronomer

A Monthly Department

THE reader who decides to take up the home hobby of building and using an astronomical telescope—grinding and polishing his own glass optical parts and becoming one of a growing host of amateur astronomers—is urged to tackle nothing larger for his first effort than an instrument of six-inch diameter. Such a telescope will, however, magnify 50 to 200 diameters, depending on conditions. At a cost of about 25 dollars for materials (which can be obtained in a "set," that is, ready-to-use), if he possesses only average handiness he can make an instrument equaling in performance one he might purchase for 500 dollars. Hundreds of our readers scattered far and wide already have done this, using the practical working instructions in the SCIENTIFIC AMERICAN book "Amatuer Telescope Making," where numerous types are clearly described.

MR. W. L. Chamberlain, 519 Liberty Street, Meriden, Connecticut, sends in a photograph of his telescope and writes as follows:

"A talk on telescope making by one who had made a very successful telescope himself, inspired me to attempt the same thing. A friend loaned me a copy of 'Amateur Telescope Making,' and after securing glass disks and other materials, a start was made. The photograph submitted shows the finished instrument, a six-inch Newtonian reflector of 48-inch focal length.

"In grinding the mirror mistakes were made, as is usual with the novice, but the work proved to be so fascinating that the extra time required to make corrections was not regretted, for it was a good schooling in the art.

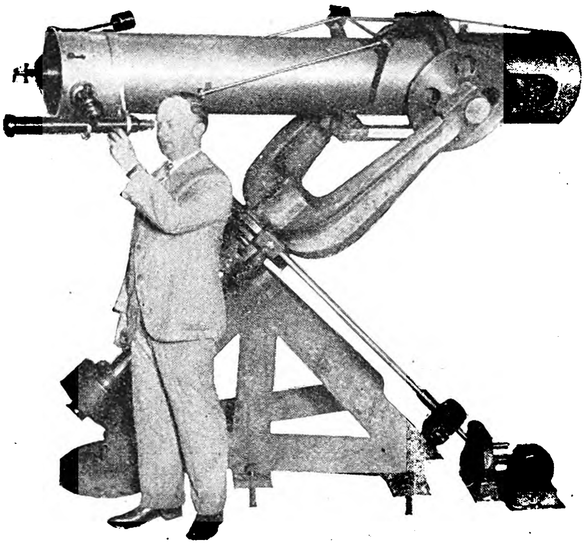
"Not wishing to be confined to a post and one location, it was decided to make the mounting of the alt-azimuth type, so that a tripod could be used as well. The sockets for the fork stem are identical on each. The fork, which has an offset angle, allows the tube to clear the post when directed at the zenith. The whole sky is seen.

"The post is an iron pipe 3½ inches in diameter, surmounted by a metal ball which just fits the inside diameter of the pipe. This ball is drilled and tapped for a short piece of steam pipe which makes the fork socket, and is held in place by three pointed set screws which are inserted through threaded holes near the top edge of the post into countersunk holes in the ball, one half of which protrudes out of the post. Two of these set screws are placed so that they form an axis on which the ball socket tube can be tilted over toward *Polaris*, thus forming a polar axis by which the telescope can be converted quickly into an English equatorial. The third set screw locks the ball in either position. The fork has two removable pins at the angle which, being reinserted in other properly located holes, straightens the fork as is usual in equatorial mounts.

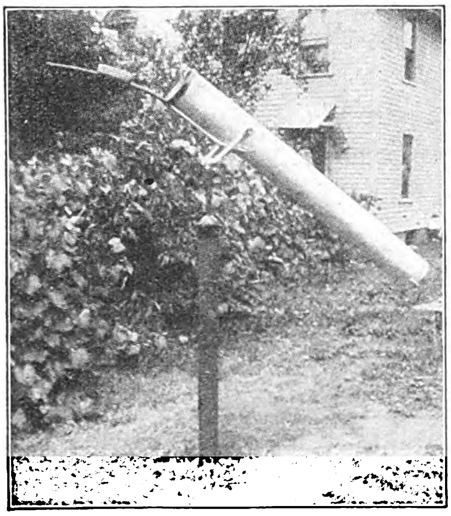
"When the telescope is used as an alt-azimuth, the eyepiece is inserted in the end of the declination axis. This gives the observer the great satisfaction of always having the eyepiece at the same height from the ground no matter where the telescope is pointed, and always directly above the post. This makes it possible to use a detachable bicycle seat on the post.

"The performance of the instrument exceeds my expectations. The definition is good. With my strongest eyepiece, estimated, with my focal length, to give 90 diameters magnification, the components of *Zeta* in Ursa Major are thrown wide apart, that is, *Sidus*, *Alcor*, and *Mizar;* and then the larger component *Mizar* is again split up into a close but clearly defined double. Star cluster M13 in Hercules gives momentary glimpses of individual components.

"I want to say a good word for honeycomb foundation strips in bringing up a low center when figuring a mirror. It is a most valuable addition to the possible methods of doing it."



Mr. Patton and his one-ton telescope



Chamberlain's reflector

AN interesting, though brief, letter has been received from Mr. G. O. Neser, Senior Science Master at the Boys' High School at Paarl, South Africa. He writes:

"Sir:

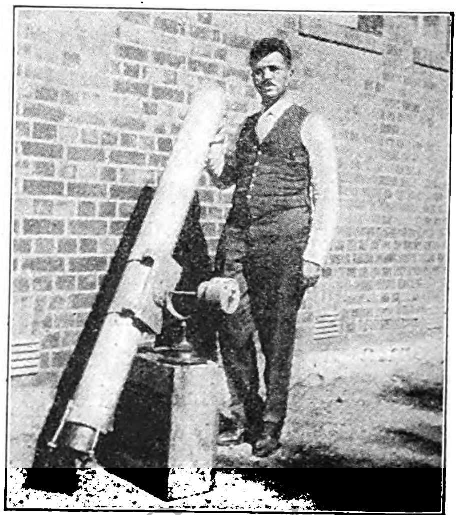
"As I recollect seeing only one photo of a South African amateur's telescope published in your journal, I am sending you a snap of my reflector. It has a six-inch mirror, focal length fifty-two inches, and is mounted temporarily and rather precariously as shown.

"I am very much indebted to the SCIENTIFIC AMERICAN for initiating me into the mysteries of mirror making. I am starting on a 10-inch one shortly. Kindly have your book department forward me a copy of the latest edition of 'Amateur Telescope Making'."

MANY amateur telescope makers have jumped from six inch to eight or ten inch size on their second instrument, or even to larger sizes. Few have jumped quite so far, however, in refinement of mounting, as Mr. Ralph C. Patton of the Patton-Macguyer Co., Baker Street and Virginia Avenue, Providence, Rhode Island, makers of stampings and novelties. At our request Mr. Patton has prepared the following description of his instrument:

"The telescope shown in the illustration has a clear aperture of 12 inches and a focal length of about eight feet. The mounting is of the English fork type, which is inherently balanced without counterweights. A tapered cylindrical aluminum casting, threaded inside throughout its length to break up light reflection, forms the main tube, and is forced into the short cast-iron barrel which acts as the lower end of the tube. This barrel is also threaded inside, so that no part of the interior presents a reflecting surface.

"The cast-iron fork has a tight, forced fit on the end of the polar axis. The latter is made of chrome vanadium steel,



Made in South Africa

heat treated and ground to exact size.

"The principal mirror is about 12¼ inches outside diameter, and is about two inches thick. It weighs 20 pounds and is mounted in a revolvable cell, with three sets of push-and-pull screws for adjustment. The revolving feature was devised so that true axial alinement of the mirror could be determined readily.

"The sky end of the tube has a cast-aluminum revolving head, carrying eyepiece and finder to insure a comfortable position for the observer, regardless of the altitude of the object being observed. The finder has a two-inch aperture.

"Five eyepieces are provided, and these can be used interchangeably in the finder or main telescope. In the latter they give magnifications varying from 64 diameters to 500.

"The mounting has closely divided circles, and is provided with clamps and slow motions for both declination and right ascension motions. The principal right ascension dial is rotated continuously during observation by means of a synchronous induction motor, which drives it through three sets of worm reduction units, having a combined ratio of more than 2,500,000 to 1.

"In using a synchronous motor drive for a telescope, it is necessary to interpose a pair of meshed gears having respectively 365 and 366 teeth, in order to change mean solar time into sidereal time. These have helical teeth to reduce vibration.

"The frame which carries the main tube is provided with two precision spirit levels for zenith setting. The declination axis and the polar axis run in eight ball bearings, which are protected from dust by felt washers within brass guards. All gearing is totally enclosed and runs in grease.

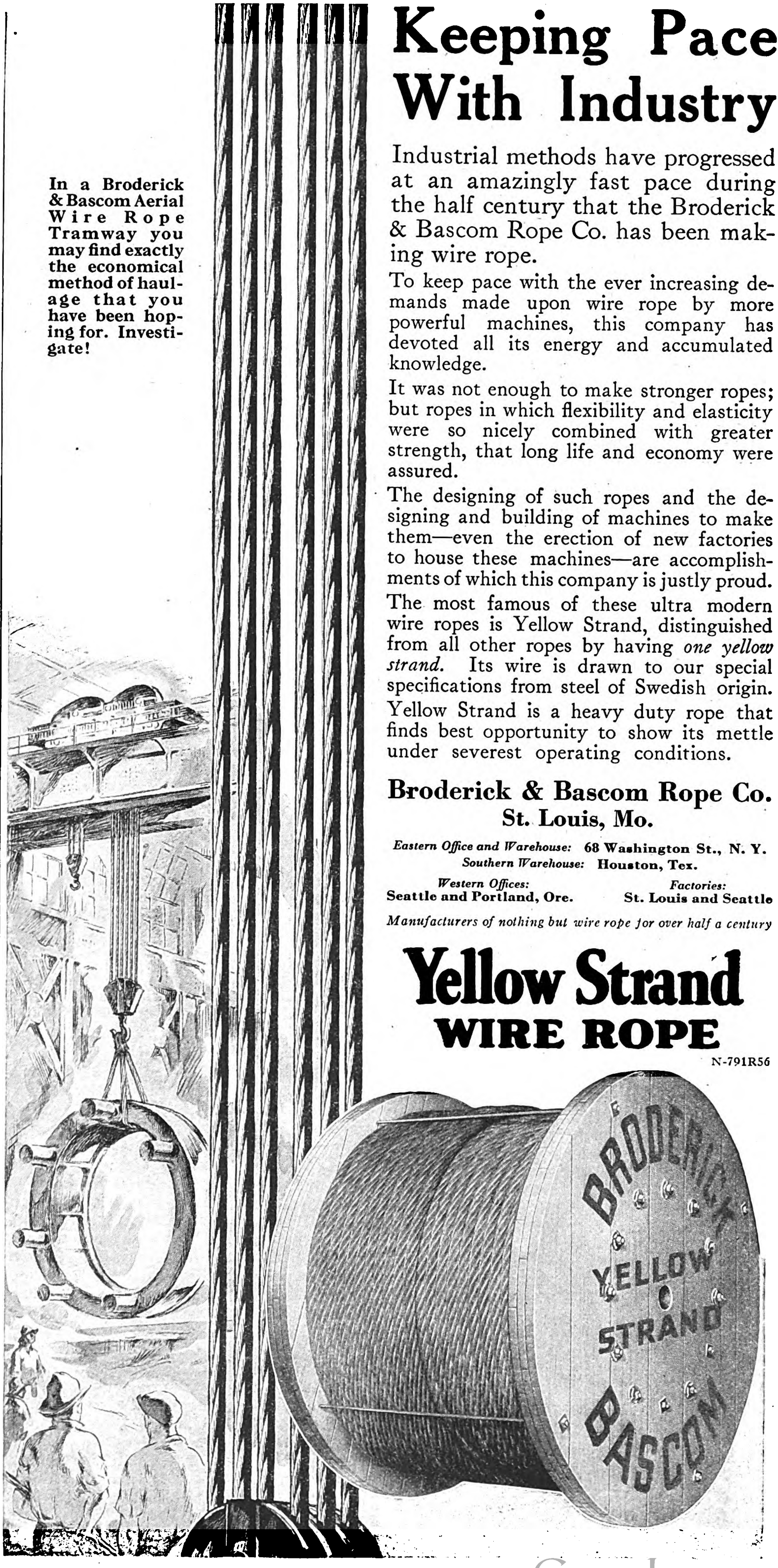
"The approximate weights of the principal parts are: base 1060 pounds; fork 410 pounds; polar axis shaft 104 pounds; assembled tube in ring with trunnions, mirror, cell, finder, and so on, 492 pounds; the total weight being over a ton.

"The telescope is housed in a sliding roof observatory, 15 feet by 18 feet, and the roof, which weighs about 2600 pounds, is moved on and off the building by a small electric motor, operating through sprockets, racks, and pinions.

"The telescope was designed, constructed and built in about two years. The mirrors were furnished by Mr. Wilbur Perry, of Springfield, Vermont. Inspiration for the work was furnished to a great extent by your book 'Amateur Telescope Making.'"

Amateur telescope makers may be surprised to learn that the first man to see the image of the new trans-Neptunian body on the photographic plate at Lowell Observatory was one of their number, Mr. Clyde W. Tombaugh. When the find was announced all the newspapers told how Tombaugh had made a telescope. Suspecting he might have used "Amateur Telescope Making" as his guide we looked in our file of purchasers, which is arranged by states, and found that he purchased the book in 1926. A wire brought from him the reply, "I used 'Amateur Telescope Making' in the construction of my telescope." Apparently, however, when he made his telescopes he never sent in a picture of the instruments for publication.

In a letter he now tells us that he has been swamped with correspondence since the discovery was made but appreciates



In a Broderick & Bascom Aerial Wire Rope Tramway you may find exactly the economical method of haulage that you have been hoping for. Investigate!

Keeping Pace With Industry

Industrial methods have progressed at an amazingly fast pace during the half century that the Broderick & Bascom Rope Co. has been making wire rope.

To keep pace with the ever increasing demands made upon wire rope by more powerful machines, this company has devoted all its energy and accumulated knowledge.

It was not enough to make stronger ropes; but ropes in which flexibility and elasticity were so nicely combined with greater strength, that long life and economy were assured.

The designing of such ropes and the designing and building of machines to make them—even the erection of new factories to house these machines—are accomplishments of which this company is justly proud.

The most famous of these ultra modern wire ropes is Yellow Strand, distinguished from all other ropes by having *one yellow strand*. Its wire is drawn to our special specifications from steel of Swedish origin.

Yellow Strand is a heavy duty rope that finds best opportunity to show its mettle under severest operating conditions.

Broderick & Bascom Rope Co.
St. Louis, Mo.

Eastern Office and Warehouse: 68 Washington St., N. Y.
Southern Warehouse: Houston, Tex.
Western Offices: Seattle and Portland, Ore.
Factories: St. Louis and Seattle

Manufacturers of nothing but wire rope for over half a century

Yellow Strand
WIRE ROPE

N-791R56

DR. DICKEY TO SEEK SOURCE OF ORINOCO
Party to Take Store of Trinkets to Win Over Savages, Who Have Thwarted Five Expeditions.

ANOTHER FAMOUS EXPLORER CHOOSES THE LEICA CAMERA

Because of its compactness and unfailing service on an instant's notice, Leica, the universal camera, was the choice of Dr. Dickey when he and his party of five started into South America to find the unexplored watershed of the Orinoco River.

Invariably this remarkable camera is the companion of explorers, scientists, professional photographers and amateurs who recognize superlative camera quality. Several Leicas are owned by members of the Byrd Antarctic Expedition. Others were taken on the Graf Zeppelin's World cruise, the Greenland Expedition, through the Carlsbad Caves, and on the transcontinental Glider Flight of Capt. Hawks, sponsored by the Texas Company.

If you want better pictures under all conditions of light and weather carry a Leica wherever you go. It fits the vest pocket or purse—and weighs less than a pound. Yet it is marvelously perfect mechanically and optically. Takes 36 pictures on a single roll of standard cinema film, double-frame size. And enlargements to 12 x 18 inches or more preserve and accentuate all detail. The ideal camera for snapshots, sport pictures, photomicrographs, or other exacting work. See it now at your dealer's or write for catalog 1174. E. Leitz, Inc., 60 East 10th Street, New York, N. Y.

THE Leica CAMERA

Fits Vest Pocket or Purse
Weighs Less than a Pound

E. LEITZ, Inc., Dept. S. A.
60 East 10th Street, New York, N. Y.

Please send catalog 1174 showing the Leica Camera.

Name..

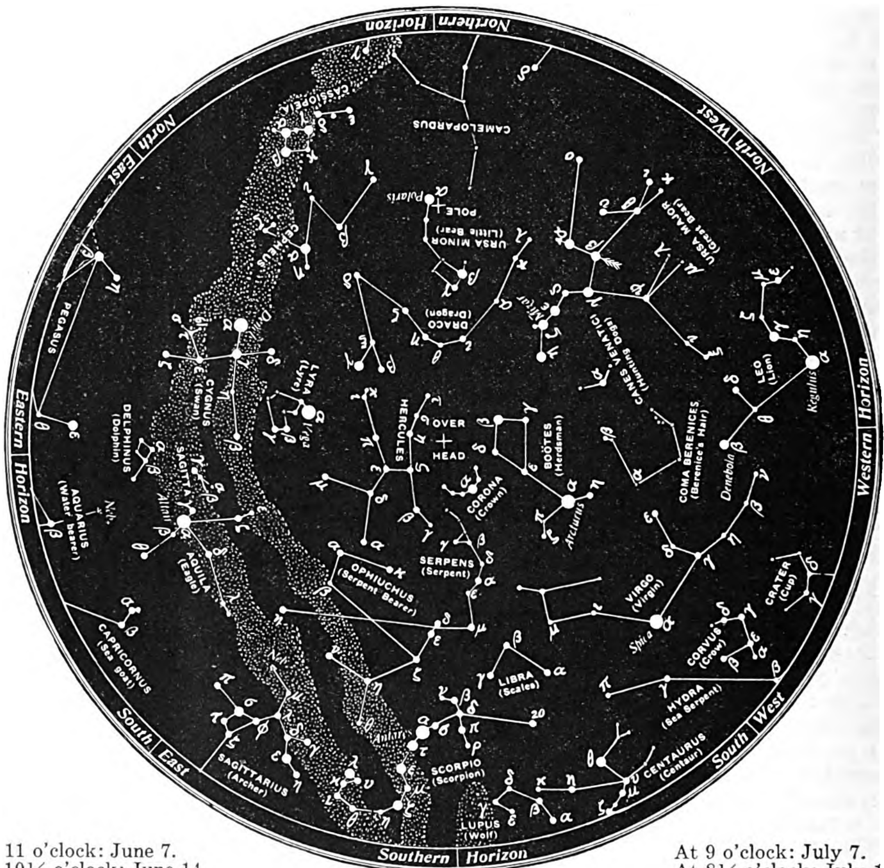
Address..

our interest, as a brother in the mirror art. At spare moments he says he is working on an article describing his construction of three telescopes, an eight-inch, a seven-inch and a nine-inch. In a later communication he apologizes for failing to keep his promise, as he has been side tracked with extra work, but ultimately will do so.

We hope this matter will reach us in time for the next number. It appears that the construction of his telescopes led Tombaugh to throw in his lot for astronomy. He asked for a place as assistant at Lowell Observatory and was accepted. Quite romantic, as it turned out.—*A. G. I., Tel. Ed.*

The Heavens in June

By PROF. HENRY NORRIS RUSSELL, Ph.D.


Northern Horizon
North East
North West
CASSIOPEIA
CAMELOPARDUS
POLE
Polaris
URSA MINOR (Little Bear)
URSA MAJOR (Great Bear)
DRACO (Dragon)
CANES VENATICI (Hunting Dogs)
LEO (Lion)
Regulus
Denebola
COMA BERENICES (Berenice's Hair)
BOOTES (Herdsman)
Arcturus
CORONA (Crown)
HERCULES
OVER HEAD
LYRA (Lyre)
Vega
CYGNUS (Swan)
DELPHINUS (Dolphin)
SAGITTA
Altair
AQUILA (Eagle)
AQUARIUS (Water Bearer)
PEGASUS
Eastern Horizon
Western Horizon
SERPENS (Serpent)
OPHIUCHUS (Serpent Bearer)
VIRGO (Virgin)
Spica
CORVUS (Crow)
CRATER (Cup)
LIBRA (Scales)
HYDRA (Sea Serpent)
CAPRICORNUS (Sea goat)
SAGITTARIUS (Archer)
SCORPIO (Scorpion)
Antares
CENTAURUS (Centaur)
LUPUS (Wolf)
South East
South West
Southern Horizon

At 11 o'clock: June 7.
At 10½ o'clock: June 14.
At 10 o'clock: June 22.
At 9½ o'clock: June 30.
At 9 o'clock: July 7.
At 8½ o'clock: July 14.
At 8 o'clock: July 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on June 7, etc.

NIGHT SKY: JUNE AND JULY

MERCURY is a morning star and is best seen about the 15th when he rises about 3.30 A.M. Venus is an evening star setting about 9:30 P.M., and is extremely bright. Telescopically she looks like the moon about half way between the quarter and the full. Mars rises a little after 2 A.M. in the middle of the month and still counts as a morning star. Jupiter is in conjunction with the sun on the 20th and is therefore unobservable. Saturn is approaching opposition and is observable in the latter part of the evening, though his low altitude is unfavorable to good telescopic definition. Uranus is a morning star and rises about 1 A.M. on the 15th; while Neptune sets at 11 P.M.

The moon is in her first quarter at 5 P.M. on the 3rd, full at 1 A.M. on the 11th, in her last quarter at 4 A.M. on the 19th, and new at 9 A.M. on the 26th. She is nearest the earth on the 27th and farthest away on the 16th. During the month she passes near Neptune on the 2nd, Saturn on the 12th, Uranus on the 20th, Mars on the 22nd, Mercury on the 24th, Jupiter on the 26th, Venus on the 28th, and Neptune for the second time on the 30th.

UNLESS protests are received from a sufficient number of its regular users the present feature, The Heavens (but not of course Dr. Russell's main articles), will be dropped and the space otherwise employed. Some believe there is but small overlap between the increasing numbers who are keeping up with the newer astronomy, mainly astrophysics, which is ably covered in Dr. Russell's monthly articles, and those who use the star maps and planet data. If the proposed change is made, a series of maps from the same plates will be especially printed in a small pamphlet for distribution to regular readers on request, and the same planet data as well as much other data not contained in the space allotted to the present department, could be obtained by the reader from the annual "Observer's Handbook" of the Royal Astronomical Society of Canada, at an outlay of only 25 cents, or from some other similarly accessible source.—*The Editor.*

Chemistry in Industry

(*Continued from page* 474)

the production of distillers' grains would amount to from 225,000 to 250,000 tons.

Beware of Noisy Grapefruit

READERS may recall the old story about the Italian fruit vendor who, annoyed by the critical examination of his wares by canny housewives, exclaimed, "If you mus' pincha da fruit, pincha da coconut!" After all, "pinching" does not prove much about the quality of the fruit and it is not surprising that a more scientific method has been sought. Now, the Bell Telephone Laboratories have developed a method of determining whether or not a grape-fruit is "good" without cutting it open.

This rather spectacular application of science is a method of detecting the Mediterranean fruit fly when it is inside citrus fruits. So far, says *Food Industries*, no way has existed for the detection of the larvae of the fruit fly inside the fruit without cutting it open—an operation which, of course, renders the fruit unsalable. The skins may appear to be healthy and yet cover a fruit that is infested with larvae that should be destroyed.

Since the worm eats by tearing off morsels of fruit, it has been argued by government entomologists that a noise should be caused by the operation, and if this sound could be sufficiently amplified by means of the thermionic valves, or tubes, used in radio, the noise of the larvae eating in the fruit should be audible to human ears. Apparatus in the nature of a glorified stethoscope has been constructed to test out the theory, and it has been found that "suspected" grape-fruit were noisy, and on cutting them open they were found to contain the offending pests, whereas noiseless grape-fruit were found to be free from larvae.

Human Chemist Can't Compete With Art of Lowly Bug

THE tremendous popularity of rayon as a substitute for natural silk must have created an unemployment problem among the silk worms. While the chemist with his wood pulp has outdone the worm with his diet of mulberry leaves, there is another insect, even humbler, which still retains his supremacy as a chemical factory. His name is *Carteria lacca* and his product is a resinous material which he produces to enshroud himself; but which man converts into the substance known as shellac.

W. H. Zinsser, writing in *Chemical Markets* reveals some of the many industrial applications dependent upon this louse-like inhabitant of India and Siam. Shellac is an organic resin produced through chemical processes taking place in the life of an insect and which, because of resiliency and soluble qualities stands out in world commerce in contrast to the vegetable resins. It has qualities possessed by no other gum and is soluble in alcohol or in an alkali water solution, but is not soluble in turpentine.

As long ago as 1590 there is a record of shellac having been dissolved and used as a coating or crude varnish, and from that date, uses, to which it is now so universally put, have been developed until to-day it

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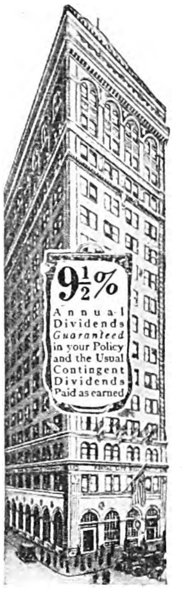
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In Surrender Values and Dividends	4,444,079
In Loans on Policies	16,761,085

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is the "open sesame" to all phases of the painting and decorating art; the friend of the sculptor, electrician, and metal worker, and the companion of the woodworker and furniture finisher. It is the facile aide of the foundry pattern makers, the base of buttons, phonograph and talking machine records, telephone parts such as receivers and mouthpieces, and imitation ivory products such as billiard balls and poker chips. It is shellac that holds the filament of the electric light bulb in place, and it is the "size" or stiffening used by the hat maker, which makes possible the many shapes and styles that fashion demands. Shellac is one of the chief ingredients in sealing wax, light drying inks, shoe dressing, and wood cements; it is the "snap" in playing cards and the artful finish for leather, imitation leather, wall paper, hardwood floors, pencils, broom and brush handles, autos, pianos, and what not. Shellac is the modern finish of the up-to-date rubber rain coat; it is the sealer used to make "leak-proof" the myriads of gasoline tanks that line the highways; and is even used as a cement for sealing the seams in the manufacture of cans for foodstuffs and liquids. It is used in the manufacture of brushes as a cement to hold bristles firmly in place. It is an important ingredient in lacquers, giving them body, adhesion, and flexibility.

Chemists have spent years looking for a substitute for shellac for use in industry but have thus far been unable to better the job done by the diminutive *Carteria lacca.*

Black Light Betrays the Bootlegger

"BLACK" light, the invisible rays which are the longer wavelength part of ultra-violet, may be used to discover the source of industrial alcohol diverted to the bootleg trade, according to Dr. Herman Goodman in a recent paper presented before the Society of Medical Jurisprudence. By adding an invisible trace of certain fluorescent dye to their industrial alcohol, the manufacturers can always identify their own product, no matter how much it has been distilled or rectified, by turning on it the invisible rays of black light.

Moisture Affects Telephone Cords

TELEPHONE cords are insulated with silk and cotton threads, but chemists in the Bell Laboratories found that the insulating quality of the fibers is different according to dampness of weather.

Research located the cause, says *Chemistry and You,* house organ of the Arthur R. Maas Chemical Laboratories. These fibers contain fine traces of chemical salts, which attract and hold moisture, and lower telephone efficiency. So methods have been worked out for washing the salts from the fibers before they are braided onto telephone wires.

The water cannot be used twice, for the infinitesimal trace of chemical salts carried away, causes it to be regarded as "contaminated."

Lake Michigan water was found better for the purpose than water from the city supply at another plant. It was even better than distilled water. This was due to a slight proportion of helpful chemical in Lake Michigan water, and too much harmful chemical in the other water, but the latter has been made satisfactory by delicate chemical treatment.

Our Point of View

Questionable Success in London

(*Continued from page* 429)

The three powers will scrap tonnage as follows:

	United States	Great Britain	Japan
Capital Ships	70,000	134,000	29,000
Destroyers	76,000	35,000	17,000
Submarines	8,000	none	14,000
	154,000	169,000	60,000

This tonnage does not include any obsolete vessels; the capital ships do not go back of our modernized *Florida* class, and only reckons destroyers less than 16 years old and submarines less than 13 years old. So, on the credit side of the Conference is a substantial reduction in tonnage. Great Britain and Japan, having already built practically up to the limit of their cruiser allowance, will have a very small cruiser program to complete. Congress has already authorized a cruiser program that will eventually complete our cruiser quota under the treaty; it will require several years to finish. In the meanwhile we are well below our strength. The President should vigorously resume the program suspended while the Conference was in being. By a happy coincidence this program will help the unemployment situation.

To obtain an agreement our delegation was forced to concede Japan parity in submarines and an increase in the 5 to 3 ratio in six-inch cruisers. We thought we had conceded Japan enough in 1922, when we agreed to cease fortifying our Far Eastern bases; certainly this concession should terminate our constant yielding to our neighbor across the Pacific.

It is reported that there is a clause in our agreement with Great Britain that might permit her to increase her cruiser strength relative to ours in the event that France increases her program; there should be no uncertainties in this treaty. In 1922 we thought parity meant parity in all classes; we so interpreted it while Great Britain and Japan built cruisers, destroyers, and submarines until they upset the ratio entirely. It would be a blow to the future confidence of our people in the efficacy of international agreements if any fine-spun interpretations are placed on this agreement.

In spite of the reductions actually obtained, Americans generally are disappointed by the events of the London Conference; and they will not quickly forget the display of European jealousies so openly disclosed by the negotiations. Americans had been told that the failure at Geneva in 1927 was due to the unyielding attitude of naval officers who sacrificed accord rather than to yield a few cruisers; at least that theory is exploded for only the Japanese delegation contained a naval officer and he was carefully classified as a statesman. Yet these selected delegations of civilian statesmen have been entirely unable to bring about a five-power pact, and only succeeded by extreme concessions to Japan in effecting an agreement for a three-power pact.

Their failure is more significant because

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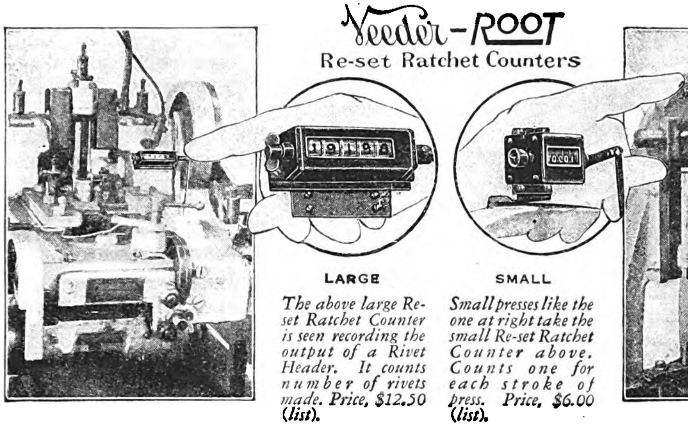

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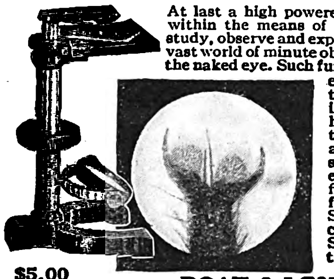

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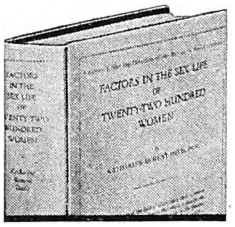
they patiently explored every avenue of approach that held any promise of agreement; and it is also possible that the delegations at London, in their desire to reach an accord, may have gone beyond the wishes of their own countrymen. After carefully following the developments at the Conference, it is hard to escape the conviction that the world powers today are not ready to confide their future to treaties, but still prefer to trust in the efficiency of their own armed forces. This is the most significant fact that has come out of the Conference.

Italy and France have not conceded an item one to the other. The reason for this inflexibility is scarcely concealed. France heads one continental group that includes Jugoslavia, Czechoslovakia, Rumania, and Poland. Italy heads another group that embraces Hungary, Albania, Bulgaria, and hopes to include Turkey. Italy would like to have England dissolve the entente with France and join her group. But for the present at least, British opinion will not hear of any continental entanglements. The old European balance of power has reasserted itself but this of itself need cause us no alarm, for it is the classical European method of preventing a continental colossus; and whatever may be urged against it by world reformers, the balance of power did preserve the peace of Europe between 1871 and 1913.

The desire to create an agreement between France and Italy caused MacDonald and Stimson to suggest a "consultative" pact to be given to France in lieu of the security guarantee she demanded for a reduction of her naval program. It is reported that MacDonald could not carry his own cabinet with him on this proposal and both Baldwin and Lloyd George are known to be against any further guarantees to France.

The reaction in this country was overwhelmingly against any form of consultative pact, on the very sound ground that if it committed the United States to intervention in European affairs it was against all our traditions and if it did not, it would mislead France. All efforts by advocates of the consultative pact to explain that the United States was already committed to an intervention by the Kellogg-Briand renunciation of war and the four-power Pacific treaty failed. And our delegation was unable to explain its complete change of attitude in this matter. Perhaps Mr. Stimson allowed his eagerness for an agreement to blind his judgment temporarily, or he wished to canvass the American public to determine if, for the sake of a reduction in armament, they were willing to re-enter Europe's political orbit. If the latter, the negative answer was plain, and cannot be misunderstood. It further developed that Great Britain is scarcely less reluctant than the United States to guarantee France's position in the Mediterranean so it was not possible to reach a real five-power agreement.

In the early days of the Conference there was some evidence of a desire on the part of the British and American delegations to put pressure on France to make concessions by a threat of a four-power agreement that would leave France isolated. When France failed to respond, the same treatment was applied to Italy without success. Then it was realized that if a five-power treaty was impossible, it was better for the good-will of Europe to go at once to a three-



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power treaty, leaving in the framework places for both France and Italy, rather than to create a four-power treaty that would isolate one of them.

Just when the vexed situation seemed at its worst, Italy raised the specter of the League of Nations, by the very pertinent, if unpleasant, suggestion that the London Conference was not a competent tribunal to determine the nature of the security guarantees made by League members and suggested that the French delegation address such queries to the League Secretariat at Geneva rather than to MacDonald and Stimson. This action convinced Mr. MacDonald that Italy was immovable and efforts to secure a five-power pact were abandoned.

The original position of the United States was that if a five-power agreement could not be obtained, a three-power agreement would not be attempted, for it was feared that an agreement between the three largest naval powers would almost surely cause the rest of the world to believe that Great Britain, Japan, and the United States are seeking to dominate the world by their navies. When we recall the persistent French suspicion of a British-American entente after the Rapidan conference, the dangers of a three-power agreement are plainly evident. Nothing we would save in dollars by a reduction in naval expenditures would compensate for wholesale suspicion aroused throughout the world by the belief, however unfounded, of an understanding between the three naval powers. Our delegation must believe they can reassure the rest of the world on this point, else they would have adhered to their original position.

The result of the Conference may be summarized as follows: Great Britain concedes us cruiser parity provided we take part of it in six-inch cruisers and France and Italy restrict their programs; Japan agrees, provided she is allowed equality in submarines and a 10 to 7 ratio in cruisers for the present and the right to re-open the question when and if we build up to a 10 to 6.4 ratio; France and Italy will not join the pact. In 1922 we scrapped battleships and battle cruisers to arrange a 5 : 5 : 3 : 1.75; 1.75 ratio among these five powers. As an additional incentive to Japan, we ceased all work on our bases in the Far East so that the continued passage of time puts them more and more at the mercy of a hostile fleet operating in those waters. In addition to her fleet, Japan possesses the second strongest army in the world; it is futile for her to urge that additional naval strength is needed for defense of her already impregnable position in the Far East.

Yet for the sake of a three-power agreement that only a short time ago we said we would not accept, our delegation has accepted a conditional equality with Great Britain, and has granted Japan an equality in submarines and a 10 to 7 to a 10 to 6 ratio in cruisers.

Surely our delegation has gone to the extreme limit in order to obtain an accord. The Senate leaders will consider the pact in detail, and it is most fortunate for our country that it cannot be committed to any foreign obligations without full discussion in the Senate. The delay entailed by discussion sometimes frets us, but such discussion informs the American people and enables American public opinion to make itself felt.

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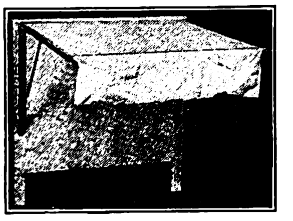

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Books Selected by the Editors

Storage Batteries—*By G. W. Vinal, Physicist, Bureau of Standards*

SINCE the first edition of this important work appeared six years ago, it has been the authoritative reference, in fact the only one which completely covers the subject so that the average consultant may obtain the information he seeks without plowing through puzzling details. Clear, concise, conclusive, and exhaustive, it is a most able presentation. $5.20 postpaid.

Elements of Electricity—*By A. Zeleny, Prof. Physics, Univ. Minnesota*

AS a book of reference available to look up a wide range of questions that will arise in the ordinary course of reading or study, this text will be found of exceeding usefulness. Every phase is treated in a thorough, concise understandable manner, for the seeker who has no special knowledge, which means therefore that formulas and mathematics have been reduced to a practical minimum. We believe this to be one of the best general references of which we have knowledge. $3.20 postpaid.

Construction and Equipment of Chemical Laboratories

THE report of the National Research Council Committee, all of the members of which have planned and built chemical laboratories within the last ten years, definitely answers the leading questions as to the requisites for a practical laboratory building. Plans are prepared in detail for new buildings, or the improvement of existing ones, the data for which was obtained by sending out questionnaires to the directors of recently constructed laboratories. It is thus a compendium of present practice and as such is invaluable to this rapidly growing field of science. $1.20 postpaid.

BOOKS are one of the most intimate influences in our lives. They both entertain and sustain, they can be our companions in solitude and a stimulation in depression, they often are exhilarating and sometimes risible—of these our own mood is most frequently the gage. It is not an easy matter, therefore, to select from the large number that are now published, those titles which will interest a most cosmopolitan audience.

On these pages will appear each month the selections which The Editors believe likely to interest the greatest number of readers, but if you do not find here just what you like, or if you want to know what is available in some line of your own desire, do not hesitate to write to Louis S. Treadwell, Associate Editor, who is responsible for this department. Every attention will be given to your needs. We want to make these columns of real value to you.

Arithmetic of Electricity—*By T. O'Conor Sloane, A.M., E.M., Ph.D.*

BECAUSE the calculations are all in plain arithmetic, this practical little volume has been widely accepted as a boon for those who are rusty on higher mathematics, or for the many who need the information but have not had the training necessary for more difficult computations. A series of rules, all of the simplest forms, each rule illustrated by practical problems and detailed solutions. Extensive tables appear before the last chapter on networks which is added in this edition. $1.65 postpaid.

Standard Wiring—1930 Edition—*By H. C. Cushing, Jr., Fellow A. I. E. E.*

THE new edition of this authoritative work has been brought up to date by the inclusion of new sections and illustrations, the 1930 national electrical code, new tables on wire and wiring for every class of work, and the latest technical terms, and has been carefully checked to the last page. It is rightfully called "The national authority on wiring" for it contains detailed explanations of the proper methods of installing all kinds of electrical equipment. $3.20 postpaid—*F. D. McH.*

Photogravure—*By H. Mills Cartwright, F. R. P. S.*

THE subhead on the title page of this volume aptly expresses its scope: "A Text Book on the Machine and Hand-printed Processes." The author presupposes that his readers have some knowledge of engraving and printing systems and therefore plunges into his discourse with but brief preliminaries. His treatment of the subject, from the practical point of view, is masterly and it gives the interested reader a thorough grasp of this particular engraving and printing process. His summation of its advantages and disadvantages is concise and of unusual interest to anyone who uses printing for any purpose. $3.70 postpaid—*A. P. P.*

Modern Science—*By Professor J. Arthur Thomson, Univ. of Aberdeen*

IN the whole English speaking world there are scarce ten men who can write *accurately* on *every* branch of science and who can really *write*. Professor J. Arthur Thomson is one of them. Qualified critics think it is the direct simplicity of his style of writing which has won him deserved world-wide fame as a popularizer of scientific thought. Nearly everyone is familiar with his famous four volume Outline of Science. His newest book is a general introduction to science, ranging in scope from cosmology, through astrophysics and physics, to the origin and evolution of life, and ending with man and his psychology. The treatment leans rather more toward the elementary than some books in this category, and therefore provides easy delightful reading. 370 pages; illustrated. $3.70 postpaid—*A. G. I.*

Science and the New Civilization
By Prof. R. A. Millikan, Norman Bridge Lab. Physics

THIS is a collection of the author's recent essays put into permanent book form. Two of the eight essays—one which disposes of the former fond dream of inexhaustible atomic energy, and one which lists and describes the 21 greatest discoveries of the last 15 years of physics—are purely scientific. The others, on Alleged Sins of Science, the Future of Steel, the Relation of Science to Industry, Michelson's Economic Value, etc., are broader. Millikan's purpose in writing these classic essays was to make people think.

Two of the statements in the publisher's blurb on the jacket are untrue. The author does not write book-jacket blurbs—the publisher does. Too often those on scientific books are inaccurate, needlessly sensational, not dependable, misleading. Thus they mar good books. $2.15 postpaid—*A. G. I.*

Aeronautical Law—*By W. Jefferson Davis, Air Law Comm. Amer. Bar Assn.*

IN six parts. The scope of Federal and State control; ownership, operation, and control of airports; regulation of aircraft common carriers, liability, and insurance; aeronautical regulations, bibliography; each part broad in scope as a full reference of this kind should be. An important and necessary adjunct to the increasing importance of technical operation. 600 pages. Buckram. $10.00 postpaid.

AMERICAN CHARITIES AND SOCIAL WORK—*By Warner-Queen-Harper.*

FOR many years the fundamental work on this subject was the first author's "American Charities." The present book has been built on that solid foundation, two thirds being new text, but the original values are retained in this connotation. Everyone who has a vital interest either as worker or giver in this essential field of sociology should have this book—it is a compendium of the research and knowledge attained by the most acceptable authorities who have studied this question during the past thirty-six years. $3.95 postpaid.

SOVIET ECONOMIC DEVELOPMENT AND AMERICAN BUSINESS—*By Saul G. Bron*

HERE are given the results of the first year under the five-year plan and future perspectives. It shows that during 1928-29 national income increased 12.4% as against a scheduled gain of 10.7% while production costs were reduced 11.5% against the original plan of 7.5%. Complete economic statistics will furnish ample food for study to all who desire the facts as ascertained by the author, who was formerly Chairman of the Board of the Amtorg Trading Corp. $1.65 postpaid.

HARTRAMPF'S VOCABULARIES

A CONDENSED workable list of synonyms, antonyms, and relatives indexed under a general classification of group meanings. The index in the back identifies the group to which belongs the word sought, and reference to this group will give related words with their meaning. Quite the best arrangement we have seen and one readily adapted for hurried reference. Cloth. $5.20 postpaid.

ANTARCTIC ADVENTURE AND RESEARCH—*By Griffith Taylor, F. R. G. S.*

A COMBINED short history of all past Antarctic expeditions (including Byrd's) and treatise on the several sciences—geology, glaciology, climatology, botany, biology—in the Antarctic Continent. The author is an Australian scientist who accompanied Scott to the Arctic as geologist, and is now professor of geography at the University of Chicago. The title of this book might be naively (and truthfully) paraphrased as "everything an intelligent reader would like to know about all branches of science as applied to Antarctica." This is no mere book of narrative; nor is it on the other hand too abstruse for the average reader who, anticipating further explorations doubtless to be made in Antarctica, wants to be prepared to read future accounts of them more intelligently than others. $2.15 postpaid—*A. G. I.*

TITANOTHERES OF ANCIENT WYOMING, DAKOTA AND NEBRASKA—*By Henry Fairfield Osborn, Sc.D., LL.D.*

THIS monumental, two-volume, 953-page work is an exhaustive monograph on the titanotheres—extinct, primitive, massive mammals of the Tertiary Period more than 10,000,000 years ago. It represents 19 years of effort on the part of its distinguished author, noted paleontologist and head of the American Museum of Natural History, and in itself will create a new epoch in Tertiary paleontology. While the work is primarily for the professional paleontologist, much of it will be understood by the serious reader of elementary works on evolution. Supt. Documents, Washington, D. C. $9.00 currency—*A. G. I.*

HARVARD ADVERTISING AWARDS

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CLEMENCEAU—*By Jean Martet*

ONE is rather confused at the number of titles which have appeared concerning this dynamic and forceful patriot. This one is by his secretary and later intimate personal friend in whose hands were placed the full documentary records and these were supplemented by intimate conversations day after day; for Clemenceau was fully aware Martet was to be his biographer. In fact one long chapter is in Clemenceau's own hand. All facets of this amazing personality are turned to the light. In many ways, therefore, this is the most important portrayal of all the books that have appeared. $5.25 postpaid.

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BORN inland, near Mark Twain's home, it seems strange that so much of the author's life should have been spent at sea. But the background serves only to enhance this story from the early seventies through a very large part of the World War. Few careers cover the breadth of experience, exploration, training, supervision of construction, navigation and finally, highest command, that is narrated here with characteristic reserve yet interlined by amusing anecdote and salty yarn. Altogether a most pleasing, interesting, and historically worthy recounting of a life devoted to country and fellowman. $4.20 postpaid.

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IRISH immigrant, Mohawk war chief, American Major-General, empire builder, Sir William Johnson was one of the commanding figures in our early history. Of tremendous influence with the Indian tribes and powerful among Colonials because of his immense wealth, his was a personality of vital import at a time when civilization was hard pressed to maintain itself on the frontier. Factual accuracy is attained by long and painstaking historical research and yet the story runs smoothly and makes most interesting reading. $5.25 postpaid.

MATA HARI. COURTESAN AND SPY—*By Major Thomas Coulson, O. B. E.*

AMONG the women spies of the Great War, certainly Mata Hari was the most interesting. "A pagan adventuress with nothing feminine about her but physical grace and quick intelligence," her operations, however, are said to have been responsible for the death of 50,000 allied troops. The author strips away the fiction and myth concerning her and gives the facts as far as they can be determined. The sustained interest of this exciting narrative almost cloaks the loathsomeness of its moral fiber. $3.20 postpaid.

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SCIENTIFIC AMERICAN
24 West 40th Street, New York City

Commercial Property News

Facts and Notes of Interest to Inventors,. Patentees, and Owners of Trademark Rights

Rules on Patent Appeals Amended

THE Commissioner of Patents, Thomas E. Robertson, has announced an order amending the rules of the Patent Office relating to appeals from its decisions and the printing of the record for use on appeal. The order follows:

Acting under the provisions of section 483 of the Revised Statutes and with the approval of the Secretary of Commerce, rules 148, 149, 150 and 162 are amended as follows, to take effect March 1, 1930:

Rules 148, 149, and 150 by striking out the words, "Court of Appeals of the District of Columbia" wherever they appear and inserting in lieu thereof: "Court of Customs and Patent Appeals."

Rule 162, by striking out in the fourth line thereof the words "Court of Appeals of the District of Columbia" and inserting in lieu thereof: "Court of Customs and Patent Appeals."

And by canceling the last sentence of the first paragraph thereof and inserting in lieu thereof the following:

"The size of the record shall be 7$^5/_8$ by 10$^1/_4$ inches and the type matter shall be 4$^1/_6$ by 7$^1/_6$ inches. They shall be printed in 11-point type and adequately leaded; and the paper must be opaque and unglazed. The names of the witnesses must appear at the top of the pages over their testimony, and the record must contain indices with the names of all witnesses and reference to the pages where copies of papers and documents introduced as exhibits are shown."

Patents for Plants

THE inventor or discoverer of a new variety of fruit tree or plant would receive the same protection by a patent as the inventor of a machine, through an amendment to the patent statutes introduced by Senator Townsend of Delaware, himself an orchardist, who said that he wished to remove the present "discrimination" against agriculture.

The patent would be granted to the experimenter under almost identical conditions governing other inventions and the law would be operative throughout the Patent Office, costing the government nothing, Senator Townsend explained, inasmuch as the Patent Office is self-supporting.

His measure, which has been passed by the Senate and approved by the House Patents Committee, reads, in part:

"Any person who has invented or discovered . . . any new and distinct variety of asexually reproduced plant other than a tuber-propagated plant or a plant which reproduces itself without human aid, not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law and other due proceedings, obtain a patent therefor."

In evidence of the value of his proposal, Senator Townsend, who owns 130,000 acres of orchards, pointed to the accomplishments of engineers during a century of patent protection.

Pointing out that "it is a notorious fact that the most successful plant breeders have lived and died in comparative poverty," Senator Townsend named as examples Ephraim Bull, Luther Burbank, Peter Gideon, C. G. Patten, J. R. Reasoner, and Dr. Van Fleet.

Californians Lead in Patent Grants

RESIDENTS of California are the nation's most prolific contributors to mechanics and the sciences, according to the records of the Commissioner of Patents. The record of patents granted during the year 1929 showed that citizens of Connecticut pressed closely on the heels of California's inventors, and three other New England states put in strong bids for the *per capita* honor. These were Massachusetts, New Hampshire, and Rhode Island.

As would be expected, the State of New York led by a wide margin in the total number of patents granted to its residents. The compilation, made by Mr. L. Edward Flaherty of Washington, D. C., shows the grants issued to the various states, the leaders ranking as follows:

New York .	7755
Illinois	4658
Pennsylvania	3639
Ohio	3595
California	3087
New Jersey	2630
Massachusetts	2309
Michigan	2218
Wisconsin	1321
Connecticut	1121

A total of 42,251 patents were issued in 1929, compared to 40,322 issued during the preceding year.

Shoe Trademarks

THE Assistant Commissioner of Patents has denied a rehearing of the appeal before him in which he decided that the notation "Foot Preserver" is registrable as a trademark for boots and shoes, despite the opposition of the owner of the mark "Arch Preserver" for the same type of goods.

It was held that the essential feature of the mark "Arch Preserver" is not "Preserver," but that "Arch" is the dominant characteristic, and hence "Foot Preserver" is not deceptively similar.

By reason of many trademarks for shoes of like import, the Assistant Commissioner stated that neither party is entitled to such broad protection of its mark as to exclude from registration the mark of the other party, and that the public must exercise unusual care in discriminating between them.

Massachusetts Bans Car Radios

RADIOS may not be operated on automobiles driven in Massachusetts, according to a ruling by the registrar of motor vehicles, George A. Parker.

The ruling followed a conference with the governor's committee on street and highway safety, which recommended that the use of radios on automobiles be discontinued, it was announced.

Automobile and radio manufacturers have joined in a protest to the department, of which the registry of motor vehicles is a part, under a law providing that any ruling by the registrar is subject to appeal to the Department of Public Works.

"Permanize" Granted Trademark Registry

ALTHOUGH two trademarks may have the same suffix, and the goods upon which the marks are used are of the same descriptive properties, they are not deceptively similar if they neither look alike, sound alike, nor convey the same thought. This decision of the Assistant Commissioner of Patents was made in the case of the Simoniz Company *vs* Permanizing Stations of America, Inc., opposition number 9230 to registration of trademark "Permanize" for a polish for auto bodies, et cetera.

The opposer, the Simoniz Company, had appealed from the decision of the examiner of interferences dismissing its opposition to the registration of the mark. The opposition was based on the fact that the mark "Simoniz" for a compound for cleaning and polishing automobile bodies, et cetera, had been adopted and used previously. Although the two compounds contain specific differences, they were held to possess the same descriptive properties.

It was brought out that of the two marks in question, "Simoniz" is derived from the proper name Simon, and suggests the thought that Simon's reputation is back of the goods. On the other hand, "Permanize" is derived from the word permanent, and suggests permanency. The testimony failed to show that any purchaser had been deceived by the alleged similarity of the marks, and it was ruled that the marks are not deceptively similar.

Models for Advertising Purposes Denied Free Entry

ACCORDING to the majority opinion of the United States Court of Customs and Patent Appeals, models of "individual wheel drives" imported by the American Brown-Boveri Electric Company are not admissible duty free, as are models which come under Section 1620 of the existing tariff act. This action was taken because the models in question were imported for the purpose of free distribution with a view to prospective sales.

In the opinion of the Court: "It is apparent that the imported articles are made to be used not as models, but for advertising purposes alone."

The models in question consist of a solid brass foundation on which are mounted three supports, also of brass. From these supports are suspended an axle and two flanged car wheels. On the outside of one of these wheels is a brass cogged wheel with an attachment by which the axle and car wheels may move in various directions without affecting the cogged or drive wheel. Attached to the supports upon which the axle is mounted are two small levers with suitable arrangements whereby the operation of the mechanism can be demonstrated.

Because of the ambiguity of the language of the statute, it was deemed necessary to take recourse to its legislative history. Earlier tariff acts provided free entry for "models of inventions and of other improvements in the arts, including patterns for machinery, but no article shall be deemed a model or pattern which can be fitted for use otherwise."

The Court ruled that models intended for advertising use did not come under the statute. Judge Bland concurred with Judge Garrett in a dissenting opinion, holding that "advertising" use should be no bar to free entry, because it is inseparable from an inspection of the structure and is a legitimate part of the function of a model.

Old Mining Claim Upheld Over Invalid Homestead Patent

If the owner of a mining claim fails to do his assessment work for one or more years, the claim is subject to relocation by other parties, providing the relocation takes place before the original owner returns and resumes work upon the claim. However, in the event that the relocation does not take place within that time, the owner's rights may be restored to the same extent as though there had been no failure to do the assessment work. These rulings were made by the Supreme Court of the state of South Dakota in the case of Frank Hebert *vs* Frank C. Bond *et al*, on appeal from the Circuit Court of Pennington County.

The defendants had acquired title to the Tin City Lode Mining Claim from a woman who had obtained a homestead patent on the property by means of false statements made to the General Land Office. The Court held that she had practiced a fraud both upon the Government and the rightful owner of the claim, so that her patent was impressed with a trust in favor of the original patentee who might go into court and have his title quieted.

The evidence showed that in 1886, Frank Hebert had discovered on unappropriated government mineral lands in South Dakota a lode of ore bearing appreciable quantities of tin and mica. He filed a claim promptly, and did all of the proper and requisite things to secure a valid title to the property covered in his claim. Later in the same year, one Mary McDermott built a cabin on an adjacent piece of farming land. After the year 1900, she filed a homestead claim in the land office, later revising her claim from time to time. In 1916 she amended her homestead claim to include the Tin City lode. As late as 1918, the testimony showed, McDermott admitted to witnesses that the mining property was owned by Hebert.

Early in 1919, Hebert contracted to sell the Tin City Mining Claim to one W. N. Hunter, for a consideration of 30,000 dollars. Hunter, with Frank C. Bond, formed the Rare Minerals Company, and entered promptly upon the property, making preparations to mine and ship ore from the mine thereon. At this time, while Hebert was away temporarily, McDermott drove the defendants (Rare Minerals Company) from the property, claiming title under a homestead patent issued by the government. The Rare Minerals Company decided that McDermott had a better title than Hebert, and purchased the McDermott homestead for the amount of 10,000 dollars. Then, attempting to repudiate the old Hebert title, the defendants filed a new mining claim on the Tin City lode.

The only questions involved in the case were: First, did the plaintiff ever make a valid location of the said ground? Second, is the ground covered by the Tin City Lode Mining Claim mineral in character? And third, if such location was made, did the plaintiff lose his rights therein by abandonment prior to the issuance of the McDermott patent? These points were decided definitely in favor of Hebert, and it was established that McDermott had practiced a fraud on both the plaintiff and the government. Under such circumstances, it was held, a court of equity has power to secure the rights of the plaintiff, and as a means best adapted to that end may declare a constructive trust in his favor. The decision of the lower court was affirmed, quieting title in the plaintiff.

"7-11" As a Trademark

The Court of Customs and Patent Appeals has affirmed the Patent Office in dismissing opposition to the application for registration of the trademark "7-11," for liquid medicinal preparations. The products of the applicant, liquid medicinal preparations for treatment of colds, et cetera, to be taken internally, and of the opposer, owner of the mark "4711," for antiseptic mouth washes and scalp remedies, cold cream, face powder, dental preparations, et cetera, were held not to be of the same descriptive properties. It was also pointed out that the labels were dissimilar and further that the opposer had made no protest to other registrations of the numbers "7-11" for other goods.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co.; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

Propelling Device—For air and water craft, whereby increased force is obtained, a quicker take-off will be possible and shorter landings at steeper angles, a gyroscopic action being generated to keep the craft steady while in flight. Patent 1750382. Westinus Boer.

Aircraft—Having a fuselage, laterally extending wings, stabilizers, and a rudder mounted at the tail, the special feature being a sail adapted to use the wind for producing the lifting action and motion to put the craft in flight. Patent 1752241. John Domenjoz.

Pertaining to Apparel

Necktie-Lining Fabric—Composed of a woven integral piece of material, adapted to be cut to serve as tie linings, having areas at one or both ends, which are of different grade of material than the remaining area. Patent 1749634. Edgar K. Frank.

Protective Garment—Designed to be worn by a messenger carrying money or valuables, so that the articles may be distributed throughout the compartments on the inner face of the garment, and securely locked on the user's body. Patent 1749714. Herman A. North.

Shoe Construction—Which has novel means for removably securing a heel to the body portion of a shoe, a frame receiving the heel, whereby a worn heel may be removed for repair, or a new one disposed in place. Patent 1749864. Joseph Weiss.

Cravat Attachment—For the small end of four-in-hand cravats, may be easily applied to provide an abutment to prevent its withdrawal through the knot, whereby the neck loop is at all times maintained without retying the cravat. Patent 1750232. Segfrid J. Lindskog.

Chemical Processes

Photographic Chemical Process and Material—For printing from tracings, etc., comprising diazotizing an aqueous solution of pyridine sulphonic acid, then reacting the product with an aqueous tartaric acid solution and an aqueous solution of a nickelous sulphate, coating photographic paper therewith, printing by contact under tracings, and developing the latent image with fumes of ammonia. Patent 1752174. Oliver A. Hall.

Designs

Design for a Table-Receptacle Holder. Patent 80626. Samuel Lapin.

Design for a Novelty Spur. Patent 80563. Grover C. Welter.

Design for a Dress.—The inventor has been granted two ornamental designs for dresses. Patents 80658 and 80659. Dorothy Long.

Design for a Dress. The inventor has been granted four patents on ornamental designs for dresses. Patents 80795, 80796, 80797, and 80798. Dorothy Long.

Electrical Devices

Modulator for Radiotelephones—For use in connection with the transmitter, use being made of carborundum, selenium, magnetite, etc., to vary in electrical conductivity, hinder action of heat or light, in producing a changing current in the talking circuit. Patent 1750579. Henry H. C. Dunwoody.

Electric Insulator—A tubular casing especially adapted for outdoor aerials in protecting then from moisture, the formation of ice, snow and water, which might tend to bridge the gap and electrically connect the wires. Patent 1750352. John F. Phillips.

Electric Storage Heater—A hollow body of heat absorbing and retaining material in which a large amount of electrically produced heat may be stored under control for use at such time as desired for various purposes. Patent 1749115. Gunnar S. Tune.

Electric Switch—The construction of which makes it impossible for an operator to leave the blades close enough to the contact to allow any passage of current, unless manually pressed into contact for closing the circuit. Patent 1752236. Vernon A. Conklin.

Of Interest to Farmers

Egg-Protecting Means—An outer protective covering adapted to be used with egg crates, as generally formed, and packed, for the complete closure and special protection of eggs in transit, when the temperature is below 32°F. Patent 1749675. Paul A. A. Rouis.

Door for Silos—Which may be readily removed to provide an opening for the discharge of grain, the door securing means also providing rungs, whereby an operator may climb to the upper portion of the silo. Patent 1750600. Levi D. Houghtaling.

Potato Separator—For use in connection with a potato digger, the tension of the balanced separating fingers permitting the lightest stone to drop from the potatoes as the digging, sorting, cleaning, and sacking operation progresses. Patent 1751391. William G. Bunker.

Doffing Device—For stripping or doffing the needles of a cotton-picking machine after the former has removed the cotton from plants, and for removing any accumulation of gum collected during abrasions of the plant stalks. Patent 1751389. Oscar F. Bledsoe.

Shipping Box for Baby Chicks—Each compartment of which has ventilated chambers of varying temperature so that the chicks may move at will to warmer or cooler places to meet their individual needs, and yet remain fully protected against drafts. Patent 1752177. Albert B. Hilkemeyer.

Of General Interest

Ventilator—For use in conjunction with a window allowing air to enter a room, but dividing the air in such manner as to prevent drafts, and also to exclude rain and other elements of weather. Patent 1750413. Albert R. Laube Nstein.

Air-Cooling Apparatus—Comprising a water supply pipe, overlapping absorbent fabric strips mounted to retard the water in its descent, and a drip pan on the window sill, the device cools and filters the air as it passes. Patent 1750047. Gustave A. Metzger.

Bag Gusset—So formed as to join the opposite ends of the side sections that they will be neat in appearance, and define a pocket which will prevent small articles from falling out. Patent 1750375. Anthony M. Vinciguera.

Combined Article of Furniture—A cabinet which includes hingedly connected sections defining storage compartments, a horizontally disposed swingable table, and swingable mirrors, normally housed, the whole serving in the capacity of a dressing table, desk or storage cabinet. Patent 1749686. Theodore Agazzi.

Brush Holding and Cleaning Device—A receptacle for receiving a quantity of turpentine or other detergent for cleaning paint brushes, scraper elements being arranged for the removal of the paint and detergent, and valves for draining off the waste matter. Patent 1748789. Harry I. Orkin.

Hair-Waving Device—Wherein the cooperating hair-waving members may be closed in engagement with the hair fully and effectually, to produce the desired waves without injury or tearing the hair. Patent 1749748. Martha A. Tienken.

Cartridge Guide for Repeating Guns—So formed that its head portion which is provided with a guiding surface shall penetrate into the breech casing between the magazine and the rear end of the barrel, or the firing chamber. Patent 1749726. Rudolf von Frommer.

Fence Post—Polygonal in cross section, and formed with means for interlocking engagement by tie wires, in securing the line wires, a projecting member at the lower end being adapted for setting into a fresh concrete base. Patent 1749640. Richard D. Martin.

Container—A simple and convenient envelope or wrapper for easily and quickly confining articles of personal wear, such as shoes, etc., when traveling, within a relatively small space, and without soiling other articles in transit. Patent 1749680. Gertrude P. Visscher.

Mop Handle—Having a simple and efficient means whereby a mop head, or mopping material, may be inserted or removed and when connected will spread out over the end of the stick to prevent contact with floors or furniture. Patent 1752250. John H. Gillis.

Display Holder—Particularly adapted for strap-watches, and formed from a single cardboard blank and a single sheet of velvet, a pocket being formed for the watch, means for displaying the strap, and supporting the holder in tilted position. Patent 1752246. Leo Flier.

Sea Tub—A hollow construction, of rigid buoyant material, such as balsa wood, adapted for floating persons in the water, the size being large enough to permit the average person to lie down in the water, as in a bath. Patent 1752191. Jere C. Moray.

Jar-Cover Remover and Fastener—A device which may be attached to a wall or other suitable support, for receiving and gripping the metal cap of a jar, while the latter is being turned for screwing or unscrewing, without spilling the contents. Patent 1752189. Joseph Lotz.

Watch Stand—Comprising a substantially dome-shaped base and a plurality of arms, pivotally mounted, wherein a watch may be quickly mounted or demounted, particularly adapted for use in repairing watches. Patent 1751286. Frank X. Mantsion.

Mop—With mechanism so constructed as to eliminate all necessity for the hands of the user to come in contact with the water in mopping, scrubbing, or wringing, the operation being easily accomplished without undue exertion. Patent 1751349. Clifton O. Morgan.

Holder for Graphic-Instrument—A holder connected with a base, for temporarily holding a fountain pen, or the like, in angular position, so that the instrument may be easily removed or inserted, the holder accommodating instruments of various sizes. Patent 1751354. Ernest Oldenbusch

Washbasin Appliance—A transportable storage tank for water, the top portion being depressed to form a basin, a lift pump transfers the water to the basin, the device is covered, very compact, and adapted for use in confined places, such as vehicles. Patent 1751294. Clifford Spital.

Hardware and Tools

Screw—Having the usual slotted head for receiving the screw driver, but being provided with lips adjacent the slot so that after the screw has been forced into position, said lips, or wings, may be swaged over the slot. Patent 1749043. Joseph Neiser.

Flat Iron and Steamer—Particularly adapted for ironing or steaming a hat, and permitting the crown or brim of the hat, or both, being ironed or steamed in a convenient manner; may also be used for other purposes. Patent 1749667. David Freedlein.

Knife Attachment—An attachment for the back of a knife blade, affording a broad support for the fingers, and preventing soreness after long use, particularly adapted for paring knives, as used for vegetables and fruit. Patent 1750577 Joseph de Bracht.

Casement-Window Latch—Which provides means for securely latching a casement window in slightly opened position for the purpose of ventilation, but in such manner as to prevent an intruder forcing or manipulating the latch to gain access. Patent 1750423. Walter S. Oglesby.

Fire-Fighting Tool—Comprising a handle, a metallic extension, and a blade with lug-receiving opening and a clamping member for securing the blade against rotation, the wooden handle being removed at quite a distance to prevent charring. Patent 1749103. John C. Kortick.

Rotary Reamer—For reaming oil wells, the reamer blade having two cutting eges, thus twice the efficiency of ordinary reamers, the tool requiring withdrawal for sharpening with but half the frequency of a single blade, thus saving time and labor. Patent 1750953. Alexander Boynton.

Safety Shackle Snap—A snap hook which when engaged about a shackle will automatically close and lock in instances of strain, but may be easily unlocked and relocked by manual operation in the absence of strain. Patent 1751458. John J. Van Valkenburg.

Pipe-Bending Tool—Which may be employed to bend the usual standard, or thin wall conduit, in various sizes, will not cause the conduit to flatten, and will prevent slipping or incidental injury during the operation. Patent 1752220. Andrew B. Allen.

Machines and Mechanical Devices

Automatic Well-Flowing Device—A combination pressure fluid and liquid velocity control device embodying a flap movable toward one side by the velocity of the stream and returning to its original position as the stream force diminishes. Patent 1749124. Alexander Boynton.

Rod Guide—Comprising a walking beam, for maintaining a polish rod of an oil well pump jack in true alinement, while providing a maximum stroke and the greatest quantity of oil, with the least sucker rod trouble and wear. Patent 1749626. Charles H. Brown.

Stripping-Finger Adjustment for Thrashing Machines—Whereby the rows of stripping fingers of machines used for operating upon the pod or hull type of crops may be projected or withdrawn at will, according to the weather conditions at the time of working. Patent 1749040. Carl R. Livermon.

Conveyer—Of the endless belt type, applicable for quenching and removing furnace or gas producer ashes, or metal articles after heat treatment, or may be applied as a hydro-mechanical conveyer and separator. Patent 1750426. Harry E. Partridge.

Device for Separating Water from Oil—A valve and float automatically acting to separate water which has gravitated at the bottom of a settling tank for oil and water, the action being accomplished in a continuous and clean manner. The float may be readily adjusted or removed from the separator tank. The inventor has been granted two patents, 1750489 and 1750490. John W. Pippin.

Mouth Wiper—For linotype machines of the Mergenthaler type, the movement being actuated by the ejector mechanism and includes a flexible wiping piece resiliently held in taut position and readily removable from or replacd on the structure. Patent 1750402. Henry G Guire and Albin L. Chalfonte.

Piston-Ring-Fitting Machine—A machine by which the grinding of piston rings incidental to fitting them in engine cylinders can be accomplished with a mathematical exactness, the machine is adjustable for practically all forms and sizes of rings. Patent 1750195. Granison M. Sanders.

Pump Plunger—A built-up plunger wherein most of the plunger is made from vitreous or other acid-resisting material capable of resisting the action of chemicals in water to be pumped from mines. Patent 1751350. Fred W. Moyer and Frank J. Reninger.

Box Forming and Sealing Device—Adapted to receive a blank which has been indented for determining the side walls, bottom and top, fold the blank, and apply a sealing tape to the abutted edges after the box-like structure has been formed. Patent 1751390. Walter W. Vrust.

Cutting Device—An attachment in the form of a rotary cutter comprising a disc-like body which may be readily mounted in connection with a paper tube forming machine for automatically cutting the product into predetermined lengths. Patent 1751293. Harold W. Sherman.

Water-Locking Suction Valve for Hydrocarbon-Fuel-Storage Tanks — Whereby fine dirt, scale, etc., frequently present in gasoline, and which settles in the water strata at the bottom of the tank, cannot be drawn up to prevent a proper closing of the check valve. Patent 1751371. John H. Viele.

Revolving Lathe Center—For the tail spindle of a lathe, which revolves instead of being stationary, thereby eliminating burning in wood turning, and is lubricated in such manner as to require less energy in running the lathe. Patent 1751711. Harold R. Ong.

Coin-Controlled Liquid-Dispensing Apparatus—Which can be operated in conjunction with gasoline and lubricant pumps, and will expedite the sale, by eliminating employees and permitting autoists to purchase the product at such times as the station is ordinarily closed. Patent 1752150. Ernest E. Cooper.

Long-Stroke Pumping Jack—Adapted for use with oil wells, may be easily unlimbered for temporary displacement preparatory to pulling a sucker rod, whereby weight elements may be added or substracted on the reciprocating chains to suit different loads. Patent 1752144. Lawrence G. Burt.

Medical and Surgical Devices

Orthodontic Dumb-Bell—Formed of a temporarily deformable elastic material, comprising a cylindrical shank with an enlarged integral spherical knob at one end, for the treatment of irregular teeth and development of the human maxillary and mandibular bones. Patent 1749632. Harry C. Ferris.

Tonsillotome—Of the guillotine type, including a pair of blades one initially directing an electrical current to the base of the tonsil, causing coagulation and reducing bleeding to a minimum, the other severing the appendages. Patent 1750874. Arthur C. Campbell.

Dental Mirror—Having a lighting attachment arranged in such a way that the rays are reflected from the surface of the mirror and illuminate the mouth so as to facilitate the inspection of the teeth. Patent 1750194. Carl G. A. Rydman.

Musical Devices

Phonograph Stylus and Sound Box—Wherein a plurality of stylus points may be associated with the sound box for consecutive use in combination with the sound groove of a record, and any one of the style positioned for playing. Patent 1750351. Auguste E. Pasche.

Plumbing and Fittings

Compound Faucet—A double faucet attachment to a single pipe whereby water may be drawn from one faucet inside the house while the other faucet is being used for a hose attachment outside the house. Patent 1750485. Gustav Muller, Jr.

Prime Movers and Their Accessories

Auxiliary Air Supply and Mixing Device for Internal-Combustion Engines—Which thoroughly incorporates the air with the explosive charge from the carbureter and causes the mixture to be automatically delivered in correct combustible quality to the manifold at all speeds of the engine. Patent 1748203. Gaston A. Brunelle.

Rotary Internal-Combustion Engine—Wherein carbon deposits are materially reduced if not eliminated, and which will develop a maximum horse-power with a minimum gaseous fuel consumption, utilizing substantially all the power before the exhaust products escape. Patent 1750502. Thomas A. Baker.

Internal-Combustion Engine—Designed to perform perfectly the four cycles of the usual four-cycle engine, and employs a new principle of compression and expansion which has distinct advantages over the usual type, the engine being comparatively light in weight. Patent 1751385. George P. Beaudry.

Two-Cycle Engine—Having a time-controlled valve which will force gases of combustion into a cylinder at the proper time, under the proper pressure and permit these gases to exhaust at the proper time. Patent 1750201. Gardner A. B. Spencer and Harry B. Cornish.

Internal-Combustion Pump — Whereby charges of fuel are controlled in such a manner as to avoid pre-ignition, thereby enabling greater compression, and so to make it possible for the pump to operate against heads of liquid in excess of two hundred feet. Patent 1752130. Eric W. MacKay-White.

Railways and their Accessories

Ballast-Dressing Machine for Railroads—A preliminary ballast spreading and leveling apparatus whereby ballast dropped upon a railroad in piles may be smoothed out or spread in an even and expeditious manner before the finishing operation. Patent 1750506. Solon F. Clapp.

Pertaining to Recreation

Doll—Constructed with a hollow hard casing and flexible swinging legs, whereby the doll may simulate the movement of human beings in walking by a forward turning movement first one side and then the other. Patent 1750404. Louis Herman.

Toy Target—In which the target elements are swingably mounted and have an indicia carrying portion adapted to be swung into position to expose the numerical value associated with each target, when struck by a projectile. Patent 1749689. Fred T. Baum.

Pertaining to Vehicles

Brake Mechanism—Wherein the braking elements will be self-centering, so that the active brake lining will be uniformly applied to the braking surface of the drums, and the wear evenly distributed over the entire area. Patent 1749624. Jonas W. Batson.

Road-Map-Exhibiting Apparatus for Motor Vehicles—Which is operable by the forward movement of the vehicle to be successively exhibited in a manner to continuously indicate to the motorist his precise geographical location, may be readily applied to an automobile. Patent 1749243. William L. Eglinton.

Gear Shift—An automatic mechanism whereby the shifting of gears from operative into neutral, and into another operative position, during one continuous movement of the clutch, prevents the gears shifting from second or third speed into reverse. Patent 1749837. Arthur C. Nickell, Jr.

Tire-Deflation Switch—A signal or alarm, electrically connected with the usual ignition or lighting circuits, and giving warning to the operator of an automobile of the deflation of one or more of the tires during travel. Patent 1750563. Joseph Berger.

Steering Mechanism—For vehicles, whereby the operator will be relieved of much manual labor, the operation requiring practically no effort regardless of whether the vehicle is moving or at a standstill, so long as the vehicle's motor is operating. Patent 1749816. William R. Hendrix.

Vacuum-Cleaner — Whereby the suction created in the intake manifold can be utilized to perform the functions of a vacuum cleaner, the dust being prevented from passing into the manifold or interrupting the normal operations of the engine. Patent 1750800. Sydney R. Gould.

Internal Spring-Metal Reenforcing Member—Which will take the place of the ordinary inner tube, may be readily inserted within a vehicle tire, and conform to the inner walls, and will force the tire beads outwardly against the rim. Patent 1751741. Victor Karbowski.

Auxiliary Control for Motor Vehicles—Which permits the driver of a house-to-house or short-stop delivery zone truck, to automatically start or stop his car, either from the usual driver's seat, or from the delivery door, thus saving much time. Patent 1748041. Herman T. Backhus.

Automobile Identifier—A frangible support for a license plate or other identifying mark, so that in a collision the supporting means breaks and causes the indicia to drop, thus leaving identification in case the driver escapes. Patent 1747446. Stephen G. Krile.

Hydraulic Power Transmission—In which a fluid is employed for effecting a silent driving engagement and cushioning effect of one shaft with another, thereby eliminating jolts and harsh mechanical connection, as in ordinary motor vehicle transmissions. Patent 1748436. Victor Arkin.

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Lack of space makes it impossible to give many cross-references or to enter a given reference in more than one place. Each article is therefore entered where it is believed it will be most easily found. In every case, the general subject should be sought rather than the supposed specific title of an article. We call special attention to the classifications "Aviation," "Engineering," "Medicine," "Miscellaneous," etc., under which many items will be found, the location of which otherwise would be very puzzling.

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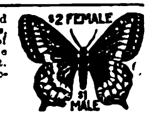

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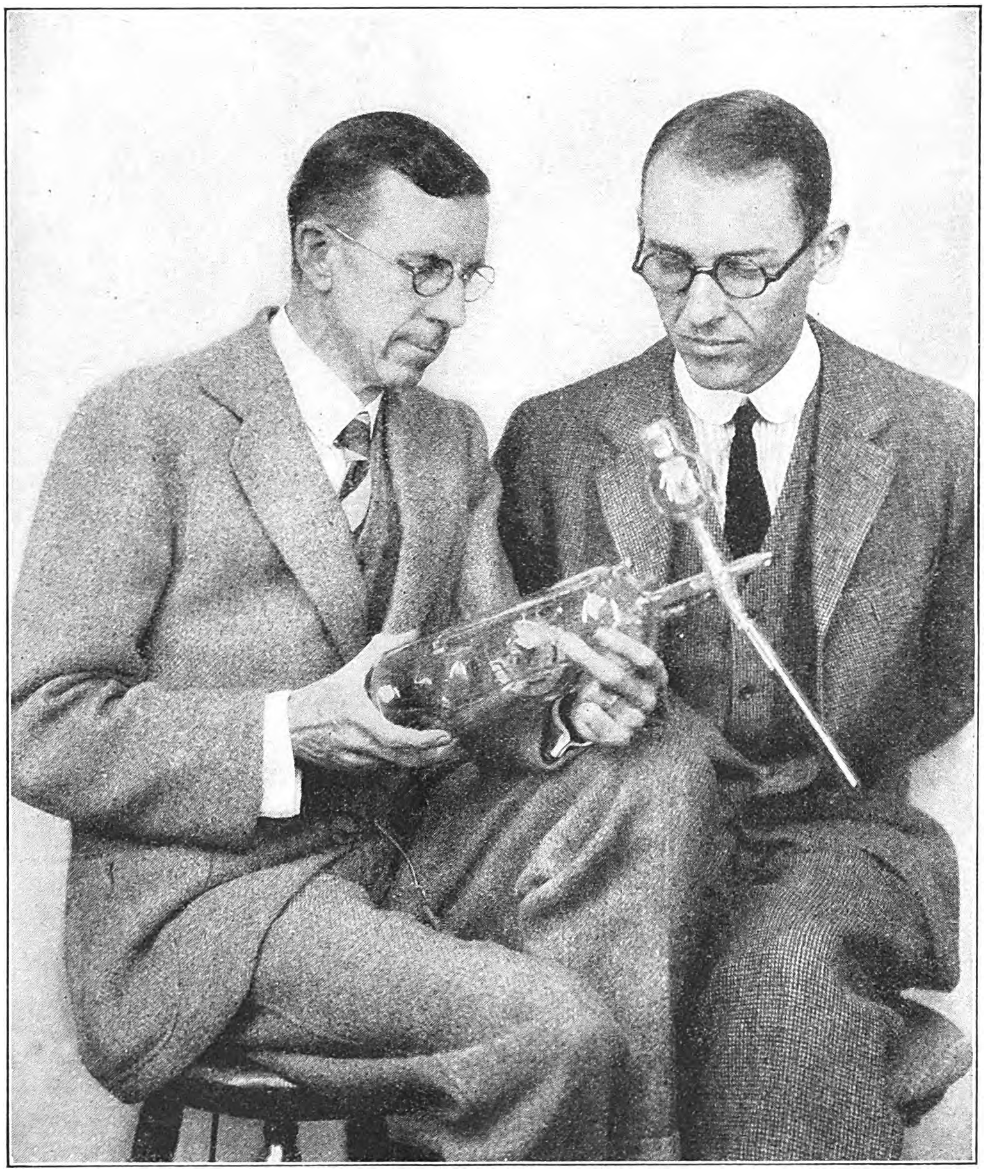
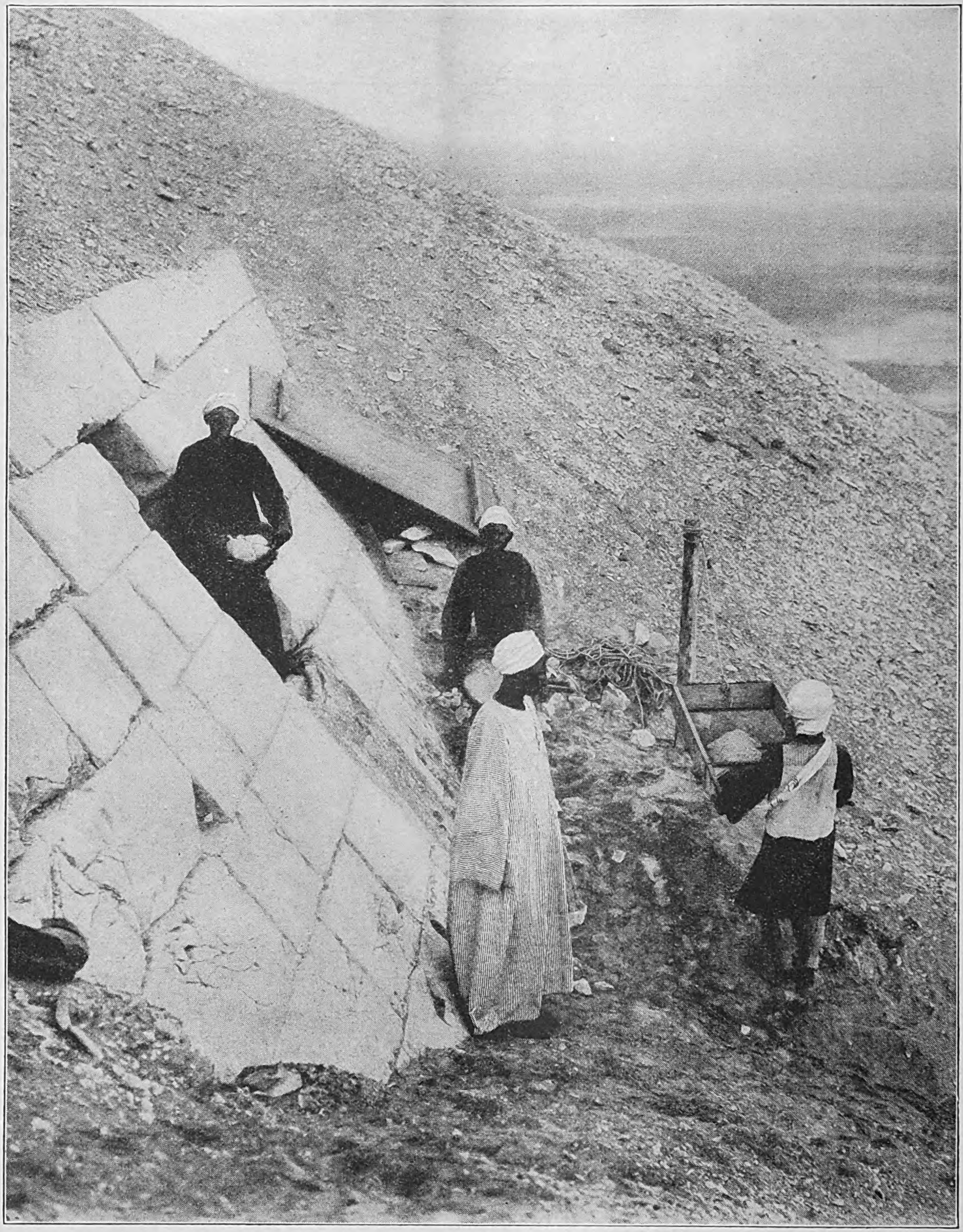


C. J. Davisson **L. H. Germer**

DOCTORS Davisson and Germer of the Bell Telephone Laboratories in New York performed experiments which furnished physics with concrete evidence that De Broglie and Schrödinger were right when they attributed a wave nature to the electron, hitherto regarded as a wholly material particle. The wave atom concept, explained on page 38, is now rapidly displacing the more familiar Bohr atom having analogy with sun and planets. This recent trend is likely to discomfit writers of popular science whose books have tended to create the unfortunate impression that the facts at last have been finally settled, instead of being constantly subject to revision in the light of new experimental evidence, as they actually are among physicists, and as they should be. Further discomfiture is in store for all who attempt to popularize the wave atom concept, for it has no cut-and-dried, familiar analogy like sun and planets and, strictly speaking, can be expressed only in the most agonizing of higher mathematics. Hence the planetary atom is likely to remain in style, popularly, some years after most physicists have discarded it. In the photograph Dr. Davisson holds in his hands the glass evacuated tube into which was sealed the same small apparatus shown on page 40. Dr. Davisson came to science via the University of Chicago and Princeton; Dr. Germer via Cornell and Columbia. They are typical examples of workers in pure science.



Clearing the Interior of a Pyramid

THE important excavations conducted by the Museum of the University of Pennsylvania at Meydum pyramid in Egypt are fully described in the article starting on the opposite page. A casing of well-cut limestone blocks completed the pyramid. On the slant of the pyramid this masonry outcrops from the debris and an opening in the casing gives access to the interior. A man is posted in the entrance who hands out the broken material passed up through the long passage by a chain of 60 men. All the loose material, earth, et cetera, is carefully sifted to see if it contains valuable material. The sifter in our photograph shows great inventiveness, for Egypt. The "boy" has attached a sieve to a post, thus taking up weight.

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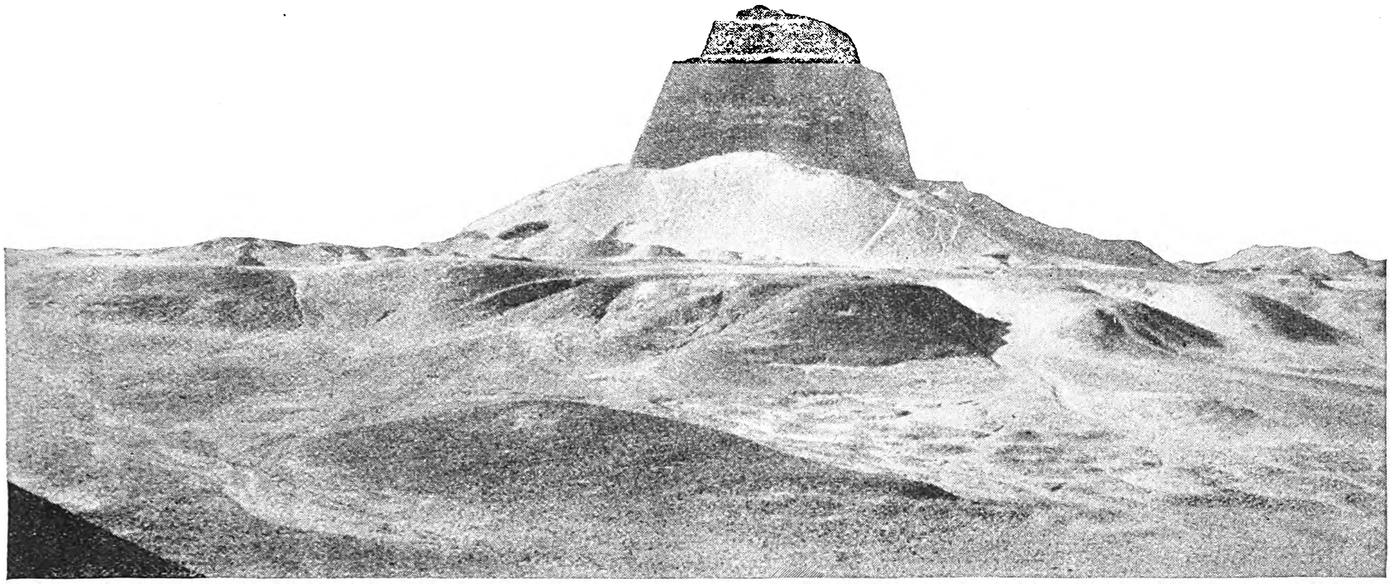


All photographs courtesy Museum of the University of Pennsylvania

The Meydum pyramid of today, as reduced from the original form, showing the southern side. This illustrates the condition of the pyramid before last season's work began

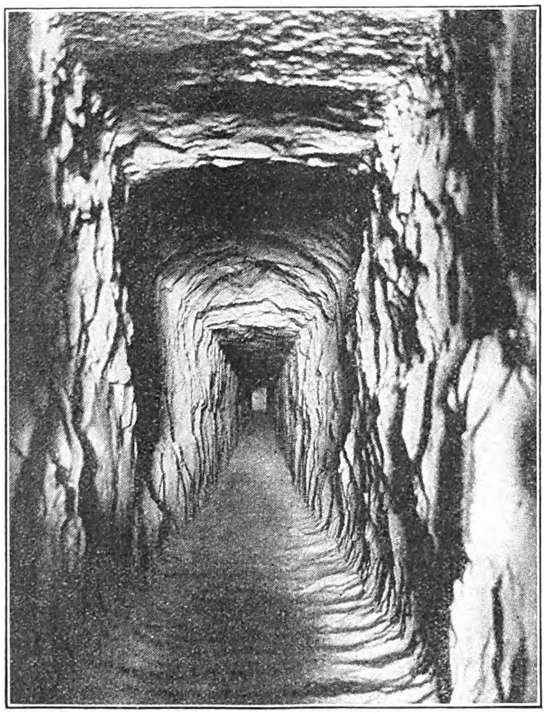
Exploring the Meydum Pyramid Site

By Cornelia H. Dam
Staff, Museum of the University of Pennsylvania

IN the age of Tutankhamen and of Rameses the Great, 1500 years before Christ, the Pharaohs of Egypt, whose empire extended from the heart of Nubia to the Mediterranean and included Libya, Sinai, Syria, and Palestine, used to boast of their exploits that "nothing like it had been done since the time of Seneferu." This venerable name, which echoes through Egyptian records for two thousand years, designates the first really great historic king of Egypt, father of that Cheops (Khufu) who built the great pyramid of Gizeh, near Cairo.

WITH Seneferu, who died about 2900 B.C., we are at last on firm ground in Egyptian history. He laid the foundations for the Fourth Dynasty, that remote, magnificent period of which the art was never again equaled, and of which the great pyramids of Cheops, Chephren, and Mycerinus are the immortal monuments. From later records, notably the Palermo Stone, we know something of his exploits: he united Egypt under his rule from Nubia to the Mediterranean, and invaded Libya, returning with 7000 prisoners; he sent a fleet of 40 vessels to the northern coast of Syria for cedar logs, and expeditions across the desert into the Sinai mountains for copper, so consistently that he was later regarded as the founder of Egyptian operations there, and stations on the desert route thither bore his name for 2000 years. He caused to be built vessels 175 feet long for his traffic on the Nile.

The marvels of his reign and the splendor of his court are referred to again and again in later records—the Westcar papyrus relates how the king, suffering from ennui, was taken to row upon a lake, with a gay party of youths and maidens, and all went well until one of the girls dropped a favorite malachite pendant overboard. But a court magician saved the day by piling up the waters of the lake, as Moses did the Red Sea, and recovered the jewel.

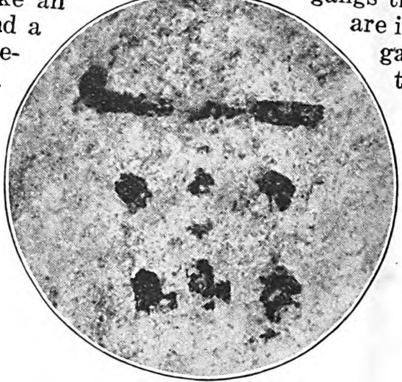


A long passage sloping downward leads to the tomb of a Pharaoh in the pyramid

At Meydum, about 50 miles south of Cairo, where the western desert edge touches the fertile floor of the Nile valley, Seneferu built the earliest known true pyramid, for the two similar earlier constructions at Sakkara and at Zawiet el Aryan seem never to have had added the outer casing which would have turned their stepped stages into a true pyramid form. And at Meydum, time and weather, and above all the depredations of man, have destroyed most of the casing and exposed the stages and the rubble core of its construction, so that today the pyramid presents a stepped appearance, not unlike the staged towers of Babylonia, and has therefore often been called a "false pyramid." Excavations, however, have revealed the original casing blocks on the lower stages, and the methods of construction, which are of considerable interest for the history of the development of architecture.

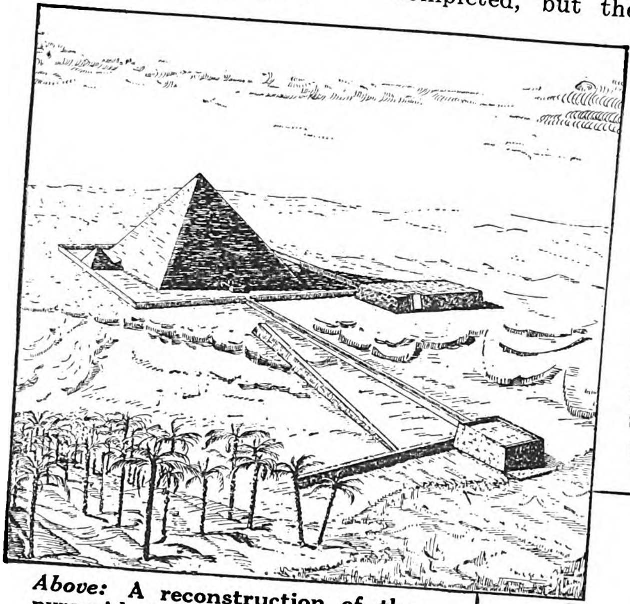
The pyramid seems to have been

built cumulatively, quite possibly over an original mastabah tomb, as a staged building of seven stories, to which a later coating was added, increasing the stories to eight; finally the steps were filled in to make an even inward slope, and a casing of well-cut limestone blocks, quarried far away across the Nile, and floated over during the inundation, completed it. The original height of the pyramid has been estimated as about 300 feet; the existing stages rise only 214, but it is still an imposing pile, visible from many miles around.



"Six cubits," a quarrymen's mark in black paint on a stone of the pyramid

The cumulative construction evident in this earliest true pyramid is particularly interesting for the light it throws on the probable development of that architectural form from a mastabah, because the next pyramid in date, that of Cheops at Gizeh, was obviously planned in its finished form from the beginning. We might say that Seneferu *invented* the pyramid!



Above: **A reconstruction of the pyramid site, showing pyramids and adjacent structures.** ***At the right:*** **Sections of the pyramid**

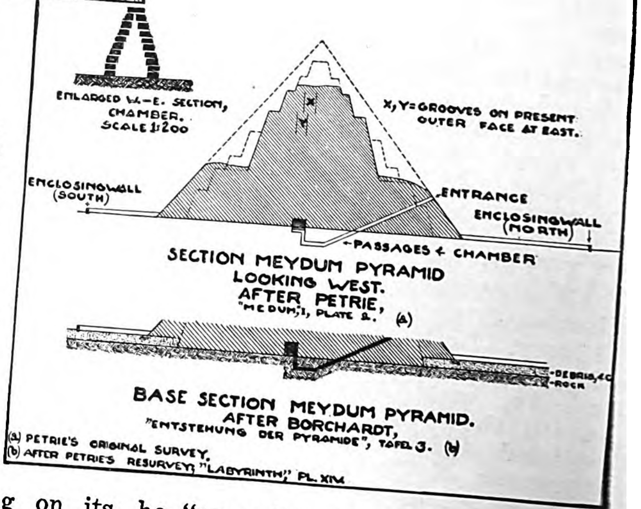
Three great Egyptologists, Mariette, Maspero, and Petrie, had each done work at Meydum before the Museum of the University of Pennsylvania undertook excavations there last November. But the site had never been thoroughly explored, and it was with reasonable, and soon justified, hopes of important finds that Mr. Alan Rowe took the field as director of the expedition.

The first work undertaken was on the pyramid itself, removing the centuries' accumulation of debris and rubbish from its base, and clearing the passages and chambers in the interior. It was a long and laborious task, involving the removal of hundreds of tons of debris, and the labor of a large party of workmen for the greater part of the season.

ON fragments of stone found in the debris around the base were painted inscriptions giving the dates of the 16th or of the 17th year of the king's reign, apparently the year in which the casing was put on, and the pyramid completed. These marks were put on the blocks in the quarry, before they were transported across the valley and presumably for the purpose of making a count of the number cut each day by the different gangs of workmen employed on the operation. The word *aperu*, which means "gang," also appeared. The names of a number of the gangs that worked at Meydum are identified: the "pyramid gang," the "north-gang," the "enduring-gang," the "vigorous-gang," and the "scepter-gang." Lines in red paint, the original levelling lines of the builders, and their measurements in cubits also appear on the stones still in situ on the pyramid.

The task of clearing away the debris outside is not yet completed, but the interior was finished in time for the visit of the king and queen of the Belgians on March 30. The entrance to the pyramid, once carefully concealed, is some 60 feet from the ground on the north side, thence a long narrow passage, less than six feet high, descends for 185 feet to an antechamber, about twice as wide as the passage, on its left, and another immediately following on its right. Thence a horizontal passage leads to the shaft which opens into the sepulchral chamber some 20 feet overhead. It is a tiny room, about 20 feet long and high, but only nine feet wide, with stone walls and floor, and a steeply corbelled ceiling.

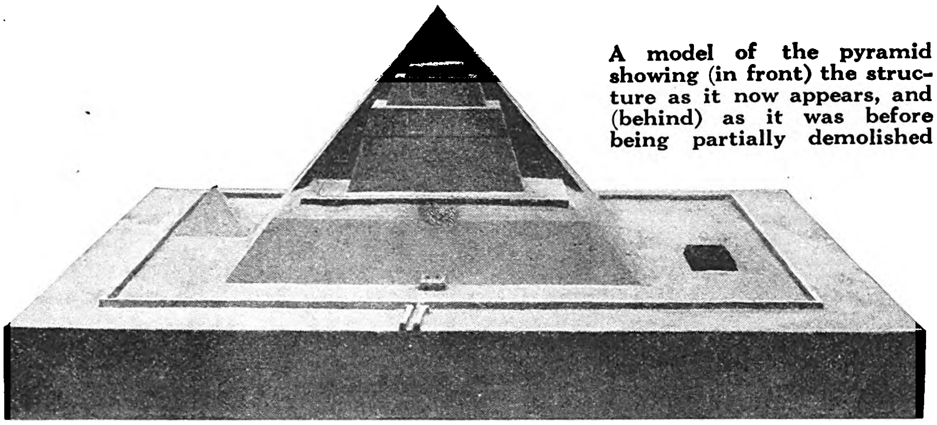
To clear the interior a long chain of men, increasing as they worked inward to the number of 90, was formed to pass in empty baskets and pass them out full, for in the narrow passage only one man at a time could work with pick and hoe. "It is a long and tedious job," wrote Mr. Rowe, in his monthly report to the Museum, "as the farther we penetrate the worse the air becomes. In fact when we had reached the bottom of the sloping passage leading from the outer entrance, just at the point where the passage runs into an antechamber, we were able to work for only one hour each day. At the end of this time our candles went out, warning us that it was unsafe to remain inside any longer." Nothing of very great importance was found inside the pyramid, as it had been opened and robbed in antiquity—how soon after it had been sealed up we cannot say, certainly it was open in the Twentieth Dynasty (c. 1200 B.C.), for the names of two scribes who visited it then are still visible on the ceiling of the passage. "Fools' names" are often valuable evidence in archeology!



ENLARGED W.-E. SECTION, CHAMBER. SCALE 1:200
X, Y = GROOVES ON PRESENT OUTER FACE AT EAST.
ENCLOSING WALL (SOUTH)
ENTRANCE
ENCLOSING WALL (NORTH)
PASSAGES & CHAMBER
SECTION MEYDUM PYRAMID LOOKING WEST. AFTER PETRIE, "MEDUM," I, PLATE 2. (a)
DEBRIS, &C
ROCK
BASE SECTION MEYDUM PYRAMID. AFTER BORCHARDT, "ENTSTEHUNG DER PYRAMIDE", TAFEL 3. (b)
(a) PETRIE'S ORIGINAL SURVEY.
(b) AFTER PETRIE'S RESURVEY, "LABYRINTH," PL. XIV.

AGAINST the east face of the pyramid is a small temple, consisting of a vestibule and a little rectangular room, behind which, in a courtyard, stand two uninscribed stelae with an offering table between them. On the walls are pictures and scribblings put there by visitors to the sacred precincts 3500 years ago. One scribe of the time of Thothmes I. (c. 1500 B.C.), wrote on the wall that he "came here to see the beautiful temple of the Horus (king) Seneferu: he found it like heaven within when the sun-god is rising in it: and he exclaimed 'the heaven rains with fresh frankincense and drops incense upon the roof of the temple of the Horus Seneferu.' "

From the valley edge (the inundation level), where by analogy with other pyramid sites there should be a small entrance temple, although none has yet been found, there runs a long brick-faced causeway, by which pilgrims in ancient days might approach the sacred pyramid area, which was surrounded by a wall, and enter it by a gate at the end of the causeway, directly opposite the entrance to the temple. To the south of this causeway are the remains of another, which was evidently used as a road to haul material during the construction of the pyramid, then partly destroyed and covered over.

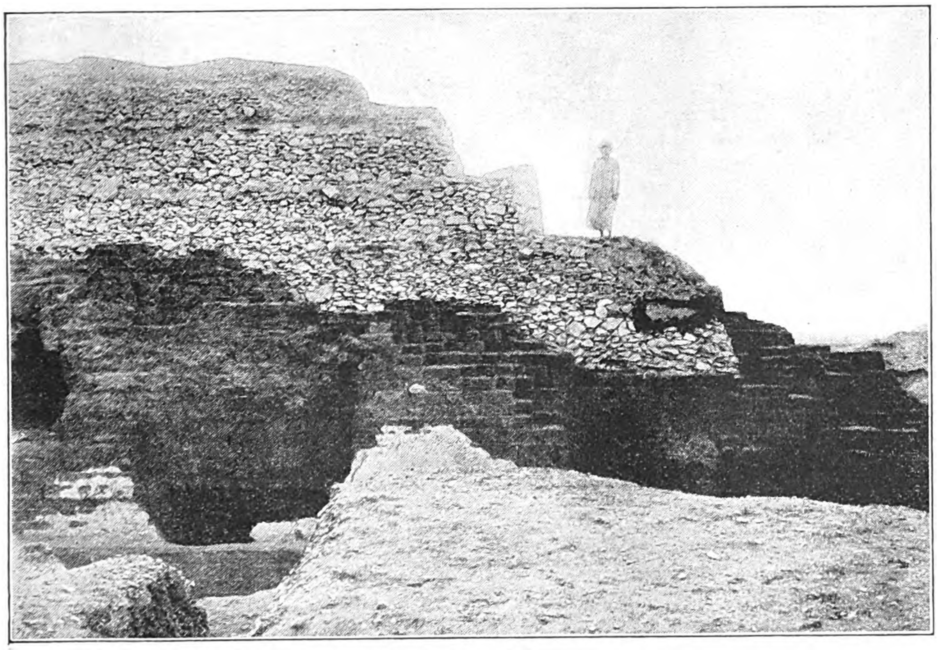


A model of the pyramid showing (in front) the structure as it now appears, and (behind) as it was before being partially demolished

WITHIN the pyramid precinct wall are the remains of a miniature pyramid, perhaps a queen's, on the south, and of a large, presumably a royal, mastabah-tomb on the north.

It is not known where Seneferu was buried. If it was at Meydum, his body was subsequently removed, either by tomb robbers, in which case it was probably destroyed, or by his pious successors who wished to avoid just such a catastrophe, in which case there is a fair chance of yet discovering it, either at Meydum, or at one of the other great Fourth Dynasty cemeteries of lower Egypt. The transferred burial of one of his Queens, Hetep-heres, mother of Cheops, was found recently by the Harvard-Boston Expedition near her son's pyramid at Gizeh, near which is also the tomb of Seneferu's eldest daughter, Nefert-kau, sister-wife of Cheops. His eldest son, Ka-Nefer, on the other hand, was buried at Dahshur, (where Seneferu had built a second pyramid, not as a tomb, but as a cenotaph) and two other sons and their wives were buried at Meydum. From the tomb of one of these royal couples, Ra-hotep and Nefert, came their portrait statues (now in the Cairo Museum) which many people consider the finest known Egyptian statues, and from the other, that of Nefer-Maat and Stet, the equally famous painting of Geese (also in Cairo) and a beautifully painted fragment in the Museum of the University of Pennsylvania.

In rock-cut chambers piled-up coffins gave the appearance of a forgotten lumber room



North end of east side of mastabah tomb No. 17 showing the stepped stages in the stone core which were later filled in to support a brick casing

All around the pyramid of Seneferu stretches a vast cemetery, including examples of various types of burials used in Egypt from the Fourth Dynasty down through Ptolemaic times (3000-300 B.C.), a strong indication of the enduring renown of the sacred character of the site.

Simultaneously with the work on the pyramid Mr. Rowe started clearing a large mastabah (Number 17), which is some 350 feet long and half as broad, and is situated just to the northeast of the pyramid. The name of the original owner has not yet been discovered, but it must have belonged to a member of the royal family or at least to a very important person. Its construction proved to be analagous to that of the pyramid; that is, it was built originally in three steps, which were later filled in to give the even inward slope of a mastabah. Two brick-faced ramps led from the valley up to the eastern face of the tomb. The northern one once led to the top of the mastabah, and the southern one to a little chapel, or niche, of which only the floor now remains, but traces of the walls, as thick as the chapel was wide, enabled Mr. Rowe to reconstruct the plan of an imposing building of pure white limestone. The walls were once highly polished, and the hard stones used in the process were found in the debris nearby.

PROFESSOR PETRIE found a tomb chamber behind the niche when he worked at Meydum, so the discovery this year of a second niche at the northern end of the same side, led Mr. Rowe to hunt for another chamber and possible burial in it, at that end of the tomb. When sending his last report, he had not yet found it, but the search goes on.

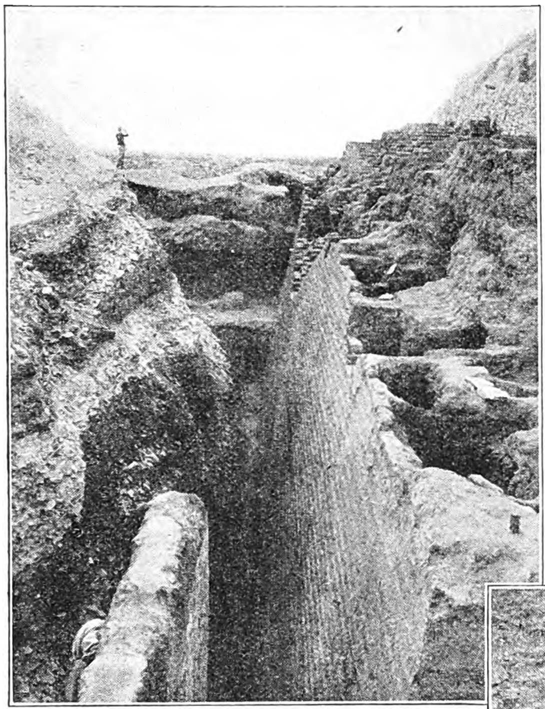
In clearing the heavy retaining walls of the mastabah, he found that they were honeycombed with intrusive (i. e.—later) burials, most of them dating from the New Empire (1500 B.C.) and later. They represent chiefly the burials of the common people, and fall into three main catagories:

(1) Unwrapped skeletons, and mummies buried simply in linen wrappings,

often fringed, occasionally with green borders;

(2) Mummies to which an additional covering of reed or palm-frond mats were added; and

(3) Mummies in coffins. Rectangular coffins were usually undecorated except for a coat of whitewash, and confined to the burials of children, adults being buried in rather crude anthropoid coffins of the type of "mummy cases" to be seen in most museum collections of Egyptian antiquities.



In the mastabah, or noble's tomb No. 17, the north (outer) casing wall is 56 feet high. Note the excellent brickwork

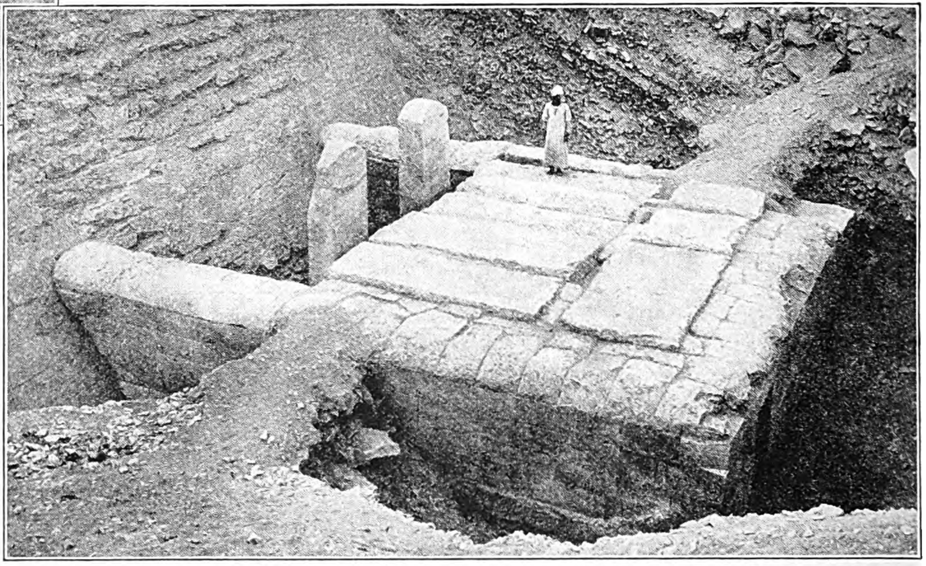
Pottery dishes and bowls buried with the mummies contained grapes, dates, palm-fruit, pomegranates, or other food, and of course there was an abundance of the essential equipment for a pleasant after-life which is usually found in Egyptian tombs: boxes of eye-paint, trinket-boxes of wood, amulets, scarabs, beads, earrings, pins and bracelets, combs of wood and haircurlers of bronze, the scribe's palettes and the craftsman's tools.

THE burial of so many persons in the actual walls of the mastabah, (not a very convenient place), indicates that the tomb was highly venerated 2000 years and more after it was built, and Mr. Rowe suggests that as the only person we know of who was so long venerated was a magician, Zedi by name, who lived in the time of Cheops, and who at the age of 110 ate 500 loaves of bread and a haunch of beef, and drank a hundred jugs of beer a day, the great mastabah might have belonged, either actually or traditionally, to this picturesque and very remarkable person.

Just to the east of the great mastabah Mr. Rowe found a miniature replica of it; it had been plundered in antiquity, and only one of the three pits beneath it contained the original Fourth Dynasty burials. Of the many types of burials already cleared in the neighborhood of the pyramid, the majority belong to the New Empire, a thousand years later than the pyramid and mastabah-tombs. There are however, a number of contemporary, that is Fourth Dynasty, tombs, most of them simply large pits with two or three recesses in the sides, in which lay skeletons, although two of the number so far excavated had large masonry chambers, illustrative of the increasing use of stone in place of brick for private as well as royal tombs in this period.

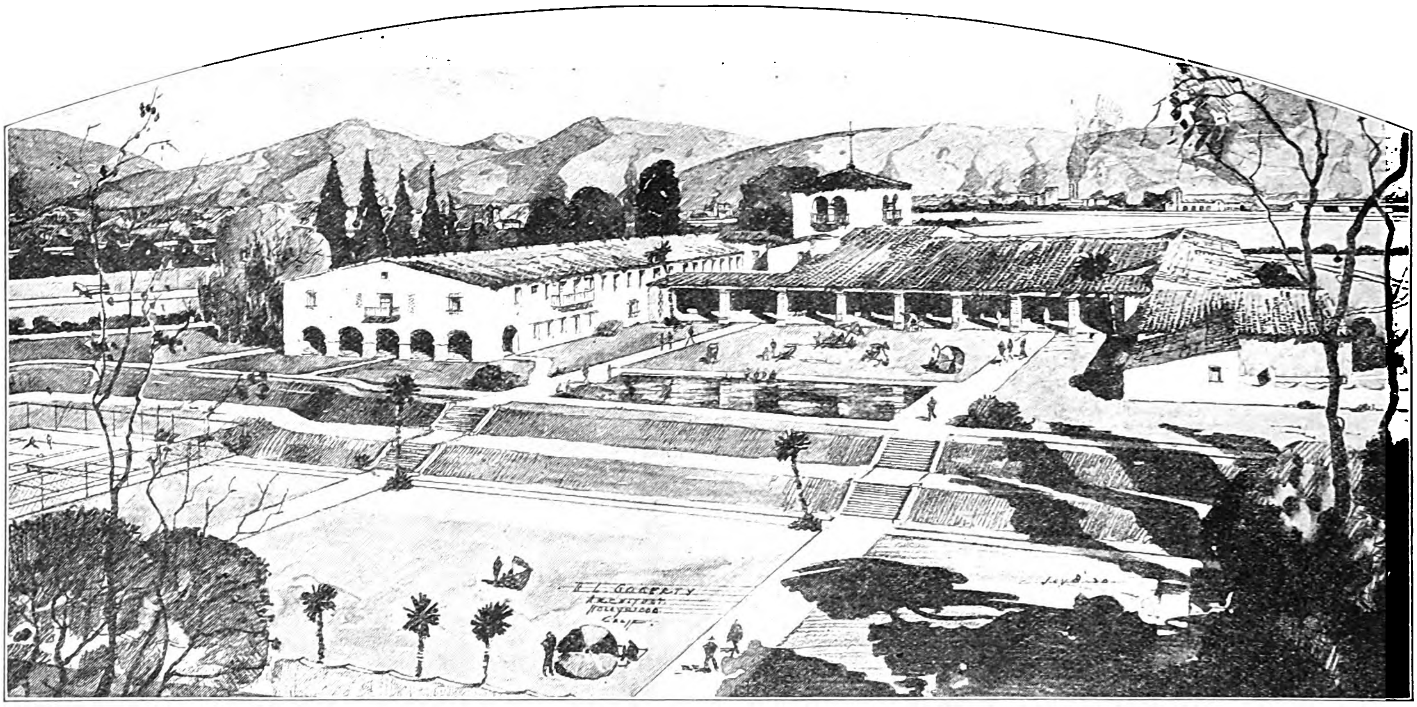
The most exciting and spectacular discovery of the season came in January, when, exploring a depression in the sand to the southwest of the pyramid, Mr. Rowe came upon a group of twelve rock-cut chambers, many of them stacked ceiling-high with coffins, "for all the world," he wrote, "like a forgotten lumber room." There were 101 mummies, besides 29 simple burials, the largest number of Ptolemaic mummies ever found together in Egypt. Of course the tomb had to be guarded day and night until it was cleared, and the first night the Arab workmen were afraid to sleep there until two of the staff joined them, and at that passed most of the night exchanging ghost stories. "They certainly had the right setting in which to relate their experiences," Mr. Rowe added, in his report on the latest discoveries.

The majority of the coffins belong to the Twentieth Dynasty (c. 1200 B.C.) or later, and one of these contained the finest mummy yet discovered at Meydum. Its outer coffin was badly damaged by rock falls within the room, but the inner one, beautifully decorated, was well preserved, as was also the mummy itself, covered with a network of glazed pottery beads; on its head was a gilded mask, and on its breast a golden winged scarab. Two of the coffins are Twelfth Dynasty (c. 2000 B.C.), delicately painted with texts from the Heliopolitan Recension of the Book of the Dead, prayers for offerings of cakes, ale, beef, geese, bread-rolls, clothes, incense, and oil on festival days. "O lady of the house, Sat-Her-em-hat, triumphant, revered before the gods who are in the other world, they transfigure thee. Take to thee thy head, and collect to thee thy bones," says one verse.



Against the face of the pyramid is a temple consisting of a vestibule and a room; behind stand two *stelae* or pillars, with an offering table between. The location of this temple is shown in the model illustrated on page 11

AND truly, the bones of those long-buried Egyptians who strove so hard to preserve them against time, and so cunningly to hide them in pits, pyramids, and shafts, from the impious tomb robbers of their own day, are safer now than ever, in the reverent hands of science. The careful excavator is bound to earnest respect for the remains of these long-forgotten people, lest he lose through heedlessness some minute bit of evidence of great scientific value, and he spares no pains to develop the all-seeing eye and the sympathetic mind that may enable him to reconstruct for us, vividly, accurately, and at last completely, the life and thought of this great civilization that vanished from the earth so many centuries ago.



An architect's drawing of the clubhouse and grounds at Grand Central Air Terminal, Los Angeles, which the Flying Club of California has leased from the owners of the airport. Further details are given in the text

Flying Clubs for Private Fliers

By Charles L. Lawrance*

THERE are three hundred and four flying clubs in the United States today owning plane equipment. This figure is derived from reports of the Department of Commerce covering the licensing of aircraft and includes all cases where a group of individuals have jointly bought a licensed airplane. Undoubtedly many of the clubs included in the figure are of extremely loose organization owning but a single plane and renting hangar space from the nearest airport. Yet the number itself is surprising. It is estimated that 50 percent of the clubs have sprung up during the past 18 months.

In other words, American men and women are taking to the air through the most practical means at hand—the flying club. By organizing into groups, people can afford to buy and to maintain an airplane the cost of which may be beyond the means of any one of the group. The small flying club is one of the most important manifestations of democracy in the airplane field today. It means that flying is not only for the rich but is possible for men of moderate means who are willing to work together so that they may fly.

In no place is this co-operative movement toward flying more clearly marked than in American colleges. While only at Harvard University do students own their own ship, yet the tendency to combine into organized units to promote flying has touched nearly all of the great universities. On May 10 in connection with the Air Show in New York City the first college aeronautical conference was held. Delegates from the flying clubs of 10 colleges were flown to New York in planes of the Curtiss-Wright Flying Service which picked up representatives from as far west as the University of Kansas.

OTHER universities represented included the University of Illinois, the University of Michigan, Ohio State University, and New York University. In every case it was reported that members of the clubs were putting in flying time with planes rented from the nearest airport. In some cases faculty opposition was reported, but as a rule professors themselves were said to be interested in the movement. The membership of every club included a number of licensed pilots, in some cases of the higher grades.

Thus the flying club, even where no equipment is owned, is a powerful factor in increasing the number of people who fly and know how to fly. At the same time larger clubs have made flying a far more comfortable and convenient thing than it ever has been before. This is especially true in the case of such a club as the Aviation Country Club of Long Island opened over a year ago. This club, modeled more on the flying clubs of England and Canada, owns its own clubhouse and field as well as four planes. It includes an associate membership of 180. Fifty planes are owned privately.

The formation of such a club represents a large outlay of capital and its membership is of necessity limited to the more wealthy type of individual. On the other hand the small, loosely organized club which rents hangar space from the nearest airport is under the handicap of having no clubhouse or headquarters. A compromise between these two types of club is now being worked out by the Flying Club of California which in July will move into the clubhouse being built for it at Grand Central Air Terminal outside of Los Angeles.

The expense of building the 200,000-dollar Spanish-style clubhouse is being borne entirely by the Curtiss-Wright Airports Corporation, the owners of Grand Central Air Terminal. The corporation is renting the clubhouse to the Flying Club of California for a period of 20 years. Because the rental is relatively low, the dues of the Flying Club of California are only six dollars a month. Its members, however, will enjoy one of the most luxurious clubhouses in the country, equipped with dining and sitting room, squash courts, and swimming pool, with tennis courts outside and two golf courses immediately adjoining.

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*See "Among Our Contributors," page 5.

It is evident that membership in such a club is at once attractive to a man who, on the one hand, could not afford to join a club which owns its own house and field, and who, on the other hand, is unwilling to put up with the inconveniences inherent in a club which has no permanent headquarters. It is altogether probable that the next few years will see clubs similar to the Flying Club of California established at the great eastern and middlewestern airports.

In the vicinity of New York, for example, there are a number of fields at which flying clubs could establish themselves in co-operation with the owners. Land has been set aside at the Curtiss-Wright Airport at Valley Stream for the building of a clubhouse for lease to a private flying club. Residents of the Oranges and Morristown, New Jersey, on the other hand, may some day organize into a club which will make use of the facilities of Essex Airport at Caldwell. The fact that many New Yorkers live in the country during the summer makes such ports particularly well suited to flying clubs.

Members of a flying club which has its clubhouse at a large landing field naturally enjoy all of the facilities of the port. Hangar space, machine shops, and repair facilities are all at hand. Flying instruction, always an important consideration in forming a club, is available at most large flying fields.

It is interesting now, when the United States has plenty of flying-club news and activity of its own, to look back only a year when most of our knowledge of such clubs came from abroad. The retrospect shows that, although the flying club in America is a new thing, it has already exhibited marked differences from the clubs of Europe. In no case is the difference more striking than in the matter of subsidy from the government.

English clubs, which were the first in the field and developed soon after the war, were almost all subsidized. The English government gave 10,000 dollars to a club on its formation, for buying two airplanes and thereafter 5000 dollars a year for purposes of upkeep. Under this stimulus English clubs spread rapidly and gradually came to own their own flying fields instead of using the army fields. Today English clubs include many thousands of members with much flying time to their credit.

NO subsidy has ever been given to American clubs. Although the stimulus might have developed the movement here more swiftly, in the long run the absence of subsidizing should prove beneficial. American clubs gain an enormous amount of vitality by standing on their own feet financially. In this connection it should be noted that just as American clubs have proceeded without government aid, so, too, members of such a club as the Aviation Country Club of Long Island have tended to buy their own planes rather than to depend on the planes of the club. The fact that 50 planes are privately owned by members of this club is a distinct departure from European tradition.

A glance at the roster of the planes owned by members of the Aviation Country Club of Long Island discloses a third difference. The roster includes not only small planes such as the Moth but also cabin planes such as the Travel Air, the Robin, and the Keystone Loening amphibion. In other words, pleasure flying in America does not necessarily mean "light" flying as it does in England where distances are so much shorter. While the Englishman can use a small plane for getting to his week-end destination, New Yorkers who wish to fly to Florida or the Thousand Islands will of necessity turn to the heavier cabin type of plane.

The fact that American clubs have been developing rapidly and along their own lines should not obscure the fact that flying clubs have progressed in other countries. In Canada, for example, during 1929, members of its 23 large flying clubs flew over 1,232,000 miles in 15,400 hours of flying time. Total membership in Canadian clubs is 5092 and at the end of 1929 there were 396 solo flyers, 165 private pilots, and 58 commercial pilots—all of them trained in club flying schools. In France the flying-club movement has also developed on a large scale. There are at least nine regional clubs of the Aero-Club of France with a membership totaling close to 9000 individuals. In 1929 these members flew over 8000 hours.

The development of foreign flying clubs has in the past been a stimulus and guide to America and will no doubt remain so for some time to come. The rapid spread of small clubs throughout the country, however, in the past year indicates that America contains the possibilities of developing a system of flying clubs proportional to its size and wealth. The coming year should see more small clubs formed and the organization of many existing clubs into tighter and more efficient units. The building of private clubhouses at the great airports of the country should follow naturally and with far-reaching results. The flying club is important to American aviation: it is a powerful influence in leading people to fly and to learn to fly.

A few of the members of the Long Island Aviation Country Club, with a member-owned plane

OUR POINT OF VIEW

Naval Officers in Aviation

IN view of aviation's unquestionable importance in the defense of the country, it will doubtless come as a distinct surprise to most people to learn that there is a considerable lack of knowledge of it among the older officers of the Navy. As a result of this fact, it is said that a certain amount of prejudice exists today within the Navy itself.

The natural way to overcome this prejudice and increase the efficiency of the Navy in these days when all naval activities are so closely associated in some way or another with aviation, would seem to be to train as fliers some of the older officers who naturally exercise the higher commands. Personal knowledge of aviation coupled with their years of experience on the water would enable these seasoned men to exercise their commands more intelligently and efficiently in co-ordinating the activities of the fighting fleet with those of the air fleet.

It is claimed that the Navy Department excludes the senior officers from all opportunity to take the flight training course at the Naval Air Training Station at Pensacola—this on an arbitrary basis whether or not they are physically and temperamentally qualified. It is the announced purpose to concentrate on younger officer pilots. At the same time, however, more than half the capacity of the training school at Pensacola is taken up by enlisted men and reserves on whom the government has only one to three years' claim at the outside. The thorough training there enables these men to qualify for positions in civil life at government expense.

Senior officers who are physically qualified, should not only be allowed to take this course, but should be forced to take it. It is believed that the efficiency of the Navy will suffer if the older officers who command it know nothing of aviation, and the only way they can understand it is through learning to fly.

Engineering Opportunities

TO the youth who expects to take up engineering but cannot decide in what branch of it to major, we suggest an investigation of the possibilities in highway engineering. Perhaps the fastest growing of the newer engineering fields, highway engineering concerns all the activities that have to do with the highway industry which has attained the rank of sixth of the nation's industries, financially.

With a production of over 5,000,000 motor vehicles and a total registration of 26,400,000 in this country last year, and a steadily increasing production each year, the need for more and better roads is impressively indicated. Registration of automobiles will grow at an amazing pace and highways must be built for them. For an indefinite period of years, there will be plenty of work for road builders, road machinery manufacturers, highway planners, cement and asphalt chemists, and others. The vast scope of the industry is of such a nature as to affect the daily life of practically every citizen of almost every country of the world.

Declining Conversational English

IS our coversational English or, more specifically, American language becoming debilitated through disuse? Many of us have thought so, but indications point that way more than ever if we are to judge by the results of an investigation conducted in New York City by American Telephone and Telegraph Company engineers who listened in on toll circuits over which business calls predominated.

Of the 79,390 words recorded, 30 simple words—principally the personal pronouns, prepositions, conjunctions, and a few verbs—made up nearly half. More astonishing still is the fact that 155 words, including the 30 already mentioned, made up more than 80 percent. Purists and philologists will be horrified to learn that "shall" was heard only six times; while "yeah," "uh-huh," and "er" were plentiful; and the grunts and monosyllabic replies recorded ran into the thousands.

It has been remarked that this study shows a "facility of expression and economy of vocabulary" that is apparently held to be congruous with the rapid pace of our age. But to the thinking man, it is appalling, in that it shows an utter lack of imagination among business men, a lazy mentality that does not fit into the picture of modern efficient business. It is hoped that this sorry record, spoken into the telephone by New York business men, is not representative of the country at large. If it is, we are sure to retrogress. If we take up once again the grunting "speech" of our prehistoric forbears, the "culture" of the machine age may be set down in the histories of a future Renaissance in a hastily written paragraph or two!

Of the total 3,016,281 miles of highway in the United States, only 660,000 miles are surfaced—or slightly more than 20 percent. Fortunately our people are highway conscious and it is certain, therefore, that this percentage will rapidly mount. This is borne out by the fact that Congress passed this year, with rare speed, a bill for adding 50,000,000 dollars to the present 75,000,000 which is given the states to build highways in the Federal Aid Program.

With so much work necessary on roads at home and an increasingly larger amount necessary abroad, it may be said without fear of contradiction that highway engineering today offers as fine a career as did electrical engineering in its early days—and with a decidedly wider field for the application of particular talents and aptitudes.

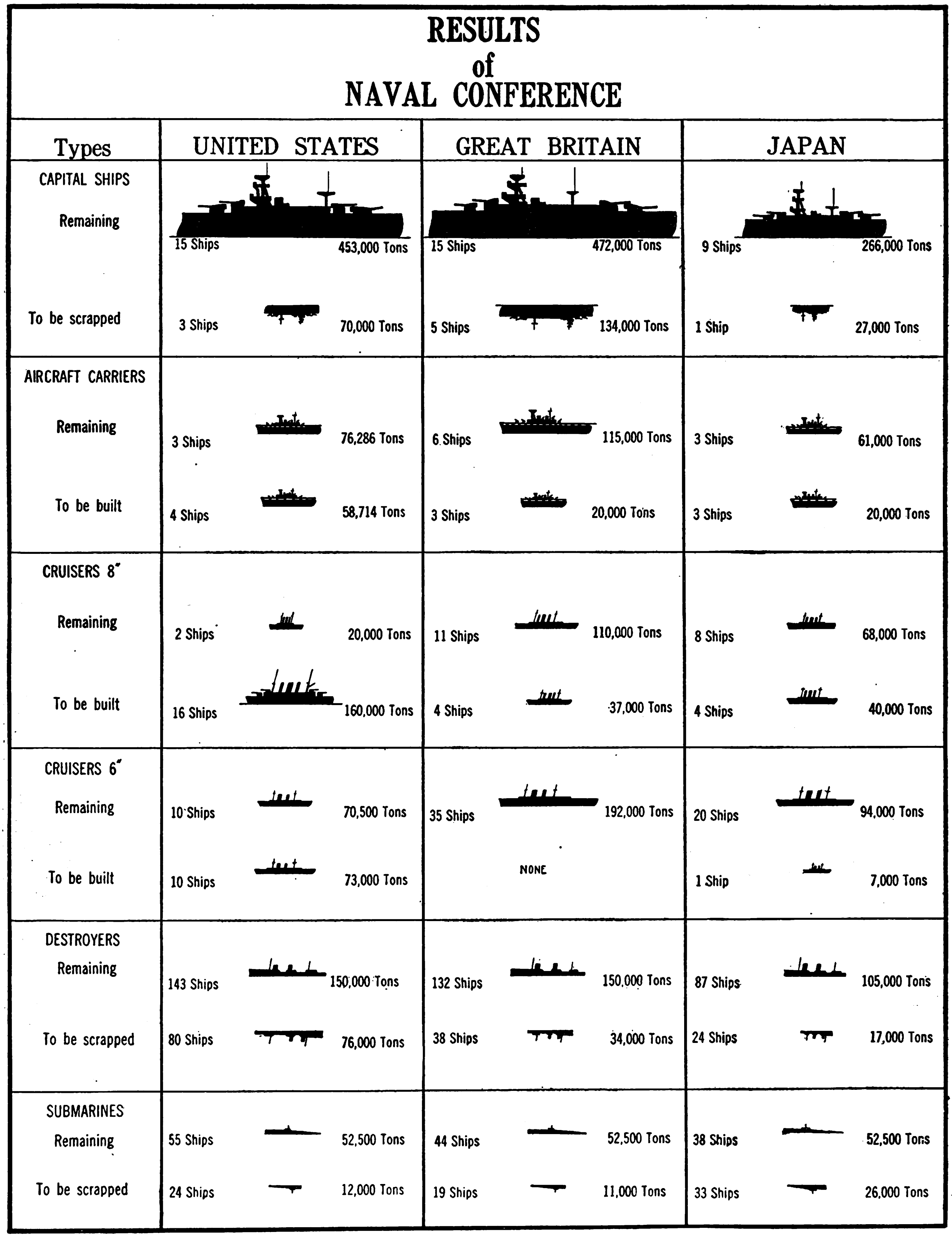
Analyzing the Naval Treaty

PRESIDENT HOOVER lost no time in transmitting the naval limitation treaty to the Senate. The Committee on Foreign Affairs and the Committee on Naval Affairs are giving immediate consideration to the treaty. They will scrutinize its provisions carefully and will hold extensive public hearings on the subject matter before giving their approval. The House Committee on Naval Affairs has demanded full information of the effect the treaty will have on the relative efficiency of our Navy. This consideration by Congress is essential. We are committing ourselves to an important agreement; no urgency demands the immediate approval of the treaty. The responsibility for our national defense rests on Congress; and it is the duty of Congress to examine minutely into all the aspects and ramifications of this treaty.

We confess that we are not enthusiastic over the part of the treaty fixing the ratios between Japan and the United States; we have the uncomfortable feeling that our delegation was embarrassed by our present naval inferiority and the Administration's eagerness for an agreement and could not properly support our country's position. In his prepared statement to the Senate Foreign Affairs Committee, Mr. Stimson tacitly admitted that, having already sacrificed our superiority in capital ships, we were handicapped throughout the negotiations. On the other hand, the position

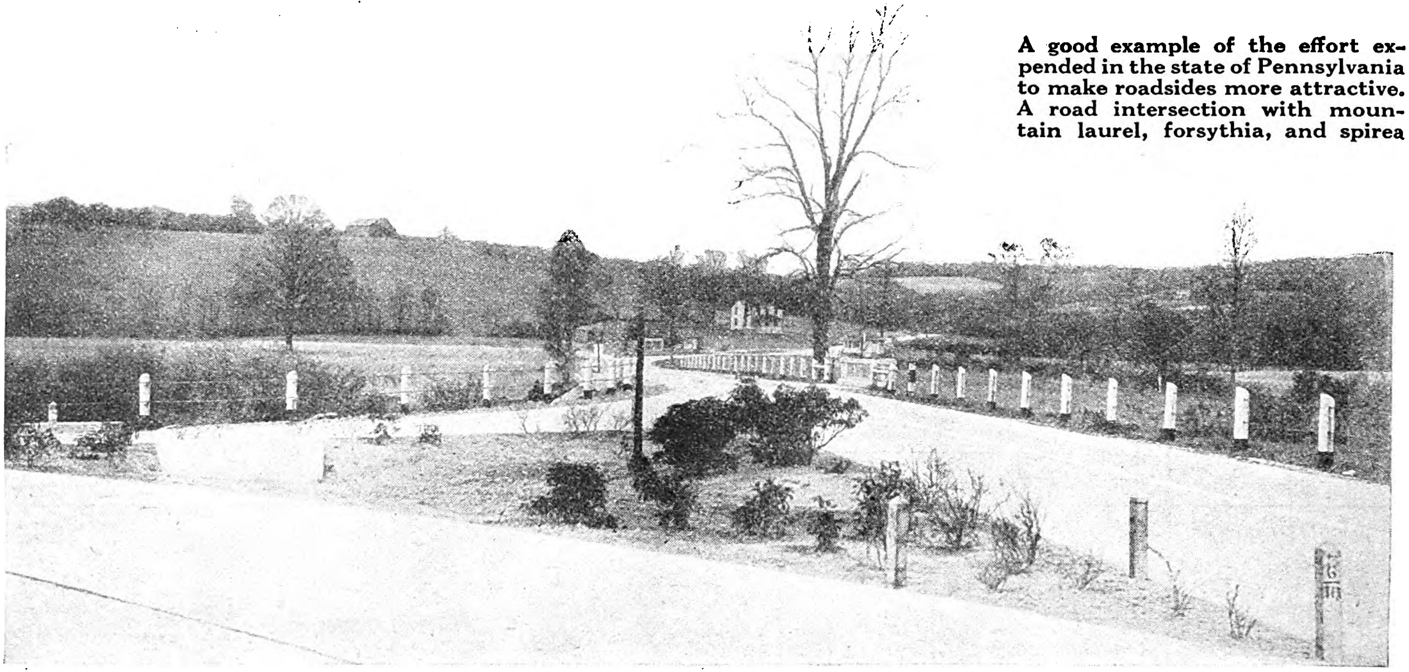
(*Please turn to page* 70)

RESULTS of NAVAL CONFERENCE



Types	UNITED STATES	GREAT BRITAIN	JAPAN
CAPITAL SHIPS			
Remaining	15 Ships 453,000 Tons	15 Ships 472,000 Tons	9 Ships 266,000 Tons
To be scrapped	3 Ships 70,000 Tons	5 Ships 134,000 Tons	1 Ship 27,000 Tons
AIRCRAFT CARRIERS			
Remaining	3 Ships 76,286 Tons	6 Ships 115,000 Tons	3 Ships 61,000 Tons
To be built	4 Ships 58,714 Tons	3 Ships 20,000 Tons	3 Ships 20,000 Tons
CRUISERS 8"			
Remaining	2 Ships 20,000 Tons	11 Ships 110,000 Tons	8 Ships 68,000 Tons
To be built	16 Ships 160,000 Tons	4 Ships 37,000 Tons	4 Ships 40,000 Tons
CRUISERS 6"			
Remaining	10 Ships 70,500 Tons	35 Ships 192,000 Tons	20 Ships 94,000 Tons
To be built	10 Ships 73,000 Tons	NONE	1 Ship 7,000 Tons
DESTROYERS			
Remaining	143 Ships 150,000 Tons	132 Ships 150,000 Tons	87 Ships 105,000 Tons
To be scrapped	80 Ships 76,000 Tons	38 Ships 34,000 Tons	24 Ships 17,000 Tons
SUBMARINES			
Remaining	55 Ships 52,500 Tons	44 Ships 52,500 Tons	38 Ships 52,500 Tons
To be scrapped	24 Ships 12,000 Tons	19 Ships 11,000 Tons	33 Ships 26,000 Tons

RELATIVE tonnage, in the six fighting ship classes, of the three signatory powers to the London agreement. The situation on May 1, 1930, showing the amount of building and scrapping necessary to carry out the provisions of the agreement after its ratification—drawn to a relative scale. "To be built" includes all ships not 100 percent complete, as, for example, six of our 16 eight-inch-gun cruisers which are 60 percent complete. Obsolete ships, such as destroyers over 16 years old and submarines over 13 years old, are not included in "ships to be scrapped."



A good example of the effort expended in the state of Pennsylvania to make roadsides more attractive. A road intersection with mountain laurel, forsythia, and spirea

Courtesy Pennsylvania Department of Highways

Beautiful Roadsides

Move for Sightly Highways Is Becoming Countrywide

By Walter E. Burton

MILLIONS of American motorists who seek restful scenery, charm, and recreation on the open road are beginning to ask for better-looking highways. To a limited extent, their demand is being answered. But there is a surprising hesitancy of some states in making use of available public funds for highway beautification.

An act of May 21, 1928, gave authorization for the inclusion of tree planting as a part of federal-aid road construction. But, more than a year after the act became effective, the Bureau of Public Roads had received no request for aid in a single road-beautification program. This does not indicate that nothing has been done to increase the beauty of modern roads, for, on the contrary, considerable progress has been made in many states.

Signboards usually constitute the first objective of a road-beautification movement. All but 11 states exert some kind of regulatory influence over roadside signs, yet not one prohibits their erection. The situation is a ticklish one because it concerns personal property rights. Some of the larger advertisers have voluntarily abandoned roadside advertising, choosing to carry their message to the public through other channels.

"In practically all cases these roadside advertisements merely repeat, in the same form, appeals that are made quite properly and insistently through other agencies," Thomas H. MacDonald, Chief of the Bureau of Public Roads, stated in his last annual report. "They are not needed by the public, and are of doubtful value to advertisers. It is hoped that means may be found by suitable legislation to effect their complete elimination upon all roads constructed in part with money appropriated by the national government."

NEVADA is the only state having laws seeking to regulate the erection of signboards. No permit is issued for signs that will measurably mar the roadside beauty, or obstruct views. Connecticut regulates signs erected by filling stations and similar business places. Illinois controls erection of signs within right-of-way limits of trunk-line highways, but has difficulty with signs inside corporation limits. California issues permits only for signs located on the right-of-way adjacent to the business they advertise. Massachusetts keeps advertising matter 300 feet from the highway, except where it is contiguous to the business it concerns.

In recent years, with the rapid development of improved roads, there has been little attention given to their esthetic aspects. Lately, a few states, notably Massachusetts, California, Connecticut, Pennsylvania, and Florida, have begun to take the matter seriously. One surprising thing was learned: Road beauty is not a costly improvement.

By judicious planting of native trees, perennial flowers, and shrubs along rights-of-way; by removing objects that are in themselves ugly; by restricting sign-board placing; and by a few other simple processes, a plain or a downright ugly road can be converted into a thing of lasting beauty.

Massachusetts, which started improving the beauty of its roads in 1921, frequently is pointed out as a model for other states. The State Department of Public Works has charge of the work. When a new road is built, it is made wide enough to permit landscaping. The maintenance division does the actual work. At Palmer is a state nursery for the propagation of trees and shrubs. This also is a training station for men who care for the plantings.

The first step in the work is the preservation of trees and plants already established. Maintenance men remove dead trees and cut stumps six inches below the ground, trim away dead or broken limbs, treat wounds by trimming and filling with tar, repair cavities by approved methods of tree surgery, and re-inforce split

Courtesy Massachusetts Department of Public Works

A group of birches bordering a New England road. Thinned out and trimmed, they increase the scenic value and do not obstruct the view

and weakened parts with cables. Undesirable branches, such as those which rub together, are removed. When advisable, trees are sprayed.

Vistas are developed by trimming away underbrush and removing obstructing trees. Roadside springs are cleaned and made usable. Seats are provided at convenient points, and rubbish barrels are placed at strategic positions.

In new planting, only domestic trees and shrubs are used. Gravel and sand slopes are a constant source of trouble because of water erosion. They are treated by planting small pines, sweet ferns, and other suitable vegetation. Whenever there is enough soil of the proper kind, grass or shrubs are planted. Extensive tree and shrub planting is confined to new roads 60 or more feet wide, so that there will be little or no subsequent widening operations to destroy the beauty. Shade trees are planted in groups, not in monotonous, military lines.

THE procedure followed in landscaping is systematic. After construction is complete, a man trained in landscape planning locates with colored pencils on a blueprint the positions of shrubs and trees. Stakes are then placed on the area being treated, to indicate the plan of digging. Dynamite is used for forming holes because it loosens the ground over a considerable area, and is about half as costly as manual or machine digging. High-grade soil is used to fill the pits. An order for planting material is sent to the nursery, and the supplies are delivered by trucks. After new shrubs are planted and well established, a final grubbing is carried out.

California considers both beauty and practical aspects of roadside improvement. Trees are planted; native wild ferns, shrubs, moss, trees, and flowers are preserved; and weed areas attacked. For utilitarian reasons, dry grass is burned, and obnoxious weeds such as the puncture vine, yellow star thistle, and mustard weed, are removed. The initial cost of tree planting is largely borne by civic and other groups, but maintenance is carried on by the state. Periodic watering of trees frequently is necessary.

Pennsylvania is one of the most recent converts to the idea of highway beauty. In 1928 a forestry unit, consisting of five trained foresters and three landscape architects, was created to act under the highway forester. Field men are located in eight state districts, and their duties are to plant and care for shade trees, plant slopes and evergreen snowbreaks, and create open views.

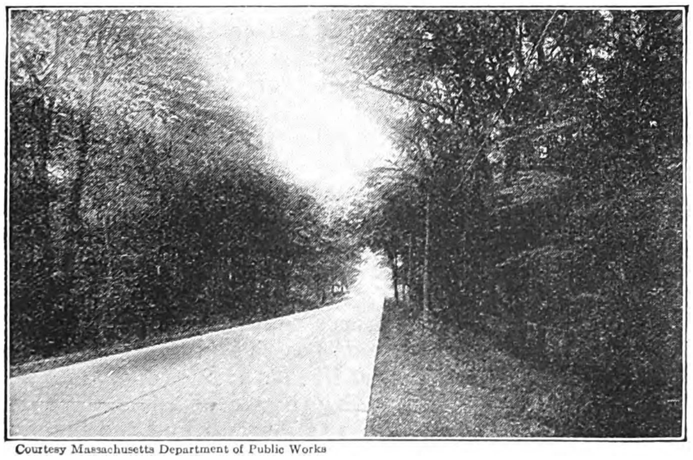
Courtesy State Road Department of Florida

Artificial aids to safe motoring such as these neatly constructed guard rails can also be made very attractive

Outside organizations have helped considerably since the work started, by providing trees and shrubs.

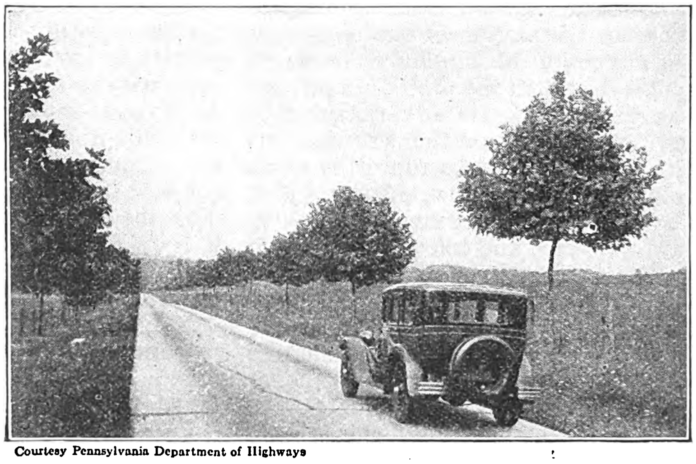
In general, the ideas used in the majority of states which give attention to highway beauty are similar. In Florida, however, the conception of beauty is somewhat different. This is largely because of the peculiar quality of Florida's semi-tropical scenery. Officials believe that the most beautiful landscape in the state consists of a well-paved road, with ditches and slopes planted in grass and carefully groomed, and with the characteristic Florida scenery forming a background on each side. Rubbish is kept cleared away, and planting of large trees and shrubs along the right-of-way is not encouraged.

It is pretty well agreed that there are few ways in which a greater return, dollar for dollar, can be obtained with public funds than by spending a little more for beautifying highways. Aside from the purely esthetic aspects of the work, roadside property values invariably are raised. A beautiful road creates a better sense of self respect in the community, and it favorably impresses the visitor who, besides bringing a measure of profit to local business when he is persuaded to linger, carries away for distribution to other places impressions which he gained in passing through.



Courtesy Massachusetts Department of Public Works

To some, a paved road is but an artificial scar across the country, but if it is well kept, it may become a thing of beauty. The shoulders in this case are sodded and clean



Courtesy Pennsylvania Department of Highways

Oriental plane trees seven years after planting. The planting of these was carefully done so that they took root firmly and but little further care was necessary

Planet X

By Henry Norris Russell, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE widespread and justified sensation caused by the discovery of the new major planet of our solar system will have passed long before these words will have reached America—much less see the light in print. But the discovery itself is so important and illustrates so well the methods of modern astronomy that it should not fail to be set out in order here.

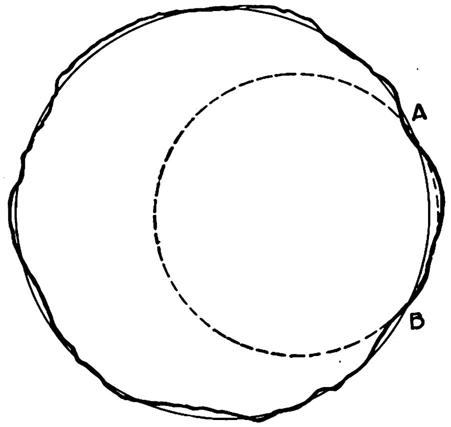
Everyone knows how the last great planet to be discovered was found. After Uranus had been known for half a century or more it was found to deviate from the orbit determined from the first 50 years of observations, after full allowance had been made for the attraction of the then known planets. Some unknown body must be pulling at it and this could only be a planet still farther from the sun. To calculate from the observed perturbations of Uranus' motion the orbit of the unknown planet which produced them was a very intricate matter. But the problem was solved by LeVerrier in France, and Adams in England, and the planet Neptune was found within a degree or so of the place in the heavens which these calculations pointed out.

Through all the 84 years since the discovery of Neptune until the present, the possibility that there was a still remoter planet has been realized, and now that it has been discovered the layman naturally may ask, "Why, if it was there all the time, did not the mathematicians tell us where to find it?" As a matter of fact they did, but through no fault of theirs their answer could not be as precise as it was for the earlier problem of Neptune.

To calculate the perturbations produced in the motion of one planet by the attraction of another is no small task, even when the orbits of both are accurately known in advance; and to work backward from the perturbations of a known planet to the orbit of an unknown one is much harder. But mathematical astronomers are used to hard problems and know how to solve this one. The worst difficulty is that to find the perturbations we must compare the observed positions of the known planet with those which it *would have had* if the unknown planet had not been attracted. To determine the latter is evidently difficult.

To see how it can be done let us ignore the attractions of the known planets (or suppose that, as in practice, their effects have been calculated and allowed for). We then know that, barring unknown influences, the planet should move in an exact ellipse about the sun in accordance with Kepler's familiar laws. What the size and shape of this ellipse may be can be found only by observing the planet. If no extraneous forces are acting, the planet will follow the same ellipse time after time, but if an unknown planet is perturbing it the tracks in the second and subsequent revolution will not be quite the same and the differences will reveal the amount and nature of the perturbations.

It is not actually necessary to wait quite so long. When a planet has been well observed half around its orbit its motion along the other half can be predicted closely enough to reveal any considerable disturbances after it has been followed in this half as well. But something like a full revolution around the sun is really necessary. With observations covering only half the orbit or less, it is possible to find a "fictitious orbit" such that a planet moving in it without perturbations (save by the attractions of known bodies) will, *over the given interval of time*, always be very near the real planet—subject though it is to additional perturbations, and though in earlier or later years this will not be true.



Why it is easy to go wrong in the prediction of planets—see the text

It may help to understand this to imagine a circular hoop which has been bent and battered a little out of shape (see drawing). If we can see the whole hoop or half a photograph of it it is easy enough to strike a true circle which follows its general course, and then find the amount of the deformations from point to point. But if our photograph covers but a small part of the hoop and we try to fit a circle to it as best we can, we may draw it too large or too small, according as this particular part of the hoop has been flattened or bent too sharply.

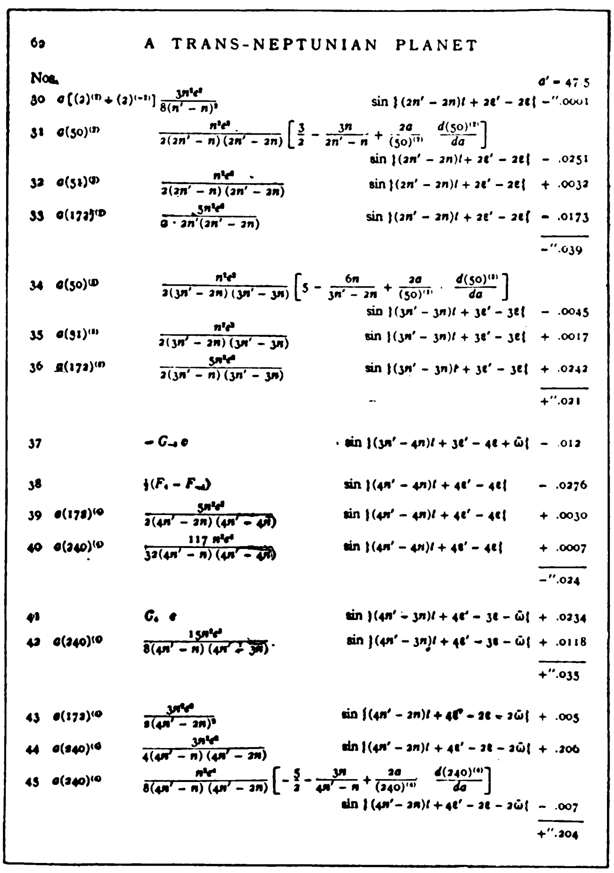
The heavy line in the drawing represents a battered hoop which in a rough way illustrates a perturbed orbit. The circle represents the hoop before it was deformed, or the unperturbed orbit. But if we knew only the part AB of the hoop we would suppose that the whole was like the dotted circle and would greatly underestimate the amount, and sometimes even the direction, in which this portion had been bent out of shape. In quite the same way we can not get any accurate idea of the perturbations of a planet unless we have observations extending pretty well around the orbit.

Now since its discovery in 1846 Neptune has been only half way around its orbit and it is therefore practically valueless for locating an outer planet by means of its perturbations. Uranus has completed two revolutions since its discovery and is fully available, but it is nearer the sun and farther from the trans-Neptunian planet and the perturbations to be anticipated are therefore small.

Several investigators have examined the question, the most comprehensive work being probably that of the late Dr. Percival Lowell which was published in 1914 but commenced more than a decade earlier. A careful mathematical investigation indicated the existence of small perturbations just within the limit of detection, and indicated that the unknown planet which produced them must be either in the direction of the constellation Gemini or just on the opposite side of the sun. The perturbations produced by planets in these two positions were so much alike that no decisive choice between the two could be made.

Lowell estimated the new planet's distance from the sun as 43 to 44.7 astronomical units (see illustration, page 22, section 9, *a'* and *a'*.—*Ed.*)—half as much again as Neptune's—and its mass as 1/50,000th that of the sun, six times the earth's, but only one third of that of Uranus or Neptune.

Accepting these conclusions the next question was, how to find the planet. Being less massive than Neptune it was doubtless smaller, and being far from the sun it must be faintly illuminated and far from conspicuous. Lowell estimated its probable brightness as from the 12th to the 13th magnitude (see illustration, page 22, section 10—*Ed.*). It is hopeless to search for such an object visually among the multitudes of stars and the only chance of success is by photography, employing substantially the same methods as have been proved so successful in finding asteroids; that is, the careful comparison of suitably duplicated plates of the same star fields.



62 A TRANS-NEPTUNIAN PLANET

Nos.				$a' = 47.5$
30	$a[(2)^{(1)} + (2)^{(-1)}]$	$\frac{3n^2e^2}{8(n'-n)^2}$	$\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$	$-''.0001$
31	$a(50)^{(1)}$	$\frac{n^2e^2}{2(2n'-n)(2n'-2n)}\left[\frac{3}{2} - \frac{3n}{2n'-n} + \frac{2a}{(50)^{(1)}} \frac{d(50)^{(1)}}{da}\right]$	$\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$	$-.0251$
32	$a(51)^{(1)}$	$\frac{n^2e^2}{2(2n'-n)(2n'-2n)}$	$\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$	$+.0032$
33	$a(172)^{(1)}$	$\frac{5n^2e^2}{a \cdot 2n'(2n'-2n)}$	$\sin\{(2n'-2n)t + 2\epsilon' - 2\epsilon\}$	$-.0173$
				$-''.039$
34	$a(50)^{(1)}$	$\frac{n^2e^3}{2(3n'-2n)(3n'-3n)}\left[5 - \frac{6n}{3n'-2n} + \frac{2a}{(50)^{(1)}} \cdot \frac{d(50)^{(1)}}{da}\right]$	$\sin\{(3n'-3n)t + 3\epsilon' - 3\epsilon\}$	$-.0045$
35	$a(91)^{(1)}$	$\frac{n^2e^3}{2(3n'-2n)(3n'-3n)}$	$\sin\{(3n'-3n)t + 3\epsilon' - 3\epsilon\}$	$+.0017$
36	$a(172)^{(1)}$	$\frac{5n^2e^3}{2(3n'-n)(3n'-3n)}$	$\sin\{(3n'-3n)t + 3\epsilon' - 3\epsilon\}$	$+.0242$
				$+''.021$
37		$-G_{-4}e$	$\sin\{(3n'-4n)t + 3\epsilon' - 4\epsilon + \hat{\omega}\}$	$-.012$
38		$\frac{1}{2}(F_4 - F_{-4})$	$\sin\{(4n'-4n)t + 4\epsilon' - 4\epsilon\}$	$-.0276$
39	$a(172)^{(1)}$	$\frac{5n^2e^4}{2(4n'-2n)(4n'-4n)}$	$\sin\{(4n'-4n)t + 4\epsilon' - 4\epsilon\}$	$+.0030$
40	$a(240)^{(1)}$	$\frac{117\,n^2e^4}{32(4n'-n)(4n'-4n)}$	$\sin\{(4n'-4n)t + 4\epsilon' - 4\epsilon\}$	$+.0007$
				$-''.024$
41		$G_4\ e$	$\sin\{(4n'-3n)t + 4\epsilon' - 3\epsilon - \hat{\omega}\}$	$+.0234$
42	$a(240)^{(1)}$	$\frac{15n^2e^4}{8(4n'-n)(4n'-3n)}$	$\sin\{(4n'-3n)t + 4\epsilon' - 3\epsilon - \hat{\omega}\}$	$+.0118$
				$+''.035$
43	$a(172)^{(1)}$	$\frac{3n^2e^4}{8(4n'-2n)^2}$	$\sin\{(4n'-2n)t + 4\epsilon' - 2\epsilon - 2\hat{\omega}\}$	$+.005$
44	$a(240)^{(1)}$	$\frac{3n^2e^4}{4(4n'-n)(4n'-2n)}$	$\sin\{(4n'-2n)t + 4\epsilon' - 2\epsilon - 2\hat{\omega}\}$	$+.206$
45	$a(240)^{(1)}$	$\frac{n^2e^4}{8(4n'-n)(4n'-2n)}\left[-\frac{5}{2} - \frac{3n}{4n'-n} + \frac{2a}{(240)^{(1)}} \frac{d(240)^{(1)}}{da}\right]$	$\sin\{(4n'-2n)t + 4\epsilon' - 2\epsilon - 2\hat{\omega}\}$	$-.007$
				$+''.204$

Giving an idea of modern mathematical planet predicting—a typical page from Lowell's original prediction of 1914. There are many pages like this

A great deal of time and labor was thus spent by Dr. Lowell and his successors at the observatory which he founded at Flagstaff, Arizona, and which bears his name. In time it became clear that the distant planet was probably fainter than the original estimate, which in the nature of the case could only be very rough, and that a very powerful instrument would be required to find it. A gift from the President of Harvard, Percival Lowell's younger brother, provided an admirable instrument. It possesses a triple objective of 13 inches aperture which gives sharp star images over a wide field, and is withal very rapid.

THE new Lawrence Lowell telescope within a year of its installation has brought the long-sought planet to light. Photographs of moderate exposure covering the whole region of the heavens around the predicted position were obtained and on one of them, taken on January 21, 1930, Mr. Tombaugh of the observatory staff found "a very promising object." It was identified from its motion past the numerous fixed stars as revealed on plates of the same star field while being compared under the blink comparator. This showed that one faint star among many thousands had shifted its place by a certain expected order of distance, in the interval between the taking of the two plates. Since that date it has been carefully followed both photographically by Dr. Lampland with the 40-inch reflector and visually by E. C. Slipher and other members of the staff. Its motion in the heavens has been just what might be expected of a trans-Neptunian planet at about the distance anticipated by Lowell, and its longitude agrees closely with his predictions. There is no doubt that it is actually a new major planet much farther away than any which has previously been known.

This admirable discovery comes to the astronomers at Flagstaff as a reward of years of skillful development of methods and patient work. It is most gratifying that this long and devoted search has been crowned with full success, though we must all regret that the originator and inspirer of the campaign did not live to witness its triumphant close.

What of the new planet itself? Full knowledge comparable to that which we have regarding the other planets of our system can come only after years of further work. For example, it will be a long time before its orbit is accurately known. A fairly good orbit of a rapidly moving asteroid can be derived from three good observations separated by intervals of a week or so. For this slowly moving body intervals of a couple of months will be desirable. Before it was lost in the light of the sun, which happened in May, sufficient data to give a good preliminary orbit which will tell us where to look for the planet at the end of summer when it can again be observed, was worked out and published (April 12). Next year's observations will permit a considerably better determination; and so on.

Even after a decade, however, we will have observations covering only a very small fraction of the orbit and will still be somewhat in the position of having to determine the course of a whole circle from a small arc. It may happen that, calculating backward, the images of the planet can be found on photographs taken years before it was discovered, though it is so faint that the chance is not very good. And in this case the arc available for determining the orbit, and the calculated results, may be increased. At this early date we can be certain only that the planet is near the ecliptic, that it is moving around the sun in the same direction as the other planets, and that the inclination of its orbit plane, while greater than the other planets, as Lowell predicted (section 11.—*Ed.*) is not extremely great. The general agreement of its apparent motion with that calculated with Lowell's estimated distance of 43 to 44.7 astronomical units shows, however, that this prediction is near the truth.

Adopting provisionally this distance, which is 50 percent greater than Neptune's, what else can now be said about the planet? Its diameter must be rather small. With the 24-inch refractor at Flagstaff the planet appears as a faint stellar point and shows no sensible disk.

IF it were really as much as 10,000 miles in diameter it would show an apparent disk of 0".5, which the experienced observers who have examined it hardly could have missed under favorable conditions. We may conclude with some confidence therefore that the new planet is little if at all larger than our earth—provided, to be sure, that the estimate of its distance here adopted is correct.

Further evidence that the planet is a small one is found in its faintness. The assigned magnitude, about 15.5, is photographic. If it is of the average color of the inner planets it should be about a magnitude brighter visually than photographically, and we may base our estimates on a visual magnitude of 14 or 14.7. This makes the planet only about 1/250th as bright, apparently, as Neptune. If Neptune could be removed to this greater distance it would look only 1/5 as bright as it does now, but even so it would outshine Planet X fifty-fold. This suggests that the diameter of the new planet is about 1/7 that of Neptune, or a little less than 3000 miles. This estimate, however, may be too small, for Neptune has the highest superficial reflecting power, or albedo, of any of the planets and a planet of lower albedo would have to be larger to reflect the same amount of light. To go to the opposite extreme we may take for comparison the moon which has about the lowest known albedo. A simple calculation shows that if removed to a distance of 45 astronomical units from us and from the sun, she would appear as a star of visual magnitude 17. Planet

X appears three magnitudes or 16 times brighter, which on this hypothesis regarding its surface brightness makes its diameter four times that of the moon, or 8600 miles. It is probable that the truth lies between these two estimates, but little more can be said for there are very great differences of albedo even among the atmosphereless asteroids, and we have no means of estimating more closely what value we should use for the new planet. It may be considered, nevertheless, that it is fairly comparable in size with the four inner planets of our system, and much smaller than the four outer ones which were previously known.

The planet's mass can probably be determined at least roughly from the perturbations it produces in Uranus and Neptune when once its orbit is accurately known. The latter statement may seem inconsistent with what has already been said, but the problem here is not quite the same as before. Suppose that, in the drawing, we knew the direction in which the wavy line deviated from the circle at each point and the relative though not the absolute amounts of these deviations. We would then have much less latitude in drawing our theoretical circle than before, and could be fairly sure of its position in cases which before were hopeless, as explained on page 20.

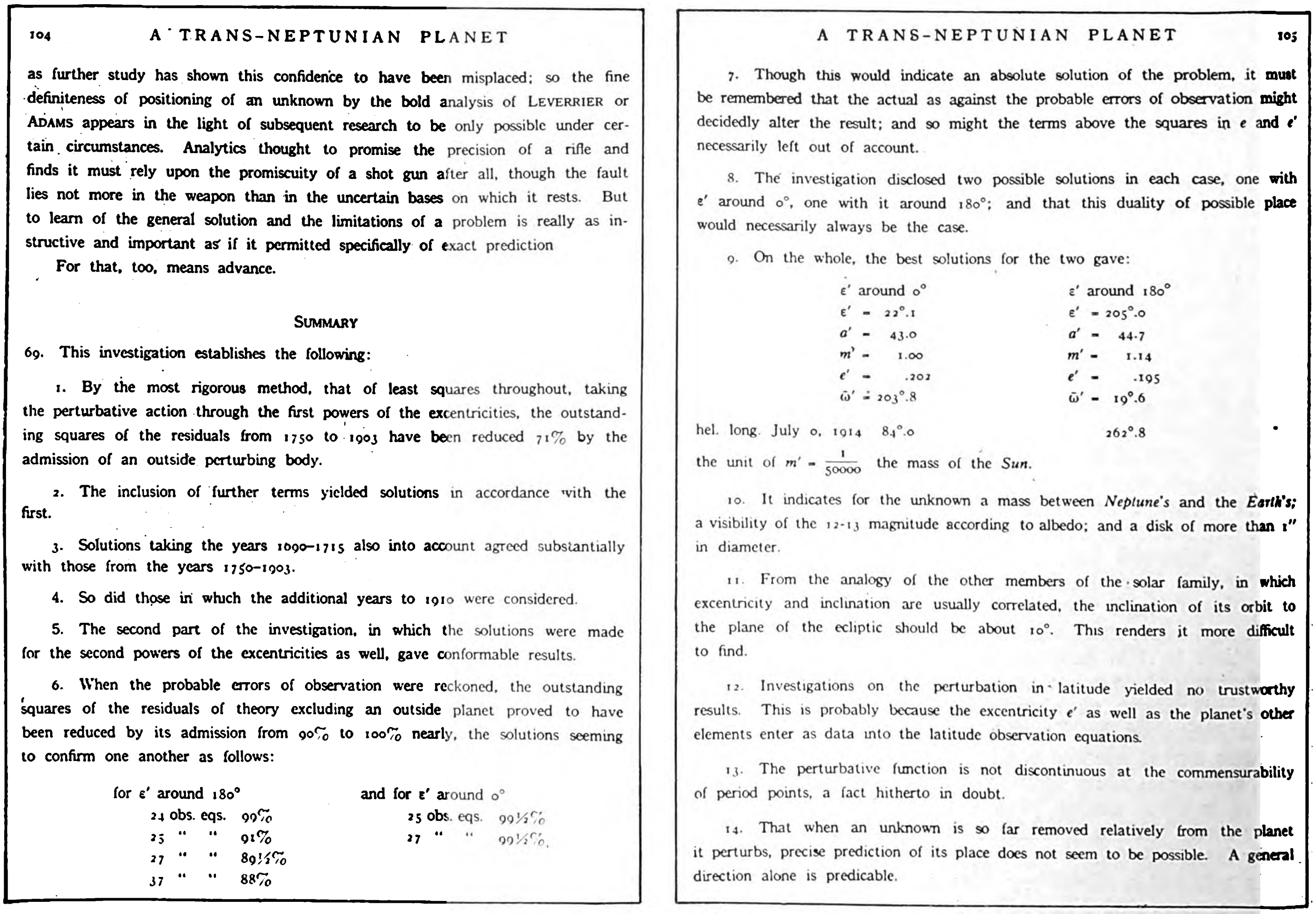
Percival Lowell

A planet less than 10,000 miles in diameter would be very unlikely to have a mass 1/50,000 that of our sun (section 9.—*Ed.*) for this would demand a mean density about 17 times that of water. The earth's mass is only 1/330,000th of the sun's, and if Planet X is no more massive it is hard to see how its attraction could produce the effects studied by Lowell. This discrepancy would be diminished if the planet's distance from the sun should turn out to be greater, but it is premature to discuss the matter further at present, without more dependable data.

The only hope of learning anything about the rotation of the new planet is by photometric means. If, like many of the asteroids, it should show regular periodic changes in brightness, these would reveal the rotation. But for so faint an object, the observations would be difficult.

Finally, there is little hope of detecting a satellite of the planet unless, like our moon, it should be almost comparable in size with its primary. Nevertheless it is probable that photographs will be made with the great reflectors, in order to investigate.

In conclusion, two tributes must be paid where honor is due: First, to the skill, assiduity, and devotion of the workers at the Lowell Observatory who have made this important discovery; and second, to the memory of Percival Lowell, traveler, man of letters and affairs, and observer of the planets. He did many things in the course of a crowded life and did them well. The mathematical researches took him outside his other fields of work and into a region full of traps for the unwary, yet the discovery of this new planet has justified him by his works despite the doubts of many of his contemporaries. His fame bids fair to increase as the years pass on.—*Athens, Greece.*



as further study has shown this confidence to have been misplaced; so the fine definiteness of positioning of an unknown by the bold analysis of LEVERRIER or ADAMS appears in the light of subsequent research to be only possible under certain circumstances. Analytics thought to promise the precision of a rifle and finds it must rely upon the promiscuity of a shot gun after all, though the fault lies not more in the weapon than in the uncertain bases on which it rests. But to learn of the general solution and the limitations of a problem is really as instructive and important as if it permitted specifically of exact prediction

For that, too, means advance.

SUMMARY

69. This investigation establishes the following:

1. By the most rigorous method, that of least squares throughout, taking the perturbative action through the first powers of the excentricities, the outstanding squares of the residuals from 1750 to 1903 have been reduced 71% by the admission of an outside perturbing body.

2. The inclusion of further terms yielded solutions in accordance with the first.

3. Solutions taking the years 1690–1715 also into account agreed substantially with those from the years 1750–1903.

4. So did those in which the additional years to 1910 were considered.

5. The second part of the investigation, in which the solutions were made for the second powers of the excentricities as well, gave conformable results.

6. When the probable errors of observation were reckoned, the outstanding squares of the residuals of theory excluding an outside planet proved to have been reduced by its admission from 90% to 100% nearly, the solutions seeming to confirm one another as follows:

for ε' around 180°		and for ε' around 0°	
24 obs. eqs.	99%	25 obs. eqs.	99½%
25 " "	91%	27 " "	99½%.
27 " "	89½%		
37 " "	88%		

7. Though this would indicate an absolute solution of the problem, it must be remembered that the actual as against the probable errors of observation might decidedly alter the result; and so might the terms above the squares in e and e' necessarily left out of account.

8. The investigation disclosed two possible solutions in each case, one with ε' around 0°, one with it around 180°; and that this duality of possible place would necessarily always be the case.

9. On the whole, the best solutions for the two gave:

	ε' around 0°	ε' around 180°
	$\varepsilon' = 22°.1$	$\varepsilon' = 205°.0$
	$a' = 43.0$	$a' = 44.7$
	$m' = 1.00$	$m' = 1.14$
	$e' = .202$	$e' = .195$
	$\bar{\omega}' = 203°.8$	$\bar{\omega}' = 19°.6$
hel. long. July 0, 1914	84°.0	262°.8

the unit of $m' = \frac{1}{50000}$ the mass of the *Sun*.

10. It indicates for the unknown a mass between *Neptune's* and the *Earth's*; a visibility of the 12-13 magnitude according to albedo; and a disk of more than 1″ in diameter.

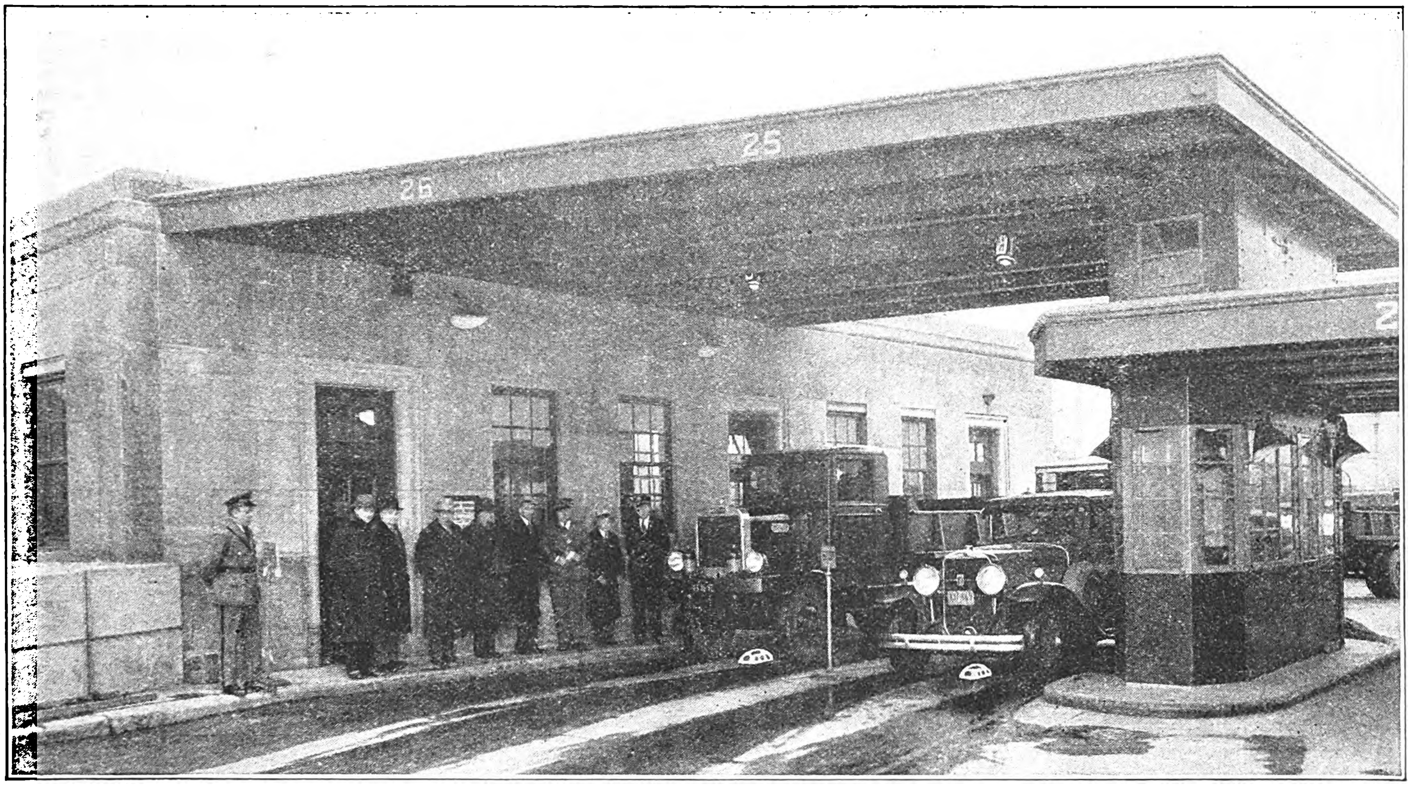
11. From the analogy of the other members of the solar family, in which excentricity and inclination are usually correlated, the inclination of its orbit to the plane of the ecliptic should be about 10°. This renders it more difficult to find.

12. Investigations on the perturbation in latitude yielded no trustworthy results. This is probably because the excentricity e' as well as the planet's other elements enter as data into the latitude observation equations.

13. The perturbative function is not discontinuous at the commensurability of period points, a fact hitherto in doubt.

14. That when an unknown is so far removed relatively from the planet it perturbs, precise prediction of its place does not seem to be possible. A general direction alone is predicable.

A photographic reproduction of the final two pages—the summary—of Lowell's original prediction, published 1914 as Memoir No. 1, Volume 1, of Lowell Observatory. Forgotten by the world, it never was forgotten by the persistent Lowell Observatory Staff. Copies of the original memoir are now very rare



A toll house showing photoelectric cells in roadbed and lights overhead

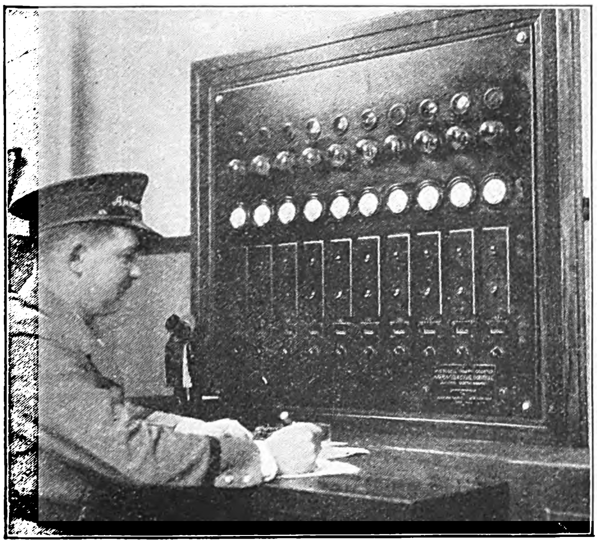
Light Counts Cars on Bridge

THE task of checking and controlling traffic over the longest span bridge in the world is being accomplished by means of photoelectric cells and light beams. The man who superintends traffic control on the new Ambassador Bridge over the Detroit River at Detroit can tell, by glancing at his control board far from the scene of operations, which traffic lanes are in operation, whether the density of traffic warrants the use of more or fewer lanes, and whether the vehicles are being cleared over the bridge efficiently. The system was devised and installed by Benjamin Cooper, a consulting engineer of New York City.

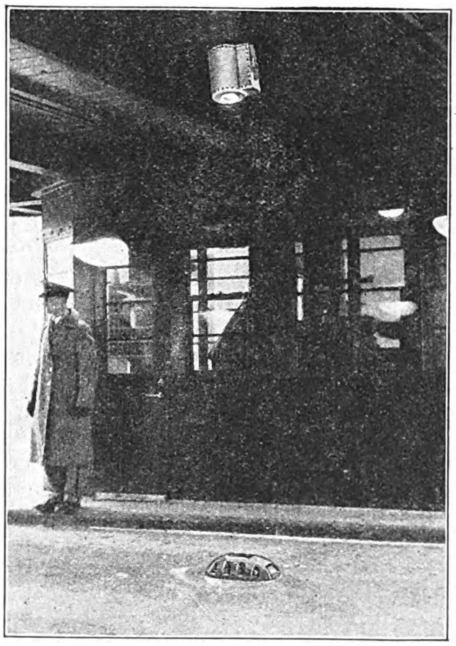
A photoelectric cell is imbedded in each of the 10 lanes provided for incoming traffic, at the point where cars must stop for payment of tolls. While the car is stopped, it intercepts a beam of light from a source in the ceiling of the toll shed. This interception causes the cell to function and it, in turn, causes a magnetic counter to register a count and also causes an indicator light to go out.

The frequency with which the indicator lamp goes on and off shows the traffic density for a particular lane. At the end of a working period, the number of tolls recorded by the cash registers must check with the count shown by the cell-operated registers.

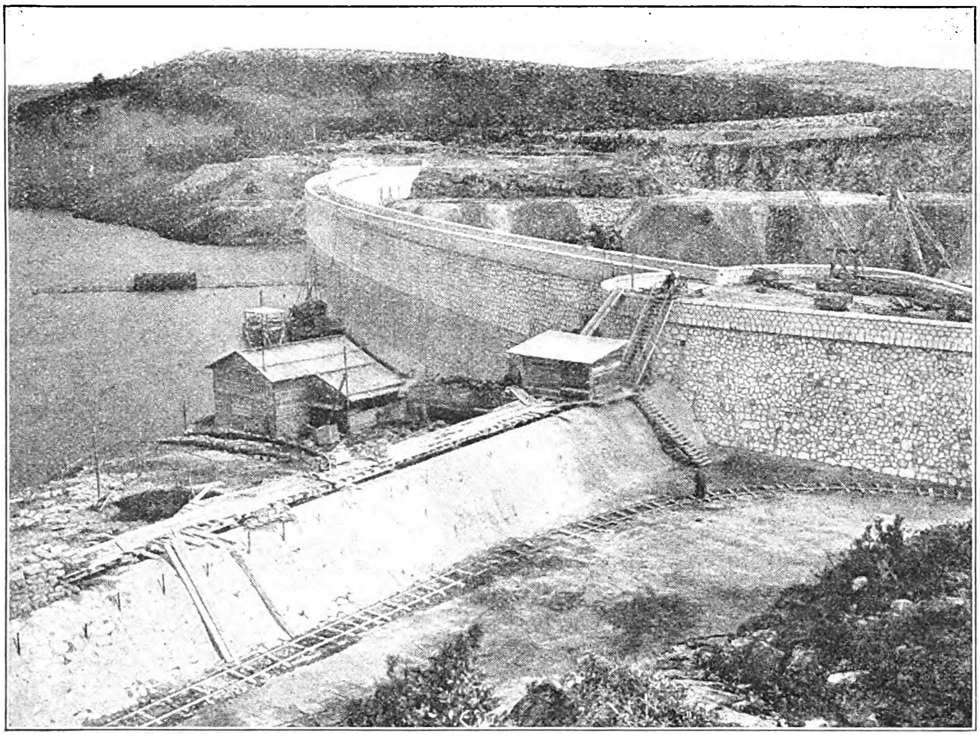
The wires that are connected to the photoelectric cells are carefully shielded from all external electrical disturbances and carried underground to the operating panel located in the toll supervisor's office. The cells are so located in the roadbed as to minimize the effect of mechanical vibration due to passing vehicles, and so shielded as not to be interfered with by outside lights. This task of protecting the cells was particularly difficult because they are in the open and because the current through them is rated in millionths of an ampere.



The toll supervisor sits before the panel-board in his office hundreds of feet from the toll sheds and keeps close tab on the movement of traffic



The photoelectric cell in the roadbed and the light source overhead



Upstream face of the Marathon Dam showing, in the foreground, the spillway under construction

Water Runs From Marathon to Athens

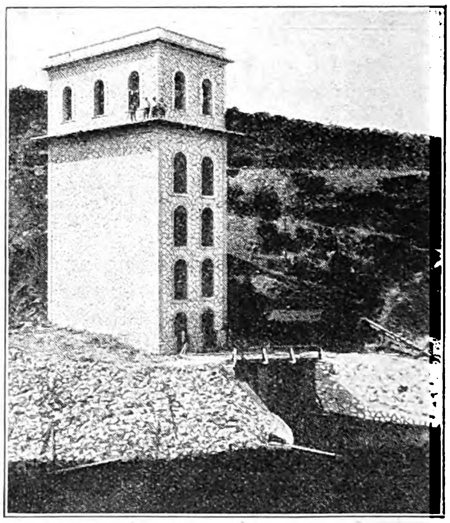
By F. D. McHugh

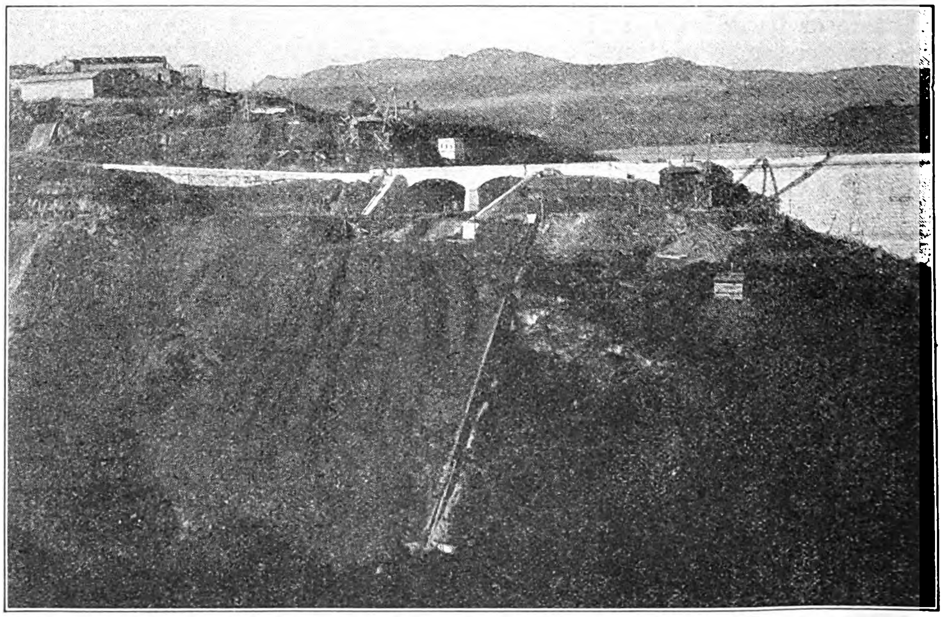
ABOUT four miles from the plains of Marathon where, in 490 B.C., the combined forces of Athenians and Plataeans numbering perhaps 10,000, won a decisive and famous victory over an invading force of approximately 50,000 Persians, a celebration of unusual importance took place last October in the presence of a large gathering including the Greek President, the Premier, and other notables. The occasion was the dedication of the Marathon Dam, construction of which had just been completed by Ulen and Company, an American engineering firm.

AS dams go, this new one presents no striking departure in construction, and in respect to size, it is far from outstanding. Its bid for fame rests upon the facts that it is practically a mass of marble, that water from it is carried through a 1900-year-old aqueduct, that it is situated in a region rich in historical associations, and that it is an important part of a very important project. Its completion marks the first big step of a plan, costing upwards of 11,000,000 dollars, to solve the age-old problem of providing an adequate supply of water for the city of Athens and environs.

One of the oldest cities of the world, Athens has been sorely pressed for water since its foundation on the sacred rock in 1259 B.C. So dry, in fact, has the Attic region always been that Aristophanes, Strabon, and Pausanias commented upon it in their writings. During Athens' early days, local springs, like the Kalirhoe with its nine spouts (Enneakrounos) and wells like the Klepsydra on the Acropolis, formed the only source of water supply. In time, the underground waters of Mount Hymettus were carried in subterranean aqueducts to the city. Yet the supply was still inadequate for, in 594 B.C., Solon found it necessary to enact strict laws regulating its use.

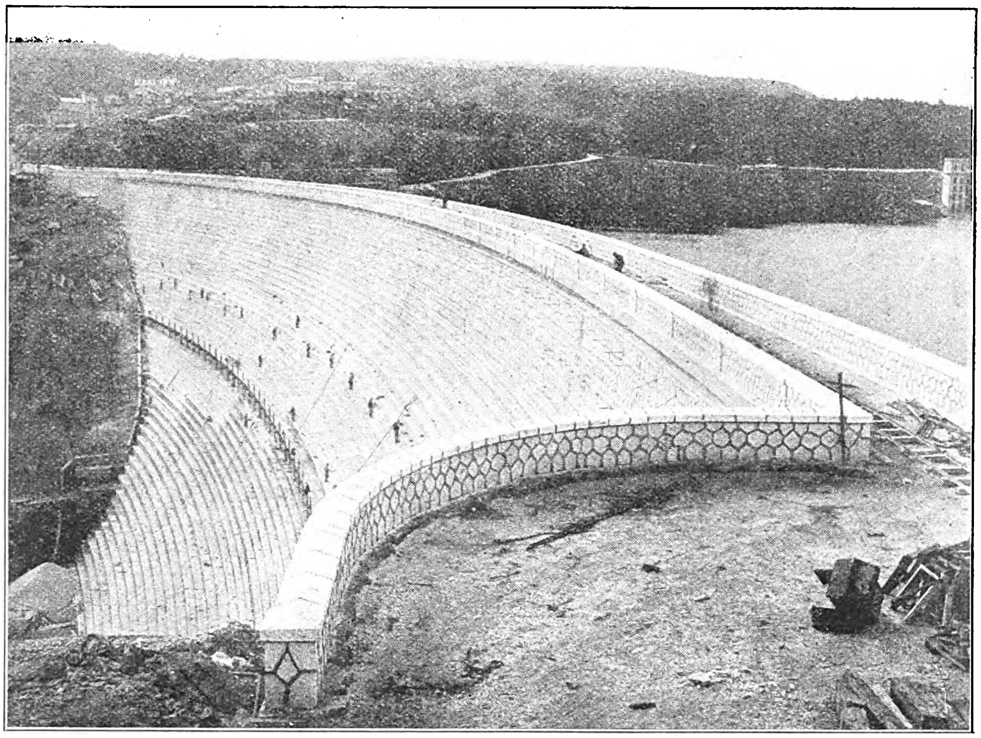
With the decline of ancient Greece, the Romans tackled the problem and solved it by constructing the famous Hadrian Aqueduct about 115-130 A.D. This





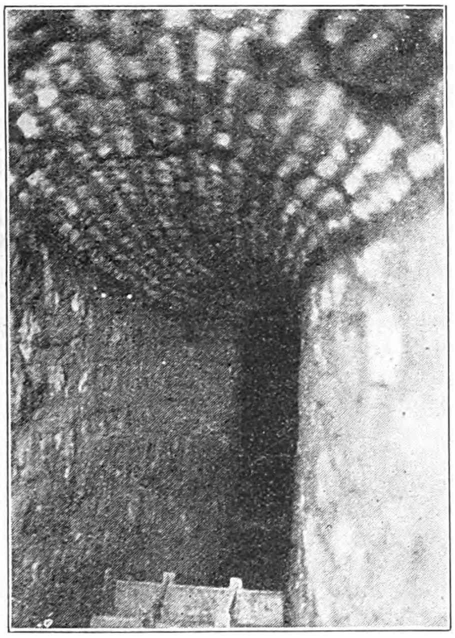
The intake tower to the water tunnel is shown in the upper illustration and in the lower one which also shows the south approach to the dam's crest

Downstream face of dam from north end showing intake tower to tunnel at extreme right and men giving the marble a final cleaning

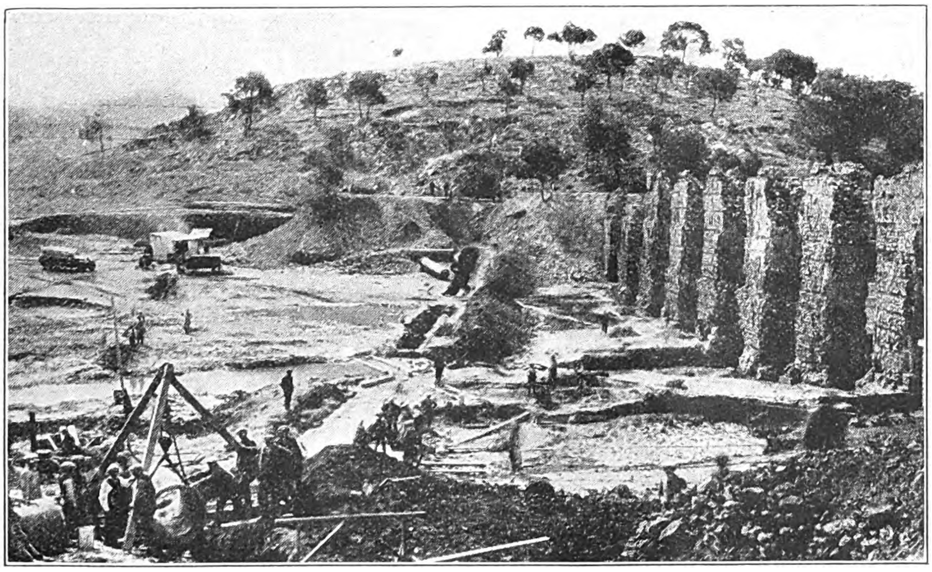


system brought water from the Pentelicon and Parnes ranges and for centuries the supply was adequate. Invasions of Goths, Vandals, and Slavs then came one after the other, and finally the country was occupied by the Turks. Amid the confusion caused by these disturbances, the aqueduct began to crumble, gradually fell into disuse, and was forgotten. Rediscovered in 1840 it was repaired and became the city's chief source of supply.

With the destruction of Smyrna in 1922 by the Turks and the driving of all Greek nationals from the territory, refugees crowded into Athens. As its population of 300,000 increased almost overnight to 800,000, the question of water supply again became acute. The government at once began consideration of various schemes and the "Marathon Project" was finally decided upon. Of this project, the Marathon Dam is the major part. Its water will flow by gravity to a storage reservoir on the Attic Plain near Athens and will be distributed from there. A secondary and separate part of the scheme is the 23½-mile pipe line through which sea water is pumped from historic Phaleron Bay for sprinkling the streets. The use of this salt water makes available more than 130,000 gallons of potable water daily—water which was formerly used for street sprinkling. Rehabilitation of existing systems was included in the provisional contract which the Hellenic Republic signed, work on which has now been completed and accepted by the government. It is expected that the entire scheme will be complete in 1931.



◂ Interior view of ancient Hadrian Aqueduct, repaired and enlarged



▾ Laying 36-inch siphon line to Athens. Ruins of the old Roman aqueduct may be seen at right

The Marathon Dam is a gravity section structure but was built on an arc radius of 1312 feet, is 174 feet high and almost 1000 feet wide along its crest. A spillway for the overflow was cut into the hill at the south end, and through its base are pipes for completely draining the lake.

WORK was begun in January, 1927, and the first concrete poured 11 months later. As has been noted, no extraordinary engineering problem was presented, but the material used in the dam is unusual. It is faced, on both the upstream and downstream sides, with Pentelic marble from the quarries nearby from which marble was taken for the famous buildings and sculptures of ancient Greece. This facing is laid in a beautiful mosaic of marble blocks in cement mortar so that the effect is very nearly that of a giant honeycomb. It is said to be the only mosaic marble-faced dam in the world. Even the sand and aggregates used in the concrete filling were ground from the same marble.

The old Hadrian Aqueduct was enlarged and repaired at several places for carrying water in this new system, and portions were extended to carry a supplemental supply.

The Pilot 'Phones His Airport Via Radio

By Harold Crary

Edmund T. Allen, who tells here of a pilot's experience with radio in an airplane

THE urgent need for radio equipment on aircraft has long been recognized by authorities in the air transportation business. With larger patronage of airmail and express, and demand for rigid adherence to schedules—and uncertain or bad weather is the chief foe of schedules—and with rapid branching out into passenger-carrying activities, the operators bend every energy to get workable radiophone equipment.

In the past, it has been necessary for the pilot to take off and fly into weather about which he knew practically nothing because it was constantly changing. Also the management was completely out of touch with the craft until it appeared at the terminal field or was forced to return due to the bad weather. If the airplane did not appear after a reasonable time had elapsed, a search had to be organized to comb the country for hundreds of miles to locate the scene of the forced landing.

Now several leading lines have authorized expenditures for necessary ground radiophone stations, hiring of operating personnel, and installation of equipment in the planes. Of these lines, the Boeing System carries passengers as well as mail, and its large-scale operations made it necessary to utilize every known aid to aircraft. Consequently it worked vigorously to perfect the radiophone. The initial use of the radiophone leads to the following positive conclusions as to its benefits:

It adds much to the safety of flying; reduces number of emergency landings due to uncertainty as to weather ahead; enables pilots on regular routes to complete a larger number of scheduled trips on time; and increases the pay load of mail, express, and passengers by reducing the amount of excess gasoline now carried to give the pilot ample cruising radius when he is uncertain as to weather. The radiophone is also of considerable value in dispatching planes and giving orders to pilots in the air.

Edmund T. Allen, whose 6000 hours in the air have included 4000 hours with the airmail, both night and day flying, on the transcontinental route, describes talking to a radio telephone station 150 miles away and several thousand feet "down" in this way:

" 'HELLO, Ed!' It is the voice of the Boeing superintendent in my ear phones. 'We have 1100-foot ceiling over the airport. Visibility five miles, barometer slightly below normal, but steady; no change in 30 minutes. Where are you?'

" 'Thirty miles out and making 115 miles per hour ground speed. How's the weather half way between here and there?'

" 'Same as here,' he answers. 'Fog begins at Summit and ceiling rises as mountains drop away. You are five miles south of the course. We will send up a yellow parachute flare when you arrive within three miles of us. What is the altitude at the top of the cloud layer?'

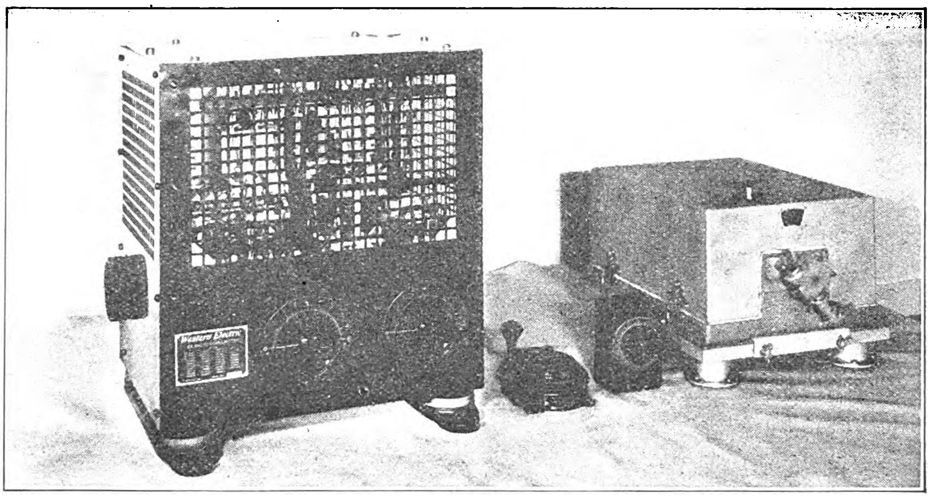
" 'Eighty-eight hundred,' I tell him. 'That gives 1500 feet thickness. Will arrive about 9:13. Shoot rocket at 9:11. Send it vertical to give me exact location. I will jazz my motor on the way down. Listen for it and tell me if I am overshooting. Where is the second section?'

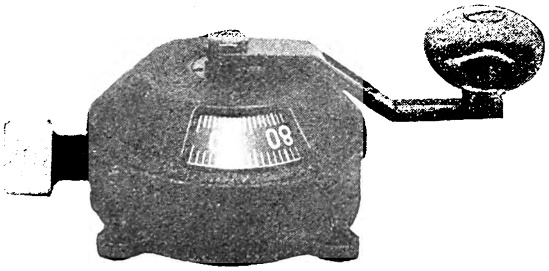
" 'John is 70 minutes behind you and is still talking with the other terminal. First section of the west-bound is due about same time as you are. Have instructed him to slow down and stay away from the airport until you are down and we tell him to come in. You are still a little south of the course. Five degrees more to the left ought to bring you right over us.' "

When asked how important he regarded the radio telephone, Allen said, "Instead of flying into the unknown and meeting shifting weather con-

Passengers who board this 18-passenger tri-motored plane, operating on a 20-hour schedule between Chicago and San Francisco, know that their pilot will have continuous radio communication with ground stations ditions single handed and without adequate information, the pilot will be maintaining uninterrupted contact with the broadcast voice of the radio.

"He may, for example, speak into the mouthpiece which unobtrusively rides in front of his lips: 'Calling Cheyenne Boeing Station—Number 12 reporting passing Elk Mountain point 106. Fog and snow coming in across course from Medicine Bow range. Fog forming along Union Pacific tracks in Rock River sector. Looks clear to north. Ceiling here 1500 feet, visibility five miles. Snow blowing on ground so badly weather station may say zero ceiling and visibility. What is weather in Laramie? Would you advise crossing Sherman Mountains north of the course and coming into Cheyenne from north?' And instantly comes a detailed answer to all his questions through his ear phones."

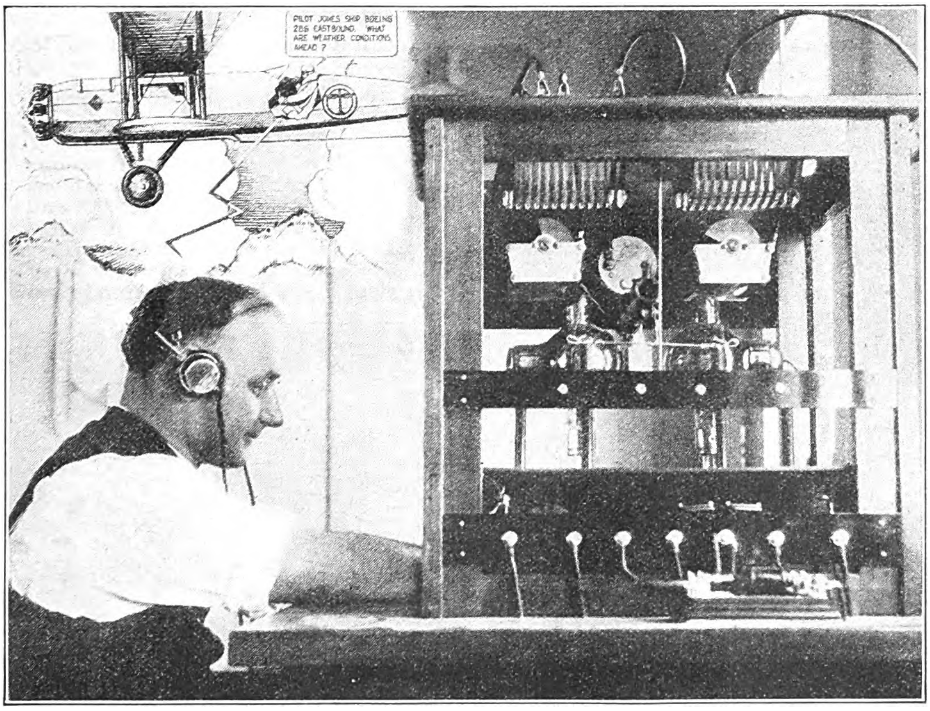




Above: The radio equipment that is installed on a plane. From left to right is the transmitter, tuning instruments, and receiver. _Left:_ The tuner. The knob can be operated even with heavy gloves on

ON one of the occasions when Lindbergh jumped from his airmail plane near Chicago after attempting to find the Chicago airport through the clouds, the field crew heard his motor overhead and knew that if they could but talk to the pilot, they could have brought him in as easily as a passenger train is threaded through the switching yards to the terminal station.

For the pilot, the operation and mechanism of the new radiophone are nearly automatic. He speaks in a normal voice and listens to the reply without the intervention of a radio operator aboard to give him the messages second hand. He can easily control the loudness of either the radio beacon signal or the voice reception as he comes nearer the station, or he can listen to both at the same time, making one or the other louder, as he desires. Boeing pilots have received clearly at 200 miles from the control station and 12,000 feet altitude, and even greater range is expected.


PILOT JONES SHIP BOEING 286 EASTBOUND. WHAT ARE WEATHER CONDITIONS AHEAD ?

There are 14 ground stations, such as this one, between Chicago and San Francisco. The pilots are never more than 100 miles distant from one of them

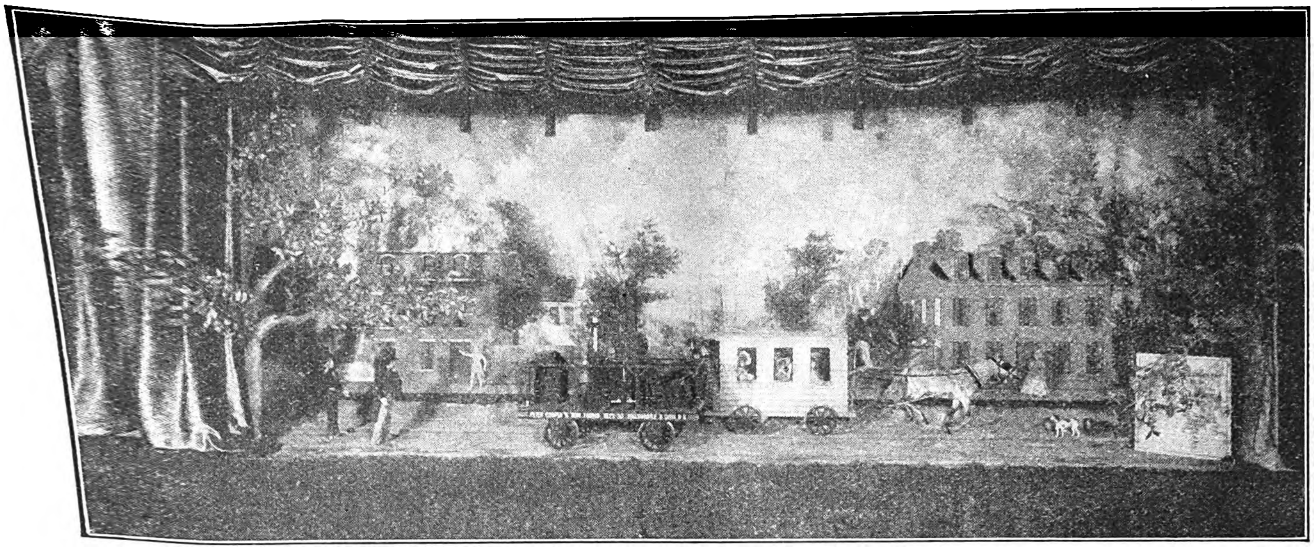
Since the equipment requires no careful adjusting on the part of the pilot, his full attention can be directed to the operation of his engine and keeping the airplane on its course. Added weight and space, which would be necessary for a special radio operator on the plane, ruled out any apparatus requiring expert manipulation in flight or the services of a special operator.

In the equipment, radio cases are mounted behind the pilot with remote controls on the instrument board. With a single throw of a switch, the pilot can change from transmission to reception. All that is required then, is for him to talk into the microphone mounted on his helmet directly in front of his lips.

TINY, soft rubber plugs, with "phonettes" attached, fit comfortably in his ears and are connected to the receiver with a fine silk cord. Thus, the pilot, if flying through a snowstorm where constant vigilance is required, will have to give no thought to the radio apparatus.

Now the United States can lay claim to the longest line in the world giving night and day passenger service, with planes having voice communication with the ground and with other planes in flight. In Europe, most of the radio sets require an operator using the Morse code. In the setup discussed here, the pilot simply talks to the nearest ground station, of which there are 14 between San Francisco and Chicago and nine between Los Angeles and Seattle. Either night or day, over plain or mountain, the pilots of the eight-ton passenger transports now place reliance on instructions 'phoned up from the ground station by men who, with the aid of reports received from weather observers on and off the line, can tell the pilot what kind of weather he will run into before he gets to the terminal port.

¶ *A coming article will describe how archeologists, under the direction of Mussolini, have found ancient Roman buildings by tearing out the walls of modern structures.*



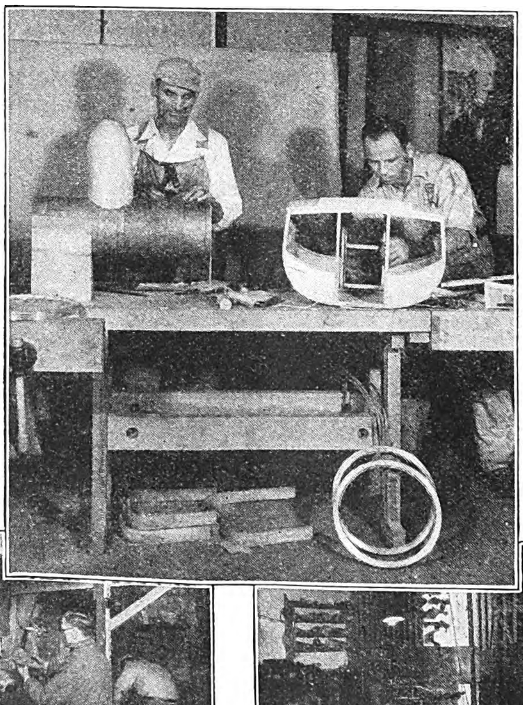
This tableau depicts the famous race between the "Tom Thumb" locomotive and the old gray mare drawing a single coach. The race took place between Baltimore and Ellicott's Mills on August 30, 1830. The rails are made of wood faced with steel. The costumes of the eight men and eight women are accurate to the last button. The horse won owing to "belt failure"

A World in Miniature

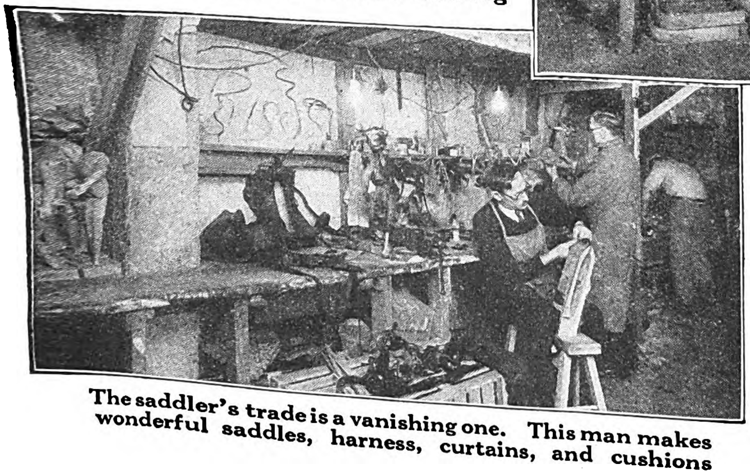
WAY down in "Chelsea Village," New York City, in an old armory is a shop which would be the delight of both the museum director and the child. Here are made camels that almost walk, monkeys that play cards—and cheat, dogs that fight for bologna links, and dolls nine feet tall. Who requires such peculiar merchandise? Department stores, pageants, fairs, children's barber shops, and dozens of others. This shop was an important factor in the "Iron Horse Fair." Here is made anything in papier mache, wood, or metal, which can be endowed with motion. We were recently invited to inspect a series of eleven miniature groups illustrating the history of transportation which were made at an expense of 150,000 dollars. The time required was one year, eight months.

We were particularly struck with the rare fidelity with which detail was handled. Think of trying to get fabrics for diminutive men's clothing and women's dresses of the period of 1830. Ancient "deposits" of textiles were uncovered and utilized. The literature of transportation and every avenue of knowledge was put under contribution, and the result is so worth while that we are presenting a series of illustrations showing how it was done.

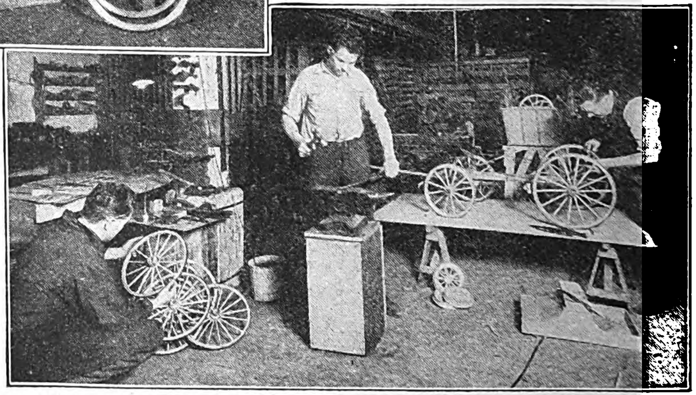
The groups are 12 feet long and six feet deep, just right size for a show window. The "ground" is a rubber composition which cannot be damaged by rolling. The whole series of groups can be packed in special water-proof cases. They can all be transported on a trailer 23½ feet long, 7 feet wide by 7 feet high, inside measurements. The groups are intended for exhibition in stores, automobile salerooms, and other places where an educational exhibit is deemed worth while. The groups are so expensive to fabricate that they could hardly be purchased, except by museums. A "Deadwood" coach would cost 5000



Coach makers and boiler makers are plying their respective trades. The coach is a marvel of skill and patience. Every cushion is beautifully fashioned and the springs are accurate reductions. Every rivet in the *DeWitt Clinton* is real

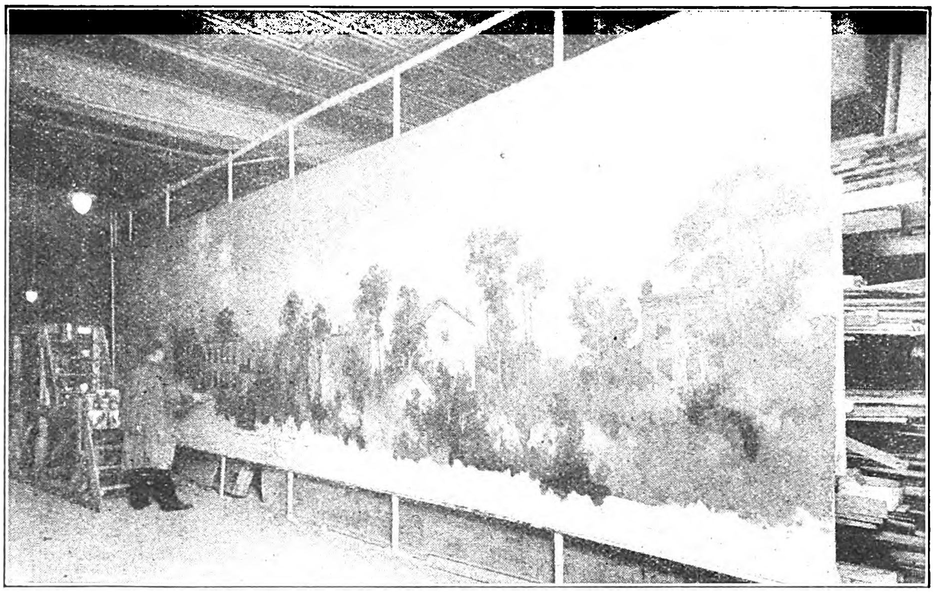


The saddler's trade is a vanishing one. This man makes wonderful saddles, harness, curtains, and cushions



The wheelwrights are on the job making miniature coach and wagon wheels as well as the running gear dollars and the *DeWitt Clinton* locomotive as much more.

The groups of this particular exhibition are as follows: The Indian Pony Drag, the Conestoga wagon (this great prairie schooner passed its 100th birthday a few weeks ago), Fulton's *Clermont*, the *Tom Thumb* locomotive on the Baltimore and Ohio Railroad, the *DeWitt Clinton* locomotive, the Deadwood Coach, the Pony Express with Buffalo Bill, Lincoln in his carriage, the race betwen the *Natchez* and the *Robert E. Lee*, the Selden automobile, the Wright airplane at Kitty Hawk.



The scenic artist is painting the background for one of the scenes. It is a compromise art between easel picture painting and scene painting. The handling of the various backgrounds helps along the illusion of reality

THE backgrounds were painted by real artists, the designs being made by Mr. Joseph Damon of Messmore and Damon, whose unique shop we are illustrating. Then began the correlation of industries and trades some of which are all but extinct. The coach maker used the care that was expended on a Brewster body. Every bolt and nut and every cushion was reproduced with absolute fidelity. The coppersmith made the boiler for the *DeWitt Clinton*, reproducing every rivet. When the tender was being made, it was found that the floor had been made with the rivets in the frame parallel instead of staggered as they should be. *Crash!* it went into the brass junk barrel and a new one was made with the rivets properly disposed. Probably only two or three persons in the United States, amateur model makers, would have noticed the difference.

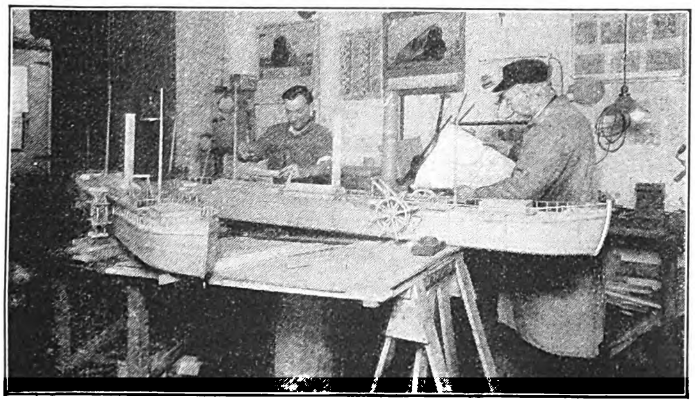
Meantime, the wheelwrights had been making the miniature wheels and the saddler had been spending days on the harness or the hood for Lincoln's state carriage. Not far away, the blacksmith had been making the springs, leaf by leaf, and the woodcarver was making the little wooden figures, for there is no composition or papier mache used here. Meantime, the wigmaker was weaving each hair into a silk foundation and the dressmaker was making poke bonnets, hoop skirts, and men's coats from material from a celebrated Chicago collection.

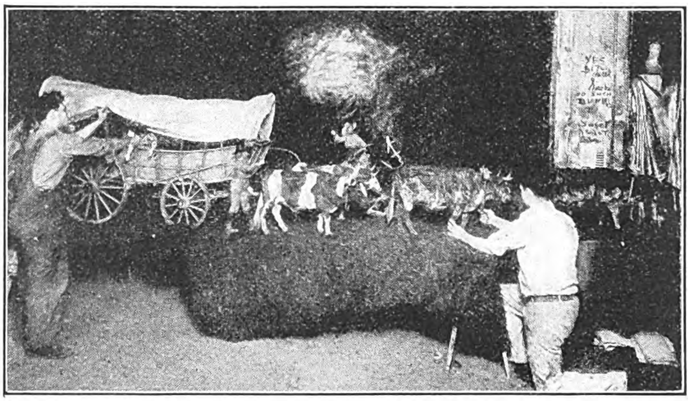
The woodcarver is also a sculptor. It took him a week to carve the head of Lincoln for the lifelike scene where the martyred President is driving. The woodcarver makes many of the accessories

The shipbuilders have been busy on their steamboats, and the sign painters are getting ready to paint the names on the paddle boxes, with the names of the company on the curve. Even such details as this required considerable search in a library where at last an early lithograph was found which gave the desired facts. Other workmen have been cutting little sticks for the fuel for the *DeWitt Clinton,* and "smoke" for the racing steamboat is supplied by mineral wool. The horses shy at the new fangled Selden automobile and it is no wonder, for it is a fearful and wonderful contraption. Nearby, the Wright Brothers are getting ready to fly 852 feet in 59 seconds. Twenty-six and one-third years later, Mr. and Mrs. Lindbergh crossed the continent, making the trip of 2100 miles in 13¾ hours at altitudes of 14,000 to 15,500 feet.

"The Story of Transportation in America," is what the show is called.

The *Clermont* will soon take the water. The model is really a monument to patience. Even the smallest detail is worked out with the greatest possible care





The Conestoga wagon was destined to carry pioneers across the continent. Its centenary has just been celebrated. Here we have the last finishing touches

The Physical Nature of Death*

By George W. Crile, M. D.,
Marie Telkes, Ph. D.,
AND
Amy F. Rowland, M. A.†

THE terms "living" and "non-living" and "dead" denote variations in energy and form. In structure the living organism is identical with the non-living—just as the live battery is identical in structure with the dead battery. But what is the essential feature in the living organism upon which structure depends? What is lost in death?

Thirty-five years ago I first attempted to approach this problem by an investigation of the basis of death. Phenomenon after phenomenon associated with death was critically examined and set aside as it was found to be a result rather than a final cause of death.

Studies of the circulation and respiration showed that the changes in these vital phenomena which are present in exhaustion and death are end effects and not primary causes of death. So, too, studies of the chemistry of the blood, while they revealed that the acid-alkali balance of the organism is of vital significance, did not reveal the cause of death.

RESUSCITATION experiments were performed in which it was found that in normal animals after complete cessation of the circulation for from five to seven and a half minutes, resuscitation followed the infusion of adrenalin into an artery; in the course of these experiments the sequence in the return of the various functions and reflexes was observed. But these experiments, important as they were, did not reveal the cause of the cessation of circulation and of the final death which would have followed had not the dose of adrenalin been administered.

By the examination of great numbers of cells under the microscope we found that certain histologic changes were invariably present in the cells of the brain and of the liver after death from any but sudden and accidental causes. The nuclear-cytoplasmic relation was disturbed and the semipermeable membranes were in process of disintegration. That life was incompatible with such a condition of the cells was obvious but was the condition of the cells in itself the actual immediate cause of death?

Later we directed our investigation to the determination of certain physical constants in various vital and lethal conditions. We found that the processes leading to death were always accompanied by a decrease in the conductivity of the brain and of other components of the central nervous system, and by an increase in the conductivity of the liver with corresponding changes in the electric capacity of the cells. But certainly a change in the conductivity and capacity could not be the immediate cause of death.

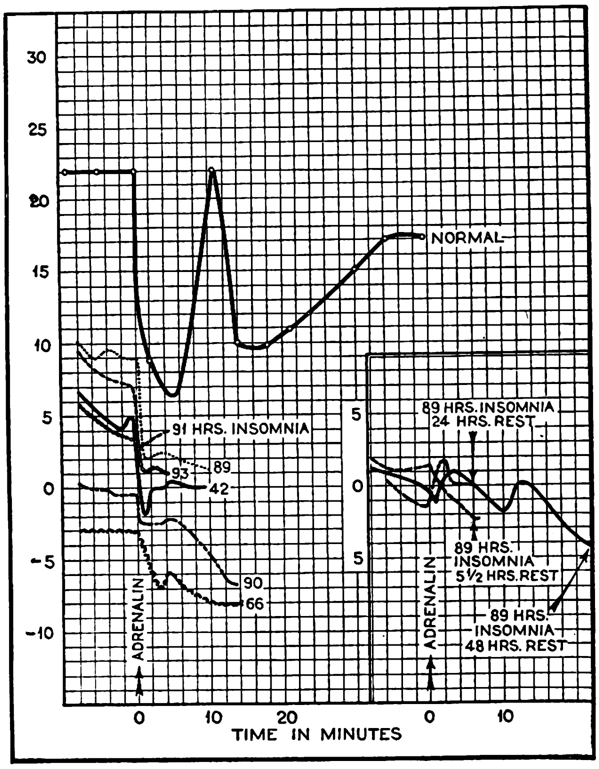


Figure 1: **Effect of insomnia on the potential of brains of rabbits. Note diminished response to adrenalin in the insomnia rabbits**

Death may result from many diverse causes: from hemorrhage, from physical injury, from infection, from insomnia, from anesthesia, from asphyxia, from surgical shock, from the excision of certain organs—any of these agents alone may produce death, or death may be due to a combination of any of these different factors. Thus in war a soldier may die not as the result of wound alone, or infection alone, or insomnia alone, or anesthesia alone but as the result of a combination of all these various factors. But whatever the cause of death the phenomena of death are identical.

In death the energy characteristic of life is lost—the dead body is in equilibrium. In death the living structures, namely, the cells, are unable to hold their form and structure and inevitably disintegrate. In death the delicate organic molecules such as the fatty-acid chains lose an organizing, binding influence and they too disintegrate.

WE propose now to offer new experimental evidence which identifies a form of energy that is lost in death—a form that is capable of constructing the films and of holding together the essential organic molecules.

These researches which have been carried out in the research laboratories of the Cleveland Clinic Foundation were directed toward finding the relation between electrical potential and oxidation; that is, toward determining whether one or the other is the primary factor in the maintenance of life and whether the loss of one or the other is the essential factor in the production of death or whether both together are primarily essential. Our researches were especially directed toward the discovery of the influence of potential on oxidation; the influence of potential

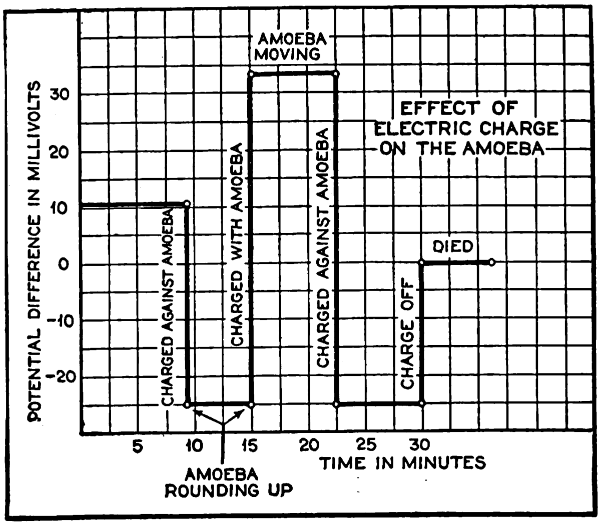


Figure 2: **Effect on the potential of an amoeba of direct and of counter electric charges**

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*A paper presented before the American Philosophical Society and reprinted by permission, from the *Proceedings* of that society, which was founded 1727 by Benjamin Franklin.

†See "Among our Contributors," page 5.

on the form of the living, and by inference on the maintenance of the organic molecules; and to the discovery of the relation of the potential to death.

The results of these researches may be summarized as follows:

1. In animals, plants, and fruits an electric potential exists during life and disappears at death.
2. The potential is varied by insomnia, by anesthetics, by poisons, by hemorrhage, by asphyxia, by change in electrolytic solution, by adrenalin, by injury, by heat, and by cold.
3. At the moment of clinical death the potential difference between different organs drops to zero for a few moments; following this, each organ regains its potential for a short time, but finally the potential of all tissues drops to zero, the respiration of the tissues stops, and molecular disintegration sets in.

ARE we then correct in ascribing the cause of clinical death to the fall in the potential between the different tissues, and the cause of the death of single cells or of tissue cultures to the fall in the potential on the cell membrane?

Of primary importance was our finding that insomnia by itself alone produces a progressive loss of potential. In our experiments, if insomnia was sufficiently protracted, the potential declined to zero and the animal died. As the potential approached zero, recovery of potential followed a sufficiently prolonged period of sleep and of rest. Of special significance was the fact that after prolonged insomnia the animal did not respond in normal fashion to the injection of adrenalin. (Figure 1.)

If the molecular structure depends upon an electric strain or potential which also enables the organism to function and grow, we must find direct evidence therefor. Happily we found such direct evidence in observations of the potential of an amoeba. Dr. Telkes designed and constructed an electrode which could be inserted into an amoeba and with this electrode she made measurements of its potential. She found that the potential of the amoeba ranges as high as 15 millivolts and that it changes with alterations in the concentration of the electrolytic solution in which it is immersed, with changes in temperature, and when anesthetics are added to the suspending solution. Radiation, adrenalin, and sodium iodid all induce characteristic changes comparable to those seen in rabbits and in dogs.

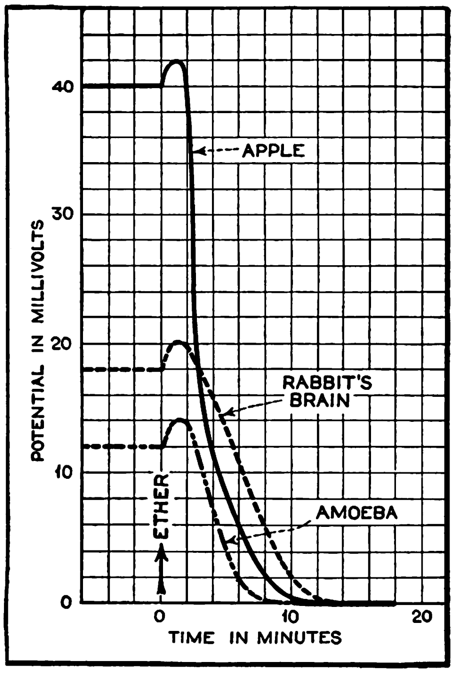


Figure 4: **Effect of ether on potential of apple, brain of rabbit, and an amoeba—again, same effect**

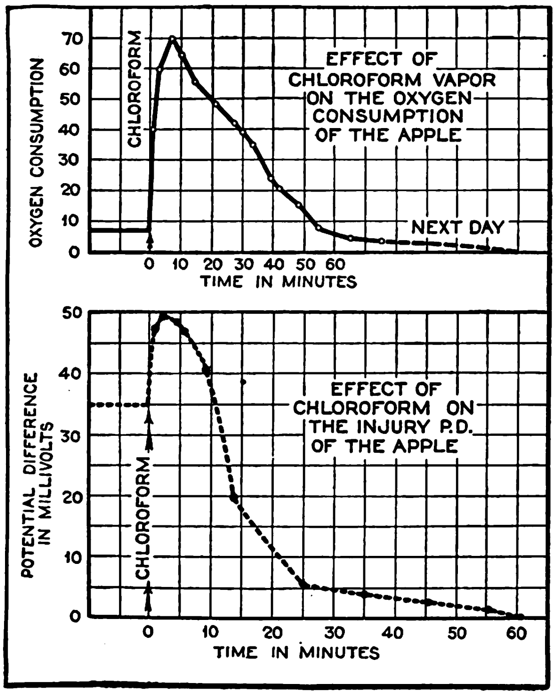


Figure 5: **How chloroform affected the potential difference of apples—again an initial rise, followed by a steady drop to zero**

The amoeba was observed under the microscope during the experiments. Here we had our first opportunity of noting under the eye the changes in structure which are produced by these various agents. Of special interest and importance were the effects of changes in potential produced by the direct application of an electric charge which could be varied at will. When the charge was increased the potential rose, and the amoeba became more active. On the other hand when the potential was diminished by introducing a current the direction of which was opposed to that in the amoeba, the amoeba progressively became less active and withdrew its pseudopodia; that is, it rounded up into a quiescent lump, until when the potential reached zero or went over to the negative side the amoeba disintegrated first into larger then into smaller granules and fragments and finally disappeared in the suspending solution. When, however, the potential was lowered by the counter-charge, and by no other factor, nearly to zero and was held there, the amoeba would round up and some granules might even disintegrate; but if at that crucial point when death and disintegration were imminent, the potential was raised by increasing the charge and by nothing else, the amoeba would pass from the resting to the active state, and would again throw out its pseudopodia. (Figure 2.)

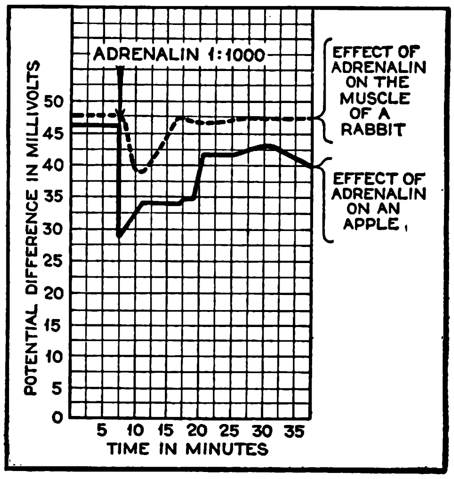


Figure 3: **Effect of adrenalin on the potential of muscle of rabbit (animal) and on potential of an apple (fruit); that is, effect was same**

This crucial experiment indicates that the fundamental control of the molecular integrity and of the activity of the amoeba—this difference between life and activity and death and dissolution—is governed by the change in the electric potential. In our experiments activity, quiescence, death, and dissolution were governed completely by the production of variations in the potential alone.

FROM this we may infer that the organic molecules that are bound together in the animal organism, the arrangement of crystalloids and colloids, the separation of nucleus and cytoplasm, the maintenance of the molecular organization—we may infer that all these phenomena are manifestations of electric force. Electrical potential is the product of chemical activity and in turn the electrical potential governs chemical activity. These electrical and chemical processes are the governing factors in the production of the phenomena which are characteristic of life. In their absence the organism is dead.

If the organic compounds, structures, and so on, in plants and in animals are created by electric potential and chemical activity, especially by

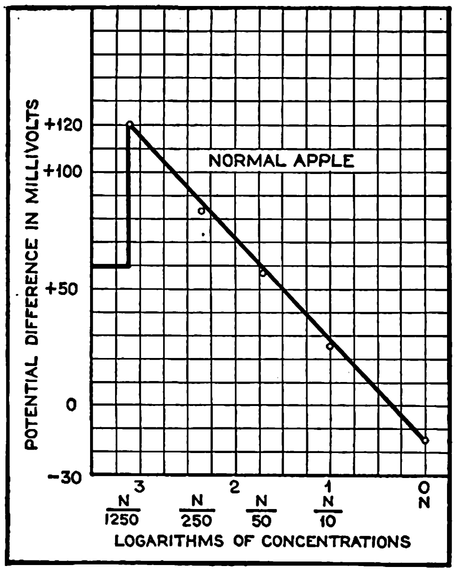


***Figure 6:* Logarithmic curve showing effect of varying concentrations of sodium chloride on the potential of a normal apple. The circles represent the five observed values**

oxidation, then in such intermediate forms of life as fruit the same law should hold.

We therefore extended our researches to an investigation of the phenomena of potential and of oxidation in fruit and we found that every kind of fruit has a potential—the potential of an apple, for example, is about 50 millivolts, and the apple has also a steady respiration—consuming from three to four cubic centimeters of oxygen every hour.

In our experiments we found that the potential and the respiration of the apple change in the same direction under the influence of anesthetics, and of changes in electrolytic concentration. The administration of adrenalin, changes in temperature, and the exclusion of oxygen affected the apple just as they affect the rabbit and the dog. (Figure 3.) Anesthetics caused first an "excitant" stage which was indicated by a rise in potential and an increased metabolism; that was followed by a continuous fall of both the potential and the metabolism to the zero point, after which neither potential nor metabolism was again manifested. (Figures 4 and 5.) Adrenalin caused a fall in potential followed by a rise and the respiration of the apple was increased. Changes in electrolytic solutions caused changes in potential which were in conformity with the Nernst formula. (Figure 6.) When the electrolytic concentration equaled the concentration of the electrolytes in the apple the potential fell to zero. Immersing the apple in oil caused the potential and respiration to fall to zero and to remain there. Increasing the temperature of the apple caused the potential and respiration to rise together and after an irregular fluctuation at a given height both fell to zero and remained there.

In all cases in which the potential was reduced to zero the apple disintegrated, just as animals and plants and the amoeba disintegrate when their potential is reduced to zero. A battery was constructed by arranging halves of apples in series and a potential of over a volt was thus created. (Figure 7.)

By this study we have demonstrated that the structure of the apple, like that of the amoeba, is dependent on potential and here again we saw the relation between electric strain and the maintenance of the organic structure.

If oxidation is due to a difference of potential and if living cells are concentration cells, then if apple juice were placed on one side of a celluloid film and distilled water on the other, oxidation and potential should be manifested just as in the apple, amoeba, or rabbit. Such an arrangement was made and as a control another artificial "concentration cell" was set up which was identical with the first, except that a hole was punched in the celluloid film in the control cell. Observations of metabolism and of potential showed that the first artificial cell functioned like the apple and the amoeba; that is, it had a potential and it showed respiration; the control cell, on the other hand, had neither oxidation nor potential.

In brief, then, in a large series of experiments we have found that in animals and in plants and in fruits there exists a potential which has a certain range during life and disappears at death. This potential is dependent on the presence of a semi-permeable film, on certain electrolytic concentrations, on water, on temperature, on oxidation, all of which together create the organizing potential. It is the charge on the films of the cells which endows the organism with its selective or adaptive property; oxidation occurs only in the presence of an electric charge and the charge is created by oxidation. Life is a phase of the organization created by electric strain or potential and death is an inert stage in which potential is lost and disintegration is inaugurated.

Or we may define life and death in the following terms: Life may be defined as a potential which is maintained and is varied adaptively according to environmental conditions, this potential being maintained by chemical activity—mainly by oxidation. The loss of this potential is death. The principal difference, then, between that potential which is life and the potential which is present in non-living systems like concentration cells is that the living potential is spontaneously and adaptively alterable.

In brief, then, life in the unicellular organism is an adaptively changing difference in potential between the cytoplasm and the medium in which it exists, and presumably between the cytoplasm and the nucleus. In the lowest forms of multi-cellular organisms life is an adaptive difference in potential between the central nervous system and the rest of the organism; in the higher multicellular organisms life is an adaptive difference in potential between the brain and the other organs and tissues, especially the liver. The life of an organ or tissue depends upon the maintenance of a difference of potential between the cells and the intercellular medium, and presumably between the nucleus and the cytoplasm of the individual cells of which it is composed. And in the unicellular and in multicellular organisms alike death is the absence of a difference of potential—final equilibrium.

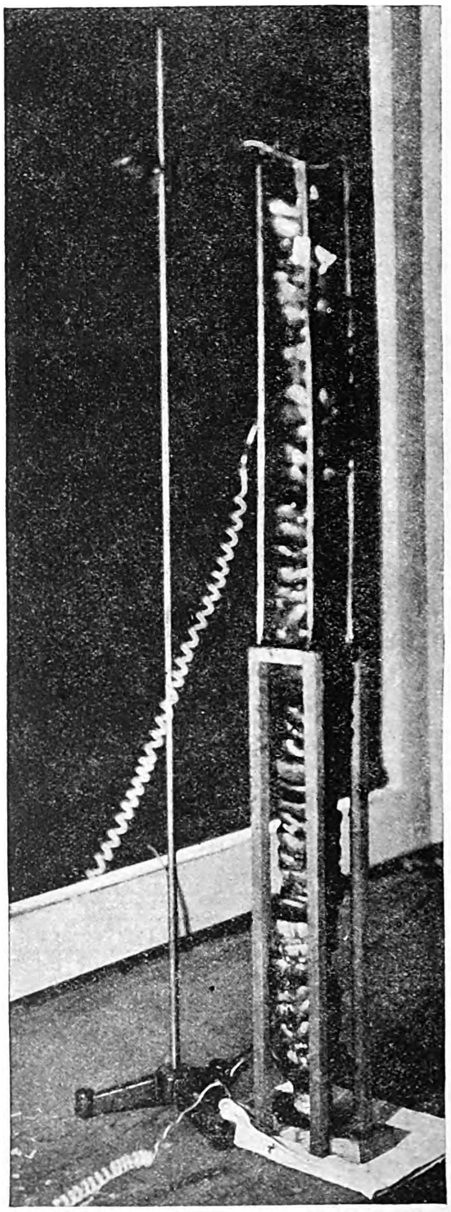
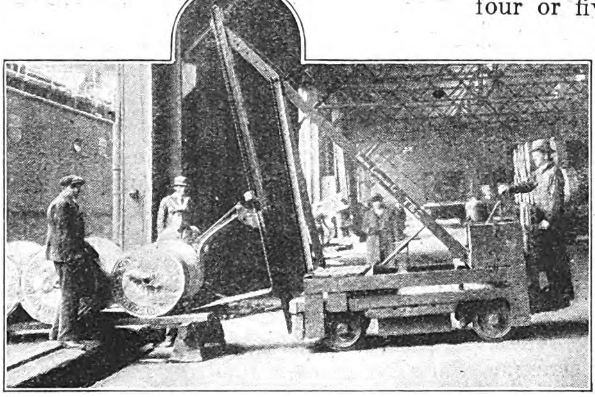


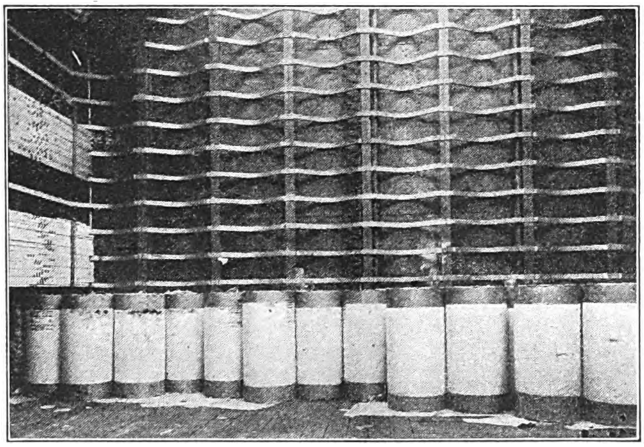
Figure 7: The apple "battery" made of 50 halves of apples arranged in series. Its potential was more than one volt. The halved apples are piled up in series and electrodes are attached to the bottom and top halves respectively

Shipping Newsprint Paper in Safety

A CURIOUS craft, the S.S. *Markland*, has been recently making trips from Liverpool, Nova Scotia, to New York at frequent intervals. She was built to perform one duty; namely, to transport 8000 rolls of newsprint paper without chafing or wetting. Of course, paper has been carried by ships from time immemorial but not in this manner. The vessel, which is 336 feet long and of 4454 gross tons, is built on the deep-frame principle. Her cargo holds are constructed with as boxlike formation as possible. All brackets, stanchions, pillars, et cetera, have been omitted and otherwise compensated for. Frames in the cargo holds are continued through the main stringer to the height of the bulwark, with the inner flange of channel removed and watertight collars fitted. The frames are bracketed to the deck. This method of construction compensates for the absence of the ordinary beam brackets usually associated with deep-frame construction, the brackets being eliminated from the hold to obtain better stowage. Frames in cargo holds have steel cargo battens covered with wood to prevent any damage to the newsprint from coming in contact with bare metal. The vertical bulkhead stiffeners support steel strips, wood covered. These strips are so curved as to allow paper rolls to be stowed snugly and firmly between the stiffeners, while the holds forward and aft are boxed vertically in the way of curvatures to allow rolls to be stowed tightly in a vertical position. Wooden battens protect the newsprint from contact with the metal.



The rolls are transferred to trucks by electric tiercing machines



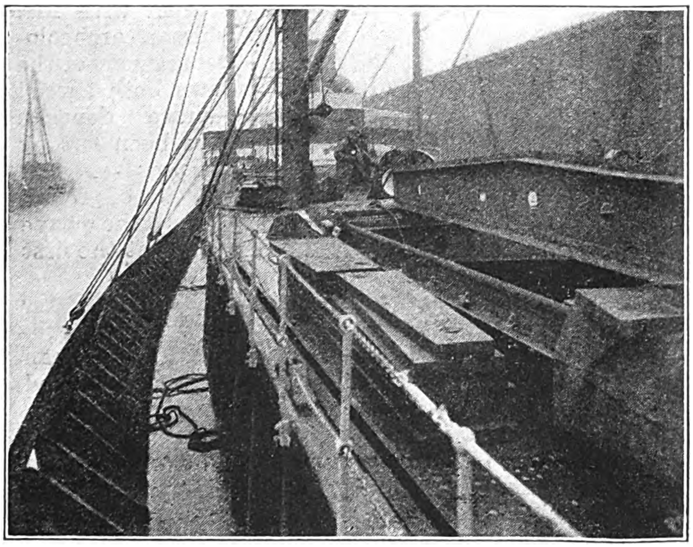
The rolls fit closely. When each tier is complete, painted boards are placed over the top, making a floor for the next tier of rolls of paper

The keel is on the duct principle forward of the machinery space to the fore peak bulkhead to allow steam lines for winches, water pipes, et cetera, to be carried forward clear of cargo holds. The *Markland* was built at Hull, England from the design of Mr. Walter Lambert of Montreal.

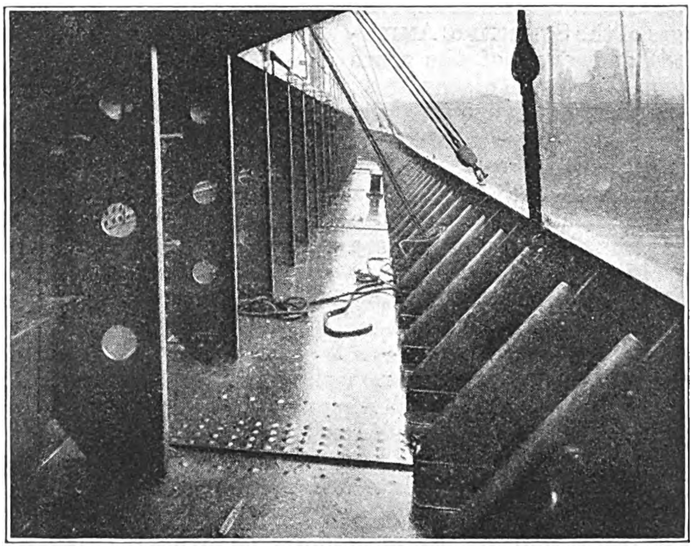
The five holds each take care of four or five tiers of paper rolls with painted wooden boards, or "dunnage" separating each tier. Every precaution is taken to avoid danger by water as well as chafing. All pipes are enclosed in other pipes to prevent dripping.

THE regular trip of the *Markland* occupies about 44 hours. Once the pier in New York is reached unloading begins at the rate of 200 tons an hour. The rolls are turned down horizontally and two are swung up through the hatch at one time, the ends of a bridle being inserted in the iron cores. Although hoisted collectively, once on the dock they are handled individually by tiercing machines or trucks which grip one roll at a time, elevating it and carrying it to the waiting truck which when fully loaded, rushes off to carry the paper to the waiting presses.

The pulp wood all comes from Nova Scotia, where the paper is made by the Mersey Paper Company of Liverpool, Nova Scotia. In this plant two paper machines each produce a ribbon of paper 222 inches wide at a speed of 1000 feet a minute.



Steel cargo battens close the five hatches; ten steam winches discharge the paper at a rate of 200 tons an hour



All stanchions, pillars, et cetera, are omitted and they are compensated for by a deep-frame construction

The Mystery of Gypsum Cave

By M. R. Harrington*
Curator, The Southwest Museum
Member, American Anthropological Association

Discoveries Near Boulder Dam Point Either to High Antiquity for Man in America, or to a Later Survival of Certain Extinct Animals Than Heretofore Has Been Believed

IN a deep, dry cavern in the mountain ranges east of Las Vegas, Nevada, overlooking a wide stretch of desert and the distant rugged gorge of Black Canyon—future site of Boulder Dam—an even dozen men and women are trying to unravel a fascinating mystery. This mystery concerns not only America's first human inhabitants, but the strange beasts of a by-gone age.

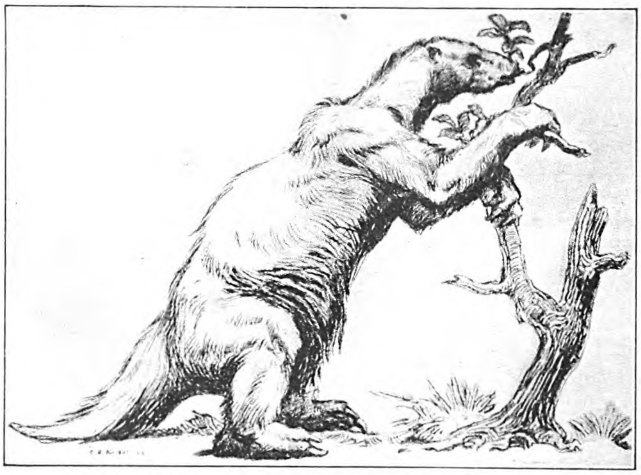
The workers represent two great institutions, the Southwest Museum of Los Angeles, and the California Institute of Technology working in co-operation, a rare example in this country of archeologists and paleontologists laboring side by side on the solution of a single problem.

I am no stranger to the exploration of caverns, but the first thing I sensed when I first entered Gypsum Cave in 1924 was the mystery of the place. Here was something different, a situation I had never found before.

A little digging near the entrance showed traces of early Pueblo Indians like those who occupied Lost City and Mesa House in the nearby Moapa Valley (both of which have been described in the pages of the SCIENTIFIC AMERICAN[1]) and even of the more recent Piutes. In the rear chambers, however—and the cavern was 300 feet long and 140 feet wide—the only human relics I could find belonged to a much more ancient people, the Basketmakers, who in fact are the oldest inhabitants of our southwest known to archeologists. Reliable authorities even estimate their date as about 1500 B.C.

The Basketmakers are remarkable for the fact that, although they had made a beginning in agriculture, they were ignorant of pottery and knew nothing whatever of the bow and arrow. In fact this weapon which we now consider so typical of the American Indian had not yet, apparently, been introduced into America at all.

Instead of the bow and arrow these ancient people used darts or small spears feathered and pointed somewhat like arrows but longer—about five feet long—and heavier. These were hurled at animals or human foes by means of the curious spear thrower known to archeologists today by its Aztec name of *atlatl*. This was a carved throwing stick about 20 inches long, with a hand hold on one end and a small hook on the other, which engaged a socket or pit drilled into the butt end of each dart. The throwing-stick or *atlatl* in effect added its 20 inches to the length of the user's arm and gave him that much more advantage in velocity when he threw his darts.



In the Pleistocene Epoch ground sloths, some as large as elephants, ranged from California and Pennsylvania to Patagonia. This one is *Nothrotherium*

One of the methods by which archeologists distinguish *atlatl* darts from large arrows is by the fact that the butts of the darts are always provided with these sockets instead of with the notches for the bow-string seen on arrows. I am describing these things here because the Basketmaker relics I found that day in the inner chambers were mainly fragments of such darts.

Now these Basketmaker remains lay on the *surface*. What might lie in the deposits below the surface was an intriguing mystery.

A few test holes revealed the fact that the deposits, upon which the dart fragments lay, consisted very largely of compact manure, reminding me strongly of some old horse corral or barnyard.

This only deepened the mystery, because I could not understand what animal might have existed before the Basketmakers that could have produced such a deposit. I knew that modern horses were introduced into America by the Spaniards, long after Basketmaker days; and that no horses could have penetrated the cave, anyway, on account of its small entrance.

IF Basketmaker dart shafts lay on its surface, the manure must certainly be older than the Basketmakers; that is to say, probably more than 3500 years old. I resolved to return some time and solve the problem, if it was solvable.

However, the Museum of the American Indian, Heye Foundation, with which I was connected at that time, abandoned its Nevada work and I was unable even to visit the cave again until January 1929, when I returned to the region in charge of an expedition from the Southwest Museum of Los Angeles, to work once more in the Moapa Valley.

During the same spring I made several visits to the cave, one of them with Mr. Jesse L. Nusbaum, archeologist for the Department of the Interior, and we both agreed that the manure deposits might well have been left by some animal now extinct, maybe some species of ground sloth, and that the cave should be explored at the first possible moment.

This opinion was strengthened after the close of the expedition when Professor Barnum Brown, of the American Museum of Natural History, examined specimens of the dung. He thought there could be little doubt that some kind of ground sloth was responsible for it, basing his deductions, I believe, on a previous find in South America.

And when the long-hoped-for chance came in January, 1930, to lead out an expedition for the express purpose of solving the mystery of Gypsum Cave, I was overjoyed. However, I fondly imagined that a few weeks would bring the answer. . . . At this writing 11 weeks have passed, and while we have learned much, the mystery is still a long way from full solution.

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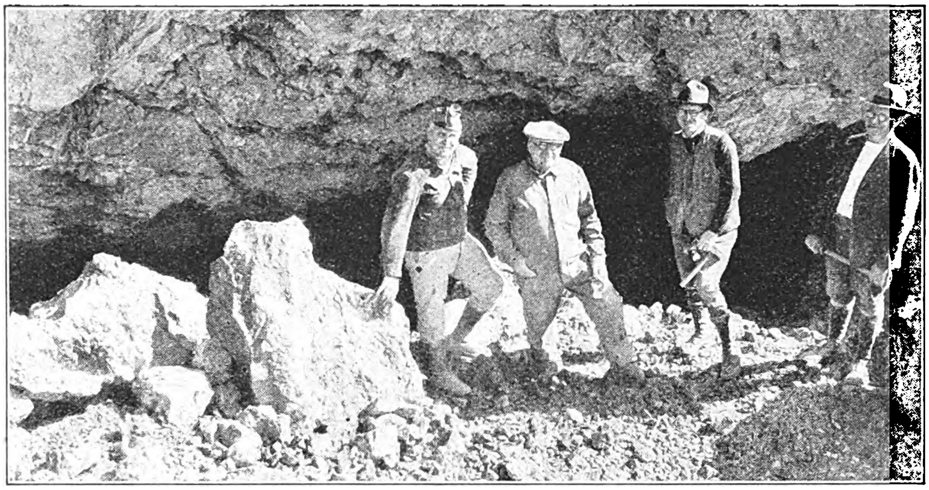
*See "Among Our Contributors," page 5.

[1] "The Lost City of Nevada," M. R. Harrington, July, 1925, pages 14-16; "The Last Stand of the Nevada Pueblos," Irwin Hayden, February, 1930, pages 132-135.

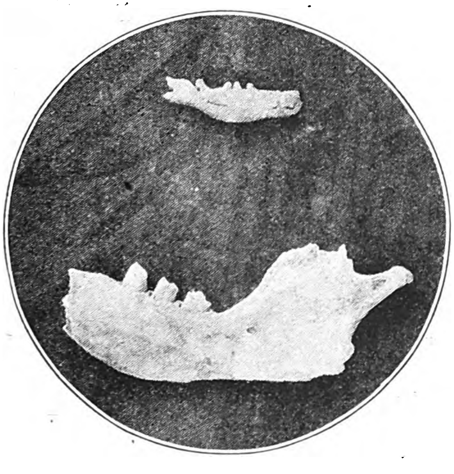
Our first task was to examine the surface of the cave floor and all its crannies and crevices as carefully as we could. This resulted in finding, scattered everywhere in the inner rooms of the cavern, hundreds of fragments of wooden and cane dart shafts broken and splintered. Most of them, as were the first ones found in 1924, seemed to be the work of the Basketmakers. There were also countless burnt sticks—the remains of torches.

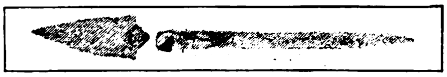


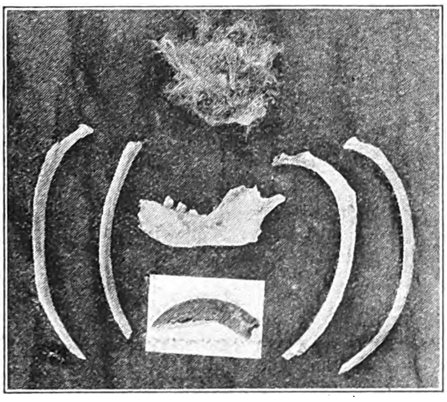
Right to left: **Dr. E. L. Furlong and Dr. Chester Stock of California Institute of Technology; Dr. Scherer, Director of Southwest Museum; the author**

TWO ancient wooden flutes, some curious bits of archaic basketry, and occasional other relics turned up, including even a few fragments of more modern arrows, but these were as nothing compared to the hundreds of splintered primeval weapons which littered the place. Why were there so many, and why so splintered? The mystery deepened.

Then we found upon the surface among the dart fragments some strange-looking bones, and then my niece, Bertha Parker Pallan, found the unmistakable skull of a ground sloth! We learned later that it belonged to the ungainly species known as *Nothrotherium*, not the largest of the ground sloths by any means, but a creature about the size of a husky brown bear. The skull was not buried; it lay upon the surface protected from view only by an uptilted slab of rock.







Jaws of baby and adult sloths; spear point found near a sloth skull; relics of *Nothrotherium*—hair, ribs, jawbone, and a claw

Was this really a clue? Our suspicions as to the origin of the manure deposits were strengthened, of course, for we now knew with certainty that the cave had been a sloth den, but what of the darts? Had they been thrown to slay the odd, misshapen beasts of the cave?

Only digging could reveal the answer, and dig we did, starting a trench in the main chamber. Here we found bones—a few of them—some of the mountain sheep, some of a small variety of horse, even a piece of a sloth claw, but nothing made by man.

It seemed a cruel fate that it was not the hard-working trench diggers who made the next big find, but an outsider, or almost an outsider. It was Mrs. Myrtle Evans, wife of one of our Indian helpers, and herself an Indian of the Washoe tribe, who was visiting the cave one afternoon with her little nephew. Scratching with a trowel in a distant end of the cavern she unexpectedly turned out a big bone. It was a sloth vertebra! Soon we had uncovered a large part of the skeleton of a *Nothrotherium*, so well preserved in parts that one great claw still retained it horny covering. Bunches of the long, coarse, tawny hair, with its dark shading, were in perfectly good condition.

In rock crevices near the bones appeared a bit of native string made of yucca fiber and some small feathers wrapped with sinew, possibly part of the decoration of a head dress or perhaps part of a votive prayer stick.

The situation seemed too much for a mere archeologist to handle and I wired for help—paleontological help. In answer, our Museum's director, Dr. James A. B. Scherer, brought to our camp Dr. Chester Stock of the California Institute of Technology, a leading authority on ground sloths, and his associate, Dr. E. L. Furlong. As a result of their visit this institution joined us, and now a joint expedition is laboring in Gypsum Cave. A paleontologist, Mr. J. F. Thurston, is continually on the ground and frequent visits are made by the others.

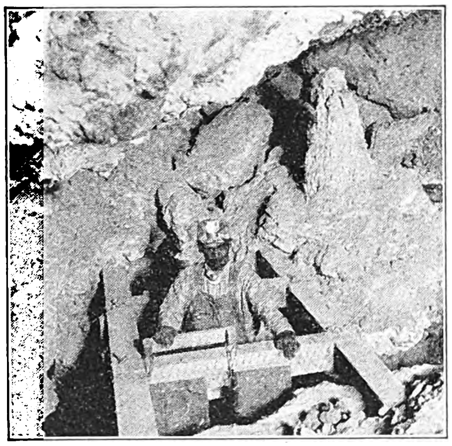
We have a capable and interested force, including Mr. Charles Amsden of the Southwest Museum, and Mr. Willis Evans, my Pit River Indian friend who worked with me at the Lost City and Lovelock Cave and is now foreman of our laboring crew.

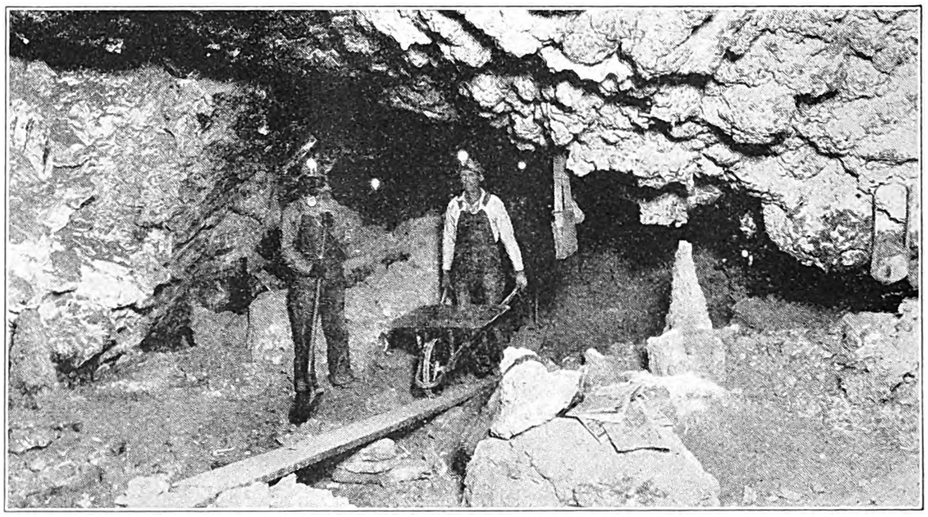
GYPSUM CAVE (named, by the way, for its beautiful crystals of gypsum or selenite) is not easy to explore. This is not only because practically every chamber is cluttered with rock falls, large and small, but principally because the lowest level is 64 feet below the entrance, and the passage from the entrance to the inner chambers is so steep and in places so narrow and tortuous that to carry our tailings or "back dirt" completely out of the cave, as we desire to do, would require a mechanical hoist such as is used in mines, and a lot of blasting. To build such a hoist would require so much outlay of time and money that it would not be justified at present. In consequence, our Zuni Indian workmen are obliged to build huge bins with stone retaining walls, in which to pile the earth and rocks dug from the trenches. Some of these bins will doubtless have to be moved and their contents rehandled when we get ready to explore the cave floor beneath them.

As in a mine, we have found it necessary to timber the roof where it seemed crumbly and in danger of falling; to build cribbing for holding back rockslides that threatened to slip down and engulf us; and even to timber like a mine shaft any pit that must be driven down into the ground to a depth of more than six or eight feet. All of these operations were new to me, after all my 30 years of archeological delving.

Some days are better than others, but almost every day is adding its bit to our knowledge of the men and the animals of the cave.

On the archeological side we are forming a picture of a people who seem to have visited the cave, long before the Basketmakers, but the portrait so far is little more than an impression. At least we know that the Basketmakers were not the first humans; for, far below the level containing their relics, we have found pieces of dart shafts differing from theirs and cruder. However, these shafts are painted with quite elaborate patterns in red and black, blue and green. We think that the points used on this type of dart were lozenge-shaped rather than notched like the Basketmakers', and were fastened in place with pitch.





Above: Mouth of shaft, 12 feet deep. At bottom were found bones of extinct American horses and camels. Near the surface to the right lay most of the ground sloth's skeleton. ***Right:*** Here were found sloth bones and various evidences suggesting that man and sloth existed at the same time

From the tiny drilled pit on the butt of the dart we surmise that the missile was hurled like those of the Basketmakers, with an *atlatl* or throwing stick, the pin of which fitted into the pit of the dart. We also know that the mysterious "first comers" made these darts of arrow brush stalks and feathered them with whole feathers, instead of the split feathers used by the Basketmakers. From the painted patterns we have some idea of their decorative art, but so far these facts are all we know about them.

If the Basketmaker was not the first human being to leave a record of his presence in the cave, neither was the sloth the first animal. Deep down in the bedded rockfalls and silt of the cave floor, at least ten feet below the level which has yielded most of the traces of the sloth, we have found bones of American horses and camels. In the upper layers other sloth bones have appeared; also more well preserved claws and hair—even the remains of a tiny baby sloth, not much larger than a cat.

But, as for the mystery, which after all may be boiled down to the question, "Did man visit the cave while it was still a den of sloths?" we have no absolutely positive answer as yet. Little by little, however, evidence is accumulating that may some day, we hope, clear away the shadows. For example in Room 1, which is near the entrance and seems to be the only chamber in which the ancients really made their home, we have found a layer, buried under more than eight feet of other deposits, containing large pieces of sloth dung, scattered specks of charcoal telling of ancient fires, and an occasional object made by man. Another bit of evidence is the discovery of some painted *atlatl* darts at depths ranging from eight to 10 feet *beneath* a layer which has yielded dung and hair of the sloth. Still another is the discovery of the lozenge-shaped dart points under the base of the rockslide upon the surface of which lay the sloth skull, only a few feet distant; while in the back chambers in the layers of sloth manure a piece of polished *atlatl* dart imbedded in the manure itself, an occasional burnt stick in the manure and sometimes even below it, are certainly interesting in the same connection.

Any one of these bits of evidence might be explained away. One can say that the ancients might have carried the pieces of manure up from the depths of the cave to Room 1 to use as fuel, or that the deposit with the hair and dung covering the painted darts was really older than they, but had slipped down upon them from some point higher up the slope of the cave floor. Or one might say that the skull of the sloth had rolled out of some other hiding place after the lozenge-shaped dart points had been buried. One might even say that the dart shaft found in the manure had worked its way in through some hole which was afterwards closed again with manure, and that the burned sticks, in spite of their resemblance to the torch sticks found all over the cave, were the result of spontaneous combustion in the manure, some of which is really burned in patches.

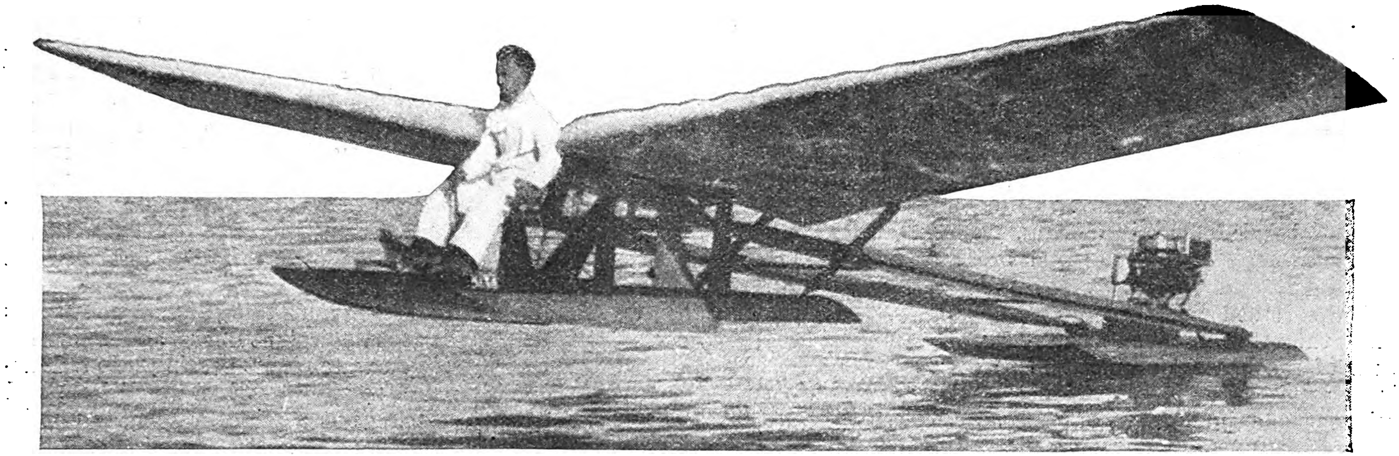
BUT so many bits of evidence in so many parts of the cave are rather hard to explain away *in toto*, and it now looks as if, when the mystery is finally cleared, we may find that the sloth, grotesque survivor of an age of monsters, was really seen in the cave by human eyes, and even possibly that the last of his race were slaughtered for food by some of the first "discoverers of America."

But even if the original mystery is cleared up finally and to the satisfaction of all, there will remain, I fear, still another one which is the outgrowth of the first.

If we prove that man and the ground sloths really existed in America at the same time, does that mean that man lived here twenty thousand or thirty thousand years ago—which is the age usually given to the strange society of animals to which the sloth belonged, the mammoth, the dire wolf, the giant lion, and the saber-toothed tiger of Pleistocene days—or does it mean that some of these animals lived on after the glaciers had receded, until comparatively recent times, say up to within ten thousand or fifteen thousand years of our times? The future alone can supply the answer, if any.

¶ *While this article was in press Dr. Frank Leverett, the widely known glaciologist, described before the National Academy of Sciences the discovery in Equador of human remains, associated with those of a mastodon. This supplies another bit of evidence on the question stated in the above paragraph.*

—The Editor.



The fuselage of the "Waterplane" rises from the water after a run of 150 feet

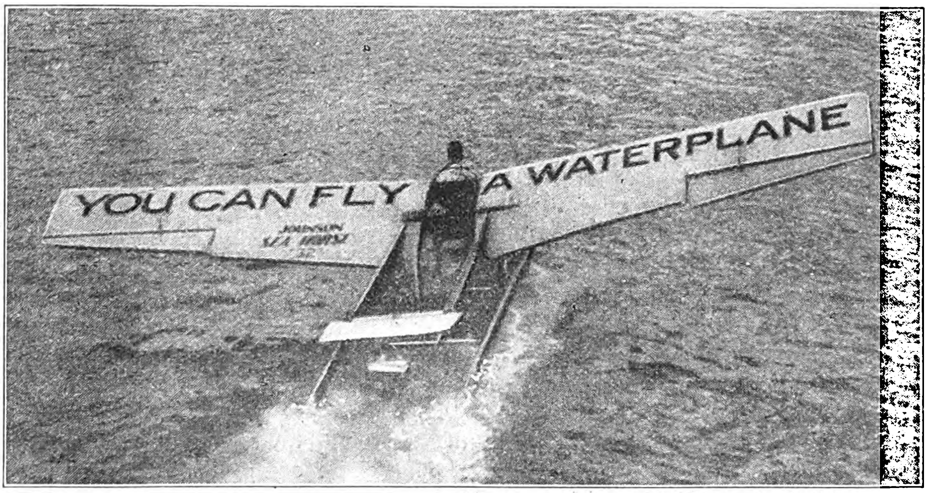
A "Flying" Outboard Motor Boat

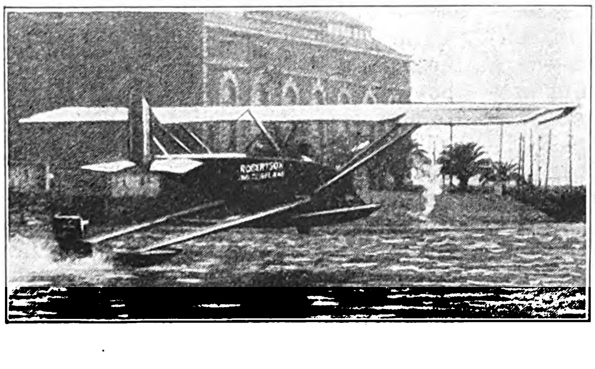
The pilot's right hand is grasping the joy stick, his left the gas control; his feet are on the rudder bar

A NEW water sport that combines the safety of outboard motor boating and the thrills of flying is made possible by the "Waterplane," designed by Russell and Milton Robertson of Alameda, California, after they had repeatedly watched tiny outboard powered racing craft rear their bows out of water. The thought occurred to them: Why not put wings on the boat and lift it completely out of the water?

Essentially the "Waterplane" consists of two units connected together by hinged arms. The rear unit is composed of two pontoons which support a standard four-cylinder outboard motor. The front unit is nothing more nor less than a glider, but in this case it is a glider that does not require a ground crew, being entirely controlled by the pilot. The fuselage of the glider is so constructed that it will float on the water, and can be pushed by the outboard motor. When the proper speed is reached, the pilot manipulates the controls and up in the air goes the glider. The motor stays in the water and continues to furnish the motive power as long as the pilot desires to stay aloft. The glider can reach a height of from 10 to 15 feet above the surface of the water.

Milton Robertson tells of flying a "Waterplane" as follows: "Seated at the controls, the pilot starts the motor by means of the electric self-starter. From a standing start to full flying speed requires a 150-foot run. At first it is best to plane over the surface, getting used to the controls. At about 35 miles per hour, the stick is pulled gently back and the 'Waterplane' leaves the water. At first it took all my attention to navigate but after the first few times aloft, the movements of the stick became automatic. Slowing the motor to a little below flying speed allows the plane to settle gently to the surface."





Above: **A rear view of an open model "Waterplane" about to take off**

At left: **All the thrills of flying in a "Waterplane" built with an enclosed pilot's cockpit**

The glider unit of the "Waterplane" is equipped with the usual controls for ailerons, rudder, and elevators. By proper manipulation of them the pilot can bank on the turns, swoop gracefully from higher to lower altitudes, and get a taste of all of the thrills of actual flight, at the same time literally "keeping one foot on the ground."

Waves and Particles[*]

By Professor George P. Thomson[†]

Professor of Natural Philosophy in the University of Aberdeen, Scotland
Non-resident Lecturer at Cornell University

The New Concept of the Nature of Matter

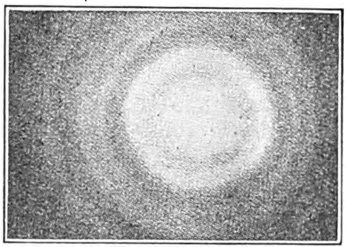
IF I break a piece of chalk, then take each of the bits and break them, and so on, is there any theoretical limit to the progress other than that imposed by the coarseness of mechanical appliances? This is a question which has occupied science since the twilight of its earliest dawn.

In the last three or four years opinions have altered as to the best answer to this question. During the first quarter of this century the answer to the question was quite definite. If the piece of chalk is continually broken and rebroken a time comes when the pieces are no longer merely smaller but become different in kind. This stage can not be reached by mechanical breaking, but it can be reached by heat and suitable chemical action. The chalk has been broken into its atoms. In chalk there are three kinds; other substances would yield other kinds, and, in all, chemists have distinguished 90 kinds from which all matter is made.

THESE atoms are small. They bear about the same relation to a drop of water that a drop of water bears to the earth. But even here the limit had not been reached. Towards the end of the 19th Century it had been found possible to break pieces off these atoms: for example, by the violent collision of other atoms. These pieces were always the same. They are called electrons and have now become almost an article of commerce, for they are the working material of the radio valve. The hot filament of the valve gives off electrons as water gives off steam, and the electric forces in the oscillating circuit control the motions of the electrons.

The older view of the electron is best expressed by regarding it as a tiny lump of electricity which had a little mass—less than a thousandth of that of a light atom—as a kind of secondary property of its charge. It was supposed to have a certain extremely minute size, but as a matter of fact the estimate of this size rested on purely theoretical arguments and no one had ever measured it. However, it soon became apparent that each atom contained electrons varying in number from one each to nearly 250 each for different kinds of atoms. Thus it was reasonable to suppose that an electron was a good deal smaller than an atom.

Later on—it is difficult to give an exact date—it became clear that there was a second universal constituent and that this was the residue of a hydrogen atom when one electron—the only one—was removed. It has been called the proton. Every atom contains, in its normal state, an equal number of electrons and protons. The protons are much the heavier of the two, but they occupy only a very small region in the center of the atom called the nucleus. This region is so small that the combined nuclei of a man's body would form a barely visible speck. Since the nucleus also contains some electrons these apparently must be at least equally small, and we are left with a picture of matter as mostly emptiness. That such a view is not purely figurative has been shown in a striking manner recently. It seems certain that some stars known as "white dwarfs" are so dense that a cubic inch would weigh a ton. This is still nothing like the density of a nucleus but it shows at least that an ordinary solid must have plenty of gaps if it can be compressed to such an extent.



Courtesy of *Nature* (London)

In the author's experiment rings were produced on a photographic plate by electrons scattered systematically in passing through a gold film. The pattern is interpreted as due to electron waves. See the text, page 40

The picture of matter was thus essentially one of discontinuity. It consisted of a number of specks—of a whole number, for an electron or proton can not be split. It is a return to the earliest philosophy, for it was Pythagoras who taught that "all is number."

But there was another side of physics in which continuity was supreme. If you had asked the question "How does one electron act on another," the answer would have been "through stresses in the ether." Now the ether has had a long and checkered history. Ethers of a sort were common in early physics—rather too common. But the ether first acquired an assured status in the scientific world when it became clear that light had to be explained as *waves*. As this introduces the other half of the title of my paper you will perhaps allow me to dwell on it in some detail.

The obvious thing about light is that it goes in straight lines—as can be seen if you watch light passing into a darkened room through a small hole and tracing out a path as it lights up the motes of dust. Now Newton said that a particle free from force goes in a straight line. It was natural to suppose that light consisted of a stream of particles shot out by the luminous object. Light can be reflected by mirrors and refracted by glass but, superficially at least, these effects can be explained as a rebounding of the light particles, or their deflection by forces at the surface of the glass, as the case may be. Nevertheless, influential men such as the Dutch physicist Huygens suggested in the 17th Century that light was a form of wave motion. Now sound is wave motion and every one knows that sound will go around corners. So will water waves. How can you explain the rectilinear propagation of light on this view?

It is all a question of the wavelength. Even in sound a high-pitched note is not heard well round a corner. If the wavelength of light is small enough rectilinear propagation is all right. Also light does bend very slightly. The really crucial test is what is called interference, the property by which two lights can produce darkness. A special form of this is to take a number of regular spaced wavelets, all derived from one wave. This gives a peculiarly marked effect. The effects of the combined wavelets are strongly concentrated in a few privileged directions and cancel everywhere else.

LIGHT shows this phenomenon to a very marked extent. For example, in the case of the diffraction grating, light scattered from a large number of regularly spaced scratches on a glass or metal surface is found to be concentrated in a few directions, and this effect can be used to measure the wavelength of light with very great accuracy.

The ether was required to carry these light waves. At first it was thought of as a kind of jelly, and Lord Kelvin used immense mathematical skill in finding the very peculiar type of jelly which alone gives exact agreement with the experimental laws of light. Now Faraday long before had regarded electric and magnetic effects as stresses in a medium, and Maxwell showed that the same medium could do double duty—carry electric effects and transmit light. Hertz crowned the theory by actually producing waves by purely electromagnetic processes which had the velocity of light, and in fact were invisible light: "light" whose wavelengths were to be measured in meters instead of thousandths of a millimeter as are those of the visible kind. I need hardly say that these waves are those now used in radio.

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[*] From the George Fisher Baker Lecture, delivered at Cornell University, and reprinted by courtesy of *Science*

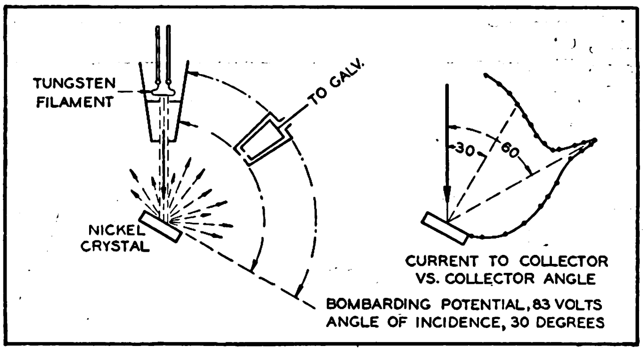
[†] See "Among Our Contributors," page 5

Later it was shown—not until 1913 indeed, but logically it comes in here—that X rays are invisible light, on the other side, as it were. Their wavelength is about 10,000 times shorter than that of ordinary light instead of millions of times longer. The way in which this was proved is of interest. To show interference well, one needs an apparatus so exactly shaped that the errors are smaller than the wavelength to be tested. Now X-ray wavelengths are smaller than most atoms. It is impossible to shape an apparatus exact to an atom. Von Laue got over the difficulty in a very ingenious way. He remembered that in a crystal the atoms are arranged in regular order like soldiers drawn up in close formation.

The result is a series of lines like a diffraction grating and about the right distance apart. Actually it is a little more complicated because the atoms are arranged in a solid array, while an ordinary grating is on a plane, but this does not really matter. The result of sending X rays through a crystal is a diffraction pattern, and in this way the wavelengths can be found.

So far, then, we have matter made of discontinuous particles, while the interaction is due to a continuous medium which can transmit waves. But now came the difficulties. I will take two selected ones which are enough to show their nature. When light is allowed to fall on a polished metal surface, electrons are thrown out from the metal. Since light is electromagnetic waves and electrons are electrical, it is not surprising that there should be an action of this kind, but the details are all wrong. The speed with which the electrons come out does not depend on the intensity of the light. They come out with just the same speed for the feeblest light as for the strongest, only there are fewer of them. Now if, for example, sea waves are breaking on the beach and rolling the pebbles about, the more violent the waves the farther the pebbles are thrown. If the water waves behaved like light, an almost calm sea would throw a few selected pebbles as violently as a great storm throws them all. This is obviously contrary to one's ordinary conception of waves, and it is equally at variance with the results of a complete mathematical treatment. Moreover, the energy with which the selected electrons appear is so great that they would take hours to absorb it from feeble light, while even with the feeblest light there is no detectable lag between switching on the light and the appearance of the electrons. Obviously something is wrong.

Einstein suggested that the light contained units of energy or quanta which behaved practically like particles. When one collides with an electron it gives up its energy to the electron which then can escape from the metal. All the quanta in a given kind of light are the same, but the stronger the light the more numerous they are. The energy of each quantum is the frequency of the light multiplied by a quantity "h," which can be found by measuring the energy of electrons emitted by light of known frequencies. This has been done by Professor Millikan. He finds $h = 6.55 \times 10^{-27}$.


TUNGSTEN FILAMENT
TO GALV.
NICKEL CRYSTAL
30
60
CURRENT TO COLLECTOR VS. COLLECTOR ANGLE
BOMBARDING POTENTIAL, 83 VOLTS
ANGLE OF INCIDENCE, 30 DEGREES

Courtesy Bell Telephone Laboratories

In measuring electron scattering, the "electron gun" at upper left corner sends a steady stream of electrons to the crystal, which scatters them in various directions. The collector (marked "to galvanometer") catches more or fewer electrons according to its position. In the case at right, for example, the maximum number of electrons caught was at 60 degrees angle. This is the principle of the method used by the physicists Davisson and Germer of the Bell Telephone Laboratories

Now this is all very well for the photoelectric effect, as the above is called, but what about the diffraction grating? We have just decided that light must be waves and now it turns out to be particles instead, for it is essential for the explanation that the quanta should be so concentrated that one electron can catch a whole quantum. This is the famous photoelectric paradox.

Before I try to answer it, I will describe the other difficulty. Atoms can be made to emit light, and each atom emits its own characteristic wavelengths. These are clearly a consequence of the structure of the particular atom, presumably of the arrangement of its electrons. Now one theory, and one only, was found capable of explaining these wavelengths even in general terms. This was the theory due to Neils Bohr according to which the electrons were supposed to move in orbits 'round the nucleus rather like planets 'round the sun. But in order to make the theory fit the facts, Bohr had to assume a behavior of the electrons which is quite contrary to ordinary dynamics, and curiously enough the same quantity "h" came in, though in quite a different way.

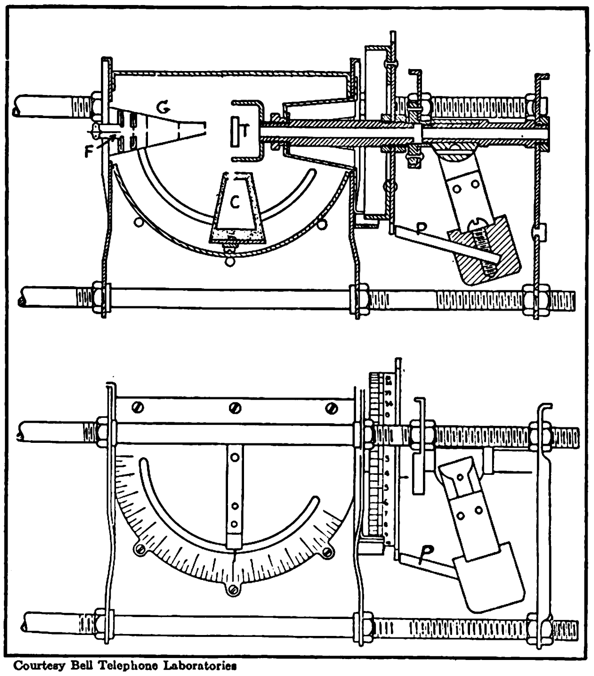
The real trouble was not so much that the electrons obeyed different laws from those of Maxwell and Newton, but that they were not consistent about it. Some of the things they did required the old laws to explain them; others required a new and inconsistent set. Sometimes both had to be used in different parts of the same calculation. The position of a physicist investigating an atom was rather like that of a man trying to make sense of an account of a game which started as golf and suddenly for no apparent reason turned into tennis and then back to golf again. Worse still, as time went on it became clear that the electrons did not play fair even at the game they had for the moment chosen. The results were nearly right but not quite. The only hint was that the quantity "h" came in whenever the atom chose to break the old rules, and this suggested a connection with the photoelectric paradox.

The first really successful attempt to solve these difficulties is due to Prince L. de Broglie. [See SCIENTIFIC AMERICAN, March, 1930, page 183.—*The Editor*.] He realized that the reason why the electron in the atom seemed to follow two different sets of rules at once was that it was behaving much more like a wave than a particle.

Now if you think that you are reading an account of a game played with a ball, when really the reporter was writing about a swimming match, it is not to be wondered at if the report does not make good sense. It is perhaps surprising that the physicists made as much of it as they did. De Broglie's theory was a mathematical one based on relativity. He reached the conclusion that any moving particle would be accompanied by a wave, and he postulated that this wave controlled the motion of the particle. Instead of Newton's laws of motion (motion in a straight line, acceleration proportional to the force, and so on) this view gives a motion governed by waves. Of course Newton's laws are true in every-day life. This is because a very short wave is indistinguishable in behavior from a particle, and the scale of de Broglie's waves is given by "h," which is a very small quantity.

But according to his theory the smaller the particle the longer the wave. For an electron in an atom the wave is quite comparable with the size of the atom, and the behavior of the electron is greatly different from what you would expect of a particle. It has been found in fact that this theory, when fully applied mathematically as it has been by Schrödinger and others, brings order out of chaos in the explanation of the properties of atoms.

Further, it is capable of dealing with the photoelectric paradox. Granting that there are in fact quanta, or particles, in radiation, they will inevitably be accompanied by waves which will guide them. The quota will appear where the waves are strong; where there are many quanta the light will be intense.



Courtesy Bell Telephone Laboratories

The actual apparatus devised by Davisson and Germer for exploring in three dimensions the space surrounding the target *T* of electron gun *G*. Angle of electron collector *C*, may be varied by means of curved slide; also target can be rotated (see dial on lower section drawing of same apparatus). Galvanometer connected to collector *C* registers the number of electrons

In other words, the regions of brightness and darkness will be just those predicted on the wave theory. This way out had indeed been suggested before. It turns the flank of the difficulty by saying that it is the natural way for a particle to behave. But if you accept this you must be prepared to take the consequences. A free electron, such as a cathode ray, should also be guided by waves and should also show diffraction. How could we hope to detect it if it did? Calculation shows that the wavelength of a free electron of manageable energy is of the same order as that of X rays. Can not we use a method similar to that by which the waves of X rays have been measured and take advantage of the regular structure of crystals?

Successful experiments on these lines have in fact been made by Dr. Davisson and Dr. Germer[1] in this country and by myself and others in Scotland. In my own experiments a narrow beam of fast electrons, cathode rays, in fact, pass through a very thin film of metal. The metal scatters the electrons, and since metals consist of a number of minute crystals, the scattering occurs predominantly in certain privileged directions, just as is the case with X rays. Accordingly, if the electron strikes a photographic plate placed somewhere behind the thin film we should expect to get a pattern similar to that produced by X rays of the same wavelength.

This expectation is in fact realized. I have obtained these diffraction patterns from a considerable number of metals. In all cases the patterns are in exact agreement with what is to be expected if they are regarded as the result of diffraction of waves by the known crystal structure of the particular metal used. The patterns are in general formed of concentric rings just like the familiar Debye-Scheerer X-ray powder photographs. From the sizes of the rings it is possible to deduce the wavelength of the waves causing them, and I find in all cases absolute agreement with the theoretical expression due to de Broglie, $\lambda = h/mv$. Thus instead of being scattered irregularly by the metal, it appears that if the film is thin enough it will guide the electrons into the direction which would be taken up by waves diffracted from the crystal structure of the metal.

If you accept the experiments as showing that electrons behave as if guided by a train of waves, you will agree that de Broglie's idea brings a remarkable simplification. Both electrons and light quanta are on the same footing as particles guided by waves.

The difficulties of physics in the earlier years of this century were due to ignorance of this dual character. For some reason we had got hold of the wave aspect of light and the particle aspect of electrons, and were running each to the exclusion of the complementary view. It also explains the curiously confusing nature of the difficulties. If we had neglected, say, the wave aspect in each case, all the new facts would have pointed to waves. As it was, some pointed to particles, and some, as we now know, to waves.

This dual aspect of things as waves and particles must be very fundamental in the world. There is little doubt that protons would show it also, though experimental proof has so far not been possible[2]. There is even strong, though indirect, evidence that a completed atom has a wave as a whole as well as component waves for its individual electrons. One reason for regarding the duality as really fundamental is that it holds for such different things as electrons and quanta. For in spite of this one point of resemblance they are essentially different. The electron has electric charge and hence is influenced by electric and magnetic forces in a way that the quantum is not. The quantum always goes (*in vacuo*) with a speed of 300,000 kilometers a second. The electron can go with any speed, provided it is less than this. For equal wavelengths the penetrating power is quite different.

These differences make it all the more significant they should both show the same curious duality. The new view is not by any means free from difficulties. To take the most obvious, many electrons form part of each of the atoms of a crystal, yet the experiments I have described essentially involve the idea that the wave of the moving electron is spread over a number of the atoms in the crystal. Have we proved that the part is greater than the whole? I think that even modern physics is not so paradoxical as this. It depends on what you mean by the size of an electron. We can measure the size of atoms in a fairly definite way by finding how many can be packed into a given space of solid. It is rather like measuring the size of shot by counting how many will fill a cartridge case of known volume. Of course we have to allow for possible empty spaces between, but this can be done if we know how they are piled together, and in many cases we do. The sizes are not quite definite; they vary a little with circumstances, but this is not surprising.

Suppose that you want to know the size of a tennis ball. It is easy enough to measure it to an accuracy which will satisfy the authorities at Wimbledon that it is legal, but if you were asked to give its diameter to a hundredth of an inch there would be difficulty. Are you going to measure it to the farthest-out hair of the felt? Obviously that is not a very important measurement, but where are you going to stop? There is no sharp edge. Here a rough measurement has a real and useful meaning, but if you try to make it precise beyond a certain point it can be done only by making some arbitrary convention, such as how hard the measuring instrument is to press.

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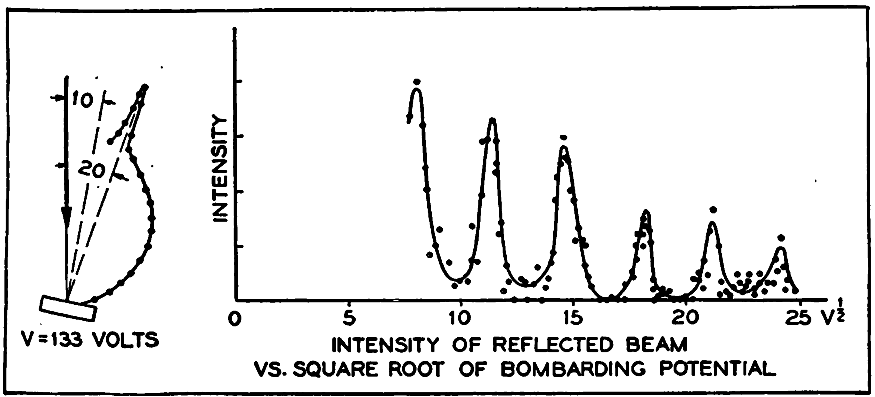
[1] See page 7.

[2] Soon after Dr. Thomson made this prediction it was made good by Professor A. J. Dempster of Ryerson Laboratory, University of Chicago. See our April number, pages 263 and 264.—*The Editor.*

This is the case of the atom, but for the electron the size is even less definite. It has not got even an approximate boundary, as far as our present knowledge goes. It is more like a gas which can expand to "fill" (in a sense) any vessel into which it is put, and yet can be compressed into a very small space. When an electron is part of an atom, its waves curl round, as it were, on themselves until it occupies only the atom, and perhaps only a part of that. When it gets free from the atom as a cathode ray, or escapes from the filament of a valve or vacuum tube, its waves can uncurl and expand indefinitely. I think, however, that in all cases one must consider it as also having a sort of center, even if this is only a mathematical point. Whenever an electron produces any detectable effect it does so as a particle, and it seems easiest to suppose that even when it is not producing an effect the particle is somewhere 'round. The best analogy I have been able to find for this view is a gossamer spider.

WHEN this little animal is clinging to the stalk of a plant, it is a small solid object. When it wants to move it shoots out long filaments many times its own length. The wind catches these and wafts it away. I regard the filaments as analogous to the waves which surround the electron, while the body of the spider is analogous to the central point. One can press the analogy further. If the wind carries the spider so that one of its filaments is caught in an obstacle, the spider will be swung around and its path deflected although its body has not hit anything solid.



Courtesy Bell Telephone Laboratories

Davisson and Germer also measured the selective intensity of the reflected beam of electrons as a function of speed (potential) of bombardment of target. "We find," says Dr. Davisson, "that it passes through one maximum after another as the speed is increased." (Note curve.) These classic experiments are comprehensible on the hypothesis that electrons are "trains of waves of wavelengths comparable to distances between atoms in solids." All these famous experiments were performed in 1928

In just the same way with the electron, if its waves pass over an obstacle, say an atom, the direction is modified and this modification is transmitted back through the wave system to the electron itself. If we suppose that the electron is constrained always to move in a way determined by the waves in its immediate neighborhood, the motion of the electron itself will thus be modified. The waves thus act as a kind of intermediary between the disturbing objects and the electron itself. The electron goes where the waves in its immediate neighborhood carry it, just as the spider is pulled by the parts of the filaments which are actually attached to it. But the form of the waves, near the electron, is determined by events at a distance, whose effects are propagated through space in the form of waves.

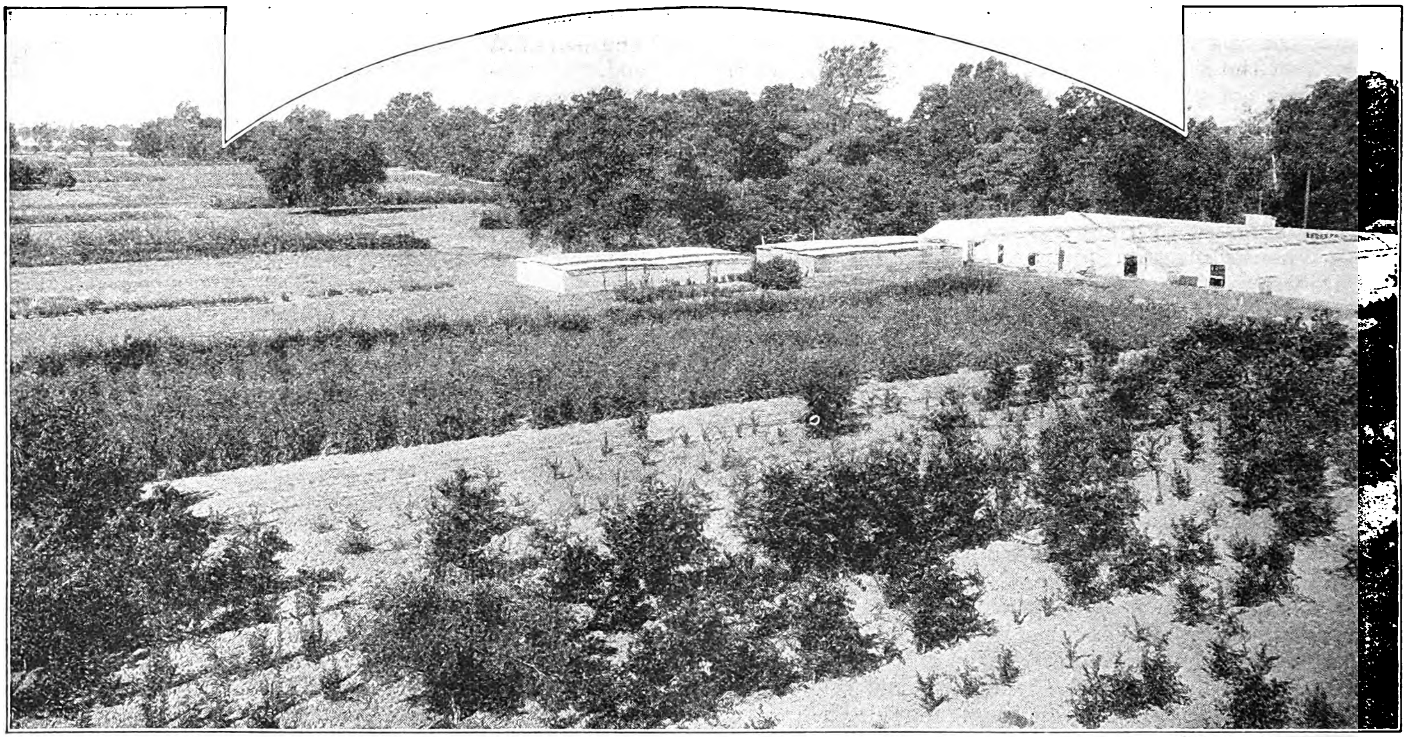
A question that inevitably arises is—what is the medium which transmits electron waves? I am sorry that I can give no entirely satisfactory answer. For the first time, physics is faced with waves in empty space which do not fit into the ordinary series of ether vibrations. All the ether vibrations differ only in wavelength; if the wavelength is given, the kind of "light" is fixed. The electron waves have varying wavelengths, depending on the speed of the electron, but they usually fall in a region of wavelengths which is already appropriated by X rays. As we have seen, they are certainly not the same as X rays. One must suppose some other medium, or at least that the ordinary ether is in some way profoundly modified by the presence of the electron. It is possible that they are waves in a "subether." But it is not a very attractive idea to have two ethers filling space, especially as the waves of protons, if they exist, would demand yet a third. Space is getting overcrowded.

Other suggestions are to regard the waves as a kind of mathematical abstraction, a sort of ghost waves. The whole question is getting very metaphysical. Perhaps a simple physicist may be content as long as the waves do their job of guiding the electron, and it is possible that, after all, the question will ultimately be seen to be meaningless. Whatever the medium is, the new wave conception has altered the view we take of the best answers to the question with which I began this lecture. Matter is still supposed made of discrete units, but instead of these units moving by laws which concern them alone as did the laws of Newtonian dynamics, we have had to introduce laws based on waves. Now a wave is essentially a continuous thing, even if the continuity is only mathematical. It is spread through space, not divided into little lumps. So although the older belief in the discontinuity of matter still holds, it has lost some of its rigidity; continuity has crept in by the back door.

The idea of the ether has also changed. The sole function left it is to guide the quanta; they do the work. The picture of light as waves breaking on a shore of matter, and thus disturbing it, is replaced by one of a stream of bullets which affect only the particular objects which they hit. The bullets, it is true, do not move quite as ordinary bullets would; they are directed by the waves, but all the effects are bullet effects, not wave effects.

WE have seen that Newtonian mechanics needs modification; that it is a simplification which is permissible only when the wavelength is very small. This of course does not detract from its practical value in every-day life and in astronomy, nor from our estimate of the genius which gave it a form which has satisfied two and a half centuries. On the contrary, the new developments, as far as they concern light, which I have tried to explain to you at such length, are much better expressed in the words of Newton's Optics. "Those that are averse from assenting to any new discoveries but such as they can explain by an hypothesis, may for the present suppose, that as stones by falling upon water put the water into an undulatory motion, and all bodies by percussion excite vibrations in the Air; so the Rays of Light excite vibrations in the refracting Medium or Substance . . . that the vibrations thus excited are propagated in the refracting or reflecting Medium or Substance, much after the manner that vibrations are propagated in the Air for causing Sound, and move faster than the Rays so as to overtake them . . . and that every Ray is successively disposed to be easily reflected or easily transmitted by every vibration which overtakes it. But whether this Hypothesis be true or false I do not here consider."

After being regarded for generations as an artificial attempt to save a dying theory, we have proved this guess of Newton's to be a supreme example of the intuition of genius.



Jujube trees are being propagated in the foreground of this scene which shows the greenhouse and nursery at the Chico station

An Immigrant Plant Proving Ground

By Charles W. Geiger

FEW Americans realize that plant introduction has given to the United States practically all of its commercial crops. Thousands of the new plant immigrants that enter the country each year find their first home in the plant introduction field stations, or gardens, of the Department of Agriculture. These are the "Ellis Islands" of the plant immigrants, but they also are the workshops, field laboratories, and plant propagation factories of the Office of Foreign Plant Introduction.

The United States Plant Introduction Garden near Chico, California, is the largest government-owned and operated garden of its kind in the United States. This station serves the State of California primarily, and other regions on the Pacific coast generally. It is located in one of the leading deciduous-fruit, nut, and citrus sections in northern California. The high summer temperature, abundance of water for irrigation, long growing season, and mild winters of this region make possible the propagation and testing of such widely different species of plants as alfalfa from the steppes of Siberia, hardy apples, pears, and cherries from Russia, chestnuts, jujubes, and persimmons from northern China, and citrus fruits from the tropics.

The Chico station consists of 210 acres of land, three hot-houses, and office and residence buildings. The entire garden is under irrigation, the greater part of it under a pressure system. For the entire garden there is an electrical installation of approximately 30 horsepower for pumping service.

CHICO is primarily a propagating and testing station. The plants are tried out there and if they seem promising, they are then distributed for experimental purposes, on order from Washington, to state experiment stations, botanic gardens, arboreta, and similar institutions. There is, in addition, a list of qualified experimenters to whom material is sent when there is more than that required by the regular research institutions.

The thousands of new plant immigrants annually received in Washington in the form of seeds, plants, cuttings, and so forth, from the agricultural explorers and correspondents of the office, are unpacked and given an identification number in the specially equipped plant-inspection laboratory of the office. If a plant immigrant is found to be affected with insects or other pests or with diseases, it is ordered into quarantine, and the necessary treatment is prescribed and administered. If found to be free from insects and diseases, it is given a clean bill of health. It may then be forwarded to the experimenters within the department for whom it was especially secured, or to the plant introduction garden at Chico, California; Coconut Grove, Florida; Bell, Maryland; or Savannah, Georgia. The selection of any particular one of these four gardens depends largely on the character of the plant.

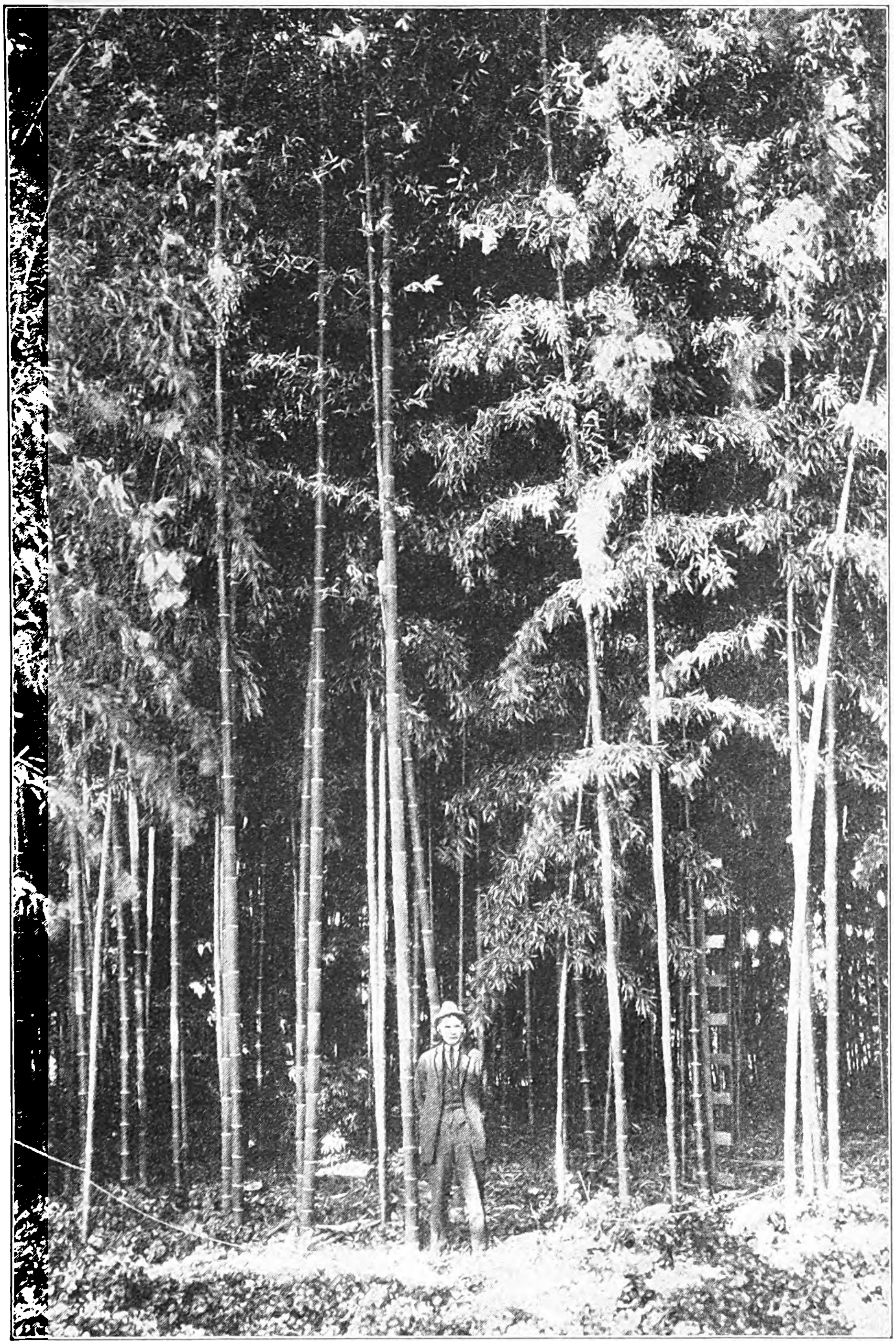
THE plant propagators at these gardens have frequently to resort to every known practice of the craft to save an introduction which arrives out of season or in a critical condition; and in some instances, when the plant introduced is unknown and no information regarding its identity can be secured, they must rely upon their own ingenuity in developing methods of handling such material in order to save what may eventually develop into an important new plant industry.

The propagation houses, cold-frames, lath sheds, greenhouses, and other equipment at the plant introduction gardens of the department, together with trained superintendents, experienced plant propagators, and a corps of capable gardeners and laborers afford excellent facilities for the propagation and preliminary testing of the thousands of new plants annually introduced. They also make possible the efficient distribution of new plant material to specialists of this department, state experiment stations, botanic gardens, and to a limited number of private experimenters.

Among the host of interesting new plant introductions which have been propagated at the Chico station, a few selected examples will give some idea of the range of species handled and the variety of the problems presented.

The jujube, or so-called Chinese date, is a promising plant for California and the semi-arid south and southwest. The experimental tests made with this alkali-resistant and drought-resistant fruit at Chico, to determine the possible value of the strains and varieties that have been introduced, have been very satisfactory. The fruit of the better varieties is fully as large as a large prune, and reddish or mahogany brown in color when ripe. While the jujube is a very good fresh fruit, it is undoubtedly of greatest value when processed with cane sugar or honey. Prepared jujubes are as delicate in flavor as many dates.

From the seed of the tung oil trees (See page 355, May, 1930, SCIENTIFIC AMERICAN) is made an oil which the paint manufacturers of this country consider one of the best drying oils known to the trade. Trees of this plant immigrant distributed from the Chico garden in 1906-07 are doing well and bearing fruit in many places in the region extending from northern California to and throughout the Gulf States, but appear to be doing best in northwestern Florida and the southern parts of Georgia and Alabama.



It has been well said that there is no other plant which is so intimately bound up with the life of man as the bamboo. Here is a forest of it at Chico

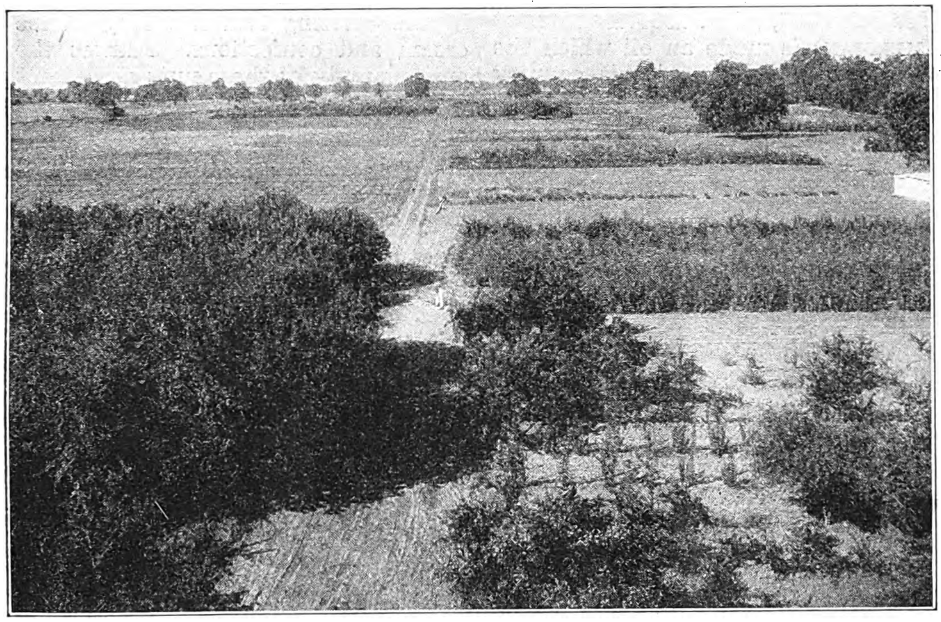
The pistache tree, a promising introduction from central western Asia, presages another new industry for the United States. The small, green-fleshed nuts are delicious when roasted and salted, and are extensively used in the coloring and flavoring of ice cream and confections. Almost the entire supply of these nuts at present comes from abroad. The trees do exceedingly well in the Sacramento and San Joaquin Valleys in California. Seedling trees near Fresno, California, have borne large crops of nuts for some years.

Budded and grafted plants of some of the best commercial varieties have been distributed to experimenters interested in testing out this introduction to determine the possibilities for its cultivation as a new plant industry. The peculiar beauty of the Chinese pistache tree and the great age to which it lives have suggested its trial as an avenue tree, and thousands of young trees have been distributed to parks throughout the country. A trial avenue, a quarter of a mile long, planted at the Chico garden in 1910, has already made an excellent appearance.

THE Chinese varieties of persimmon vie with those of Japan in size, quality, beauty, and hardiness. Many varieties have been propagated at Chico and the special Chinese stocks upon which they are grown in China have been used. The region in which the oriental persimmon can be successfully grown commercially includes California and the South, where the temperature does not fall much below freezing. The culture of this excellent fruit is destined, sooner or later, to develop into an important industry. Dried persimmons form a staple food product of China and Japan.

The Chinese dry-land elm is a promising new plant immigrant. This elm is found throughout northern China and Manchuria and is known to be very resistant to drought, neglect, and extremes of heat and cold. Seedling plants of this elm secured at Fengtsi, near Peking, Chihli, China, in 1908, were grown and distributed from the Chico station. These early distributions proved sufficiently promising to justify its propagation in quantity for distribution throughout the United States. The stock at the Chico garden being limited to a few small trees retained for permanent planting, it was necessary to resort to propagation by dormant hardwood cuttings. Tests with this elm indicate that it is likely to be of very great value for windbreaks, shelter belts, and other plantings in the Great Plains region.

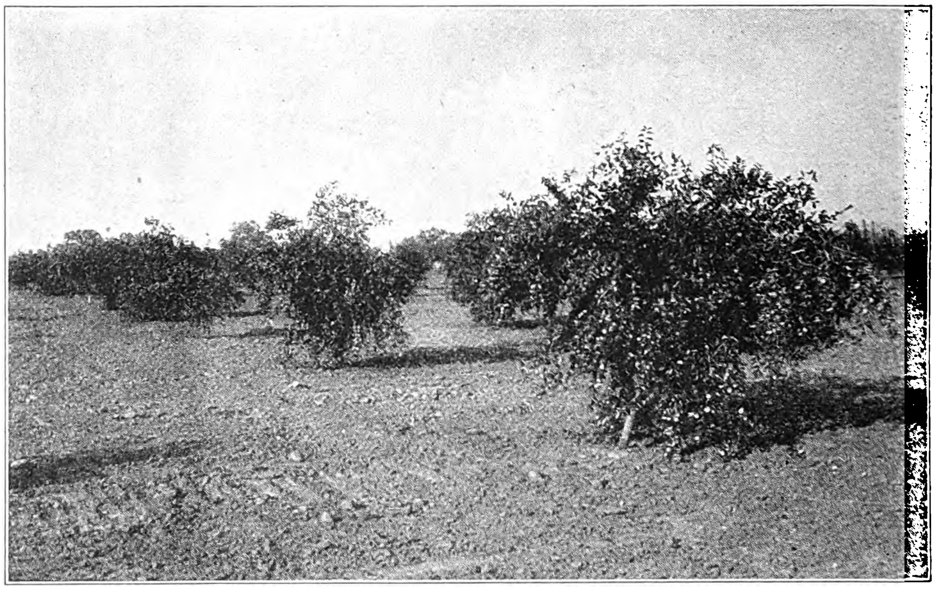
A promising, small, early, sweet cherry introduced from Tanghsi, China, in 1906, was saved to the country by a chance graft. When this introduction was received at the Chico station, the gardener, after working practically all of the scions received upon nursery stock in the usual way, conceived the idea of running the remainder into the small limbs of an old seedling cherry tree. The scion worked upon commercial stocks all perished, but two of those worked upon the old seedling tree survived. In the following spring these grafts were in full flower before the buds of the seedling tree began to swell, and they ripened their fruit by the time the old tree was in flower, or several days earlier than the earliest commercial cherries of that region. From the scions thus saved, a large number of plants have been propagated and distributed throughout the country for experimental tests. At Yuba City and Vacaville, California, this introduction gives promise of being of considerable commercial importance as an early cherry for the eastern markets.


A section of the nursery at the Chico Plant Introduction Gardens

THE Davidiana peach appears to be quite resistant to alkali and drought and well adapted to the deep alluvial soils of California. It is also succeeding at San Antonio and other places in Texas and has stood a temperature of —40 degrees at the State Agricultural Experiment Station, Ames, Iowa, with little or no injury when 50 other varieties, tested in comparison, were either killed outright or seriously injured.

The fruit of this wild peach is small and inedible, but the introduction may, because of its extreme hardiness, prove valuable in hybridization experiments for the production of much hardier types of commercial peaches.

Interest has been maintained in bamboos and their probable uses in this country for several decades. We have no native bamboos worthy of the name, our nearest approach to the many varied and useful forms of other countries being the arundinarias of the southern states. During the past 30 years the Office of Foreign Plant Introduction has imported into this country more than 60 inventoried numbers of bamboos.


An orchard of the better variety of jujube tree at Chico Gardens

Long before the Department of Agriculture inaugurated its systematic work on agricultural explorations, some 30 years ago, bamboos were being brought into the United States in various ways. These unusual and often strikingly beautiful plants naturally attracted the attention of travelers, who found they could be lifted in clumps and kept alive for several weeks. Isolated plantings were thus early established along the southern seacoasts and some of these have developed splendidly.

EARLY in 1908, David Fairchild, in charge of the plant introduction work of the Department, inaugurated some extensive measures for bamboo introduction. The services of W. D. Hills were obtained in Japan, and he was authorized to get together, grow, and ship to the United States a large collection of three or four varieties of the most important economic bamboos. When Mr. Hills had completed his plans he returned to the United States in the autumn of 1909, on an Army transport, bringing 3500 bamboo clumps with him. The plants were divided into two lots, one being sent to William Tevis, Bakersfield, California, and the other to the Plant Introduction Garden at Chico, California.

The clumps sent to the Tevis place were planted in the open ground in January, when it was cold, and although the best of care was given them, most of the plants died. The Chico shipment was put in a greenhouse and carefully nursed. Heat was supplied and plenty of water given. These plants came through in fair shape, and most of them were shipped to a garden at Brooksville, Florida.

It is impossible to foresee what the future has in store for the bamboo in the United States. That this group is worthy of study and effort is beyond question. Who knows that some day these giant grasses may play an important rôle in our welfare. As our forests disappear and the need is more and more felt for quick-growing and easily worked wood material the bamboo may find an important place here as it has found a vital niche in the scheme of things in many countries of the world.

A Clearing House for Inventions

AMONG the many things which have contributed to the development of American business, two infrequently stressed factors stand out significantly. One of these has been the remarkable ingenuity of American inventive genius; the other has been the flair of American business men for commercializing inventions. And yet until quite recently no organized facilities have existed for the promotion of new ideas. American finance, highly organized in all other branches, has left this important field to unorganized or casual direction.

It is common knowledge that the typical free-lance inventor is a lone worker who pursues his own ideas in his own way, often under obscure conditions; and it is rather a strange circumstance that the American inventor today is as much at a loss to know where to turn for the commercialization of his ideas as he was 50 years ago. In the meantime practical and profitable contact between industry and inventors is urgently needed. Every industrial concern today is in danger of having its product or products not only equaled but in some cases bettered or entirely supplanted. Obviously the one effective means of anticipating this serious competition, with its resultant slowing up of production, is to have adequate and systematic access to the wide and growing field of free-lance invention.

EVERY year inventive genius produces thousands of new inventions and numerous new industrial processes. Sometimes they justify the incorporation of separate companies but more often they call for absorption by established industries; that is, if they are properly brought to the attention of those that need them. The inventor, as has been implied, is too often an impractical business man.

Now, however, there is being assembled a group of manufacturers in an organization which will persistently search out new inventions and endeavor to place them in the hands of manufacturers most likely to be interested in their production. This corporation is Campbell, Peterson & Co., Inc., who have had seven years of specialized experience in the examination, selection, and development of new things, and have now evolved a collateral service which provides, on an organized basis, an experienced clearing agency for inventions.

Directed by men of prominence in industry and finance, who are also officers and directors of companies the combined assets of which total over five billion dollars, this corporation is an organized agency to which inventors may submit their ideas for study, classification, utilization, and financing. Fortunately the organization which undertakes this task has already been able to demonstrate in its own experience the practicability of its procedure. Since its inception in 1923 the company has developed through private development syndicates five interesting businesses based on new inventions.

As a clearing house for inventions and the utilization thereof, this organization is setting up an industrial intelligence service which will consist of an investigating and research department and an industrial service department with widespread domestic and foreign affiliations.

THE industrial service bureau will solicit, through advertising and contact, newly invented machines, devices, processes, and so forth, from various sources. It appears conservative that the number of inventions which should thus be made available will range from 10,000 to 20,000 per year, based upon the fact that without advertising or other solicitation the company has received in the past well over 1000 inventions annually. Among the sources which will be canvassed are free-lance inventors, research laboratories of technical institutions, patent attorneys, industrial advisers who have inventions submitted to them, reports of technical societies, et cetera.

In regard to foreign affiliations, the organizers have knowledge of one foreign agency which is now successfully operating and which, it is reported, has access to new inventions of central Europe. This agency, which is headed by prominent European industrialists, has expressed its interest in effecting a working agreement with the American company. Already affiliations have been established for the purpose of attracting new inventions from most of the countries of Europe. It is planned to secure through these foreign affiliations representation in all of the principal industrial cities of the countries concerned.

The present investigating department will be expanded so that its facilities will be adequate for investigating all proposals meriting more than preliminary examination. The staff of this department, trained for this purpose and experienced, will assemble and study products and inventions submitted, and satisfy themselves as to their elements of originality and commercial possibilities. It is expected that this department will provide a steady stream of analyses of new and unappropriated inventions suitable for the consideration of American manufacturers.

THE information service will be made available to suscribing members in the form of printed bulletins, and drawings or photographs if these are available. Any subscriber desiring further information on any invention may arrange for a further discussion of details. When the matter progresses to a point where purchase or license of a device or patent is contemplated, the subscribing member may either negotiate the matter direct or he may retain the service of the organization. The list of subscribing manufacturers will be limited in number to 200, including one company in each field of industry as those fields have been distinguished in a careful survey. Inventions will be placed outside this selected group when they are not wanted within the group.

Contact will be maintained with subscribing members not only through the distribution of information in printed form but also by special letters or other communications calling attention to the possible use of certain inventions to meet the particular needs of subscribing members. Regular visits to plants or offices of subscribing members will be made in order to ascertain their needs and increase co-operation. Inventors will be notified of manufacturers' needs and encouraged to co-operate in the solution of their problems.

As occasion arises for the financing of such inventions or processes as are deemed suitable for building into individual industries, the company will form underwriting syndicates.

The inventor who wishes to capitalize his "brain child" but admits a lack of the necessary knowledge of financing problems, who has not the industrial contacts, or who cannot or does not wish to spare the time attempting to sell it to some manufacturer, may thus have all the details attended to by this new well-supported organization. Its liaison service promises a solution to the inventor's problems. With his invention in their hands, the inventor stands a better chance of having it commercialized than if he attempted to do the job himself—and at a nominal cost; and he may then turn his thoughts to other inventions or projects.

ON THE OPPOSITE PAGE

1. Here we see the pioneer staff in the early nineties. These men were osteologists, geologists, zoologists, microscopists, mineralogists, ichthyologists, and anatomists or preparators. Many of them became prominent figures in the educational world. One of them has worked for this institution for 56 years

2. Preparing a rock specimen. The rocks are first broken in the mineral trimmer and then are finished with the hammer

3. Articulating a human skeleton. The osteologist is adjusting the arm so as to permit of the proper movement. Note the picturesque specimens and tools

4. A step in the production of a contour map. Mr. Blackstone is shown enlarging with a pantograph. Relief maps are largely used for educational purposes

5. The artist's corner. Here the expert, Miss Waters, is putting the finishing touches on a scientifically accurate model of an extinct animal, the *Archisaurus*

Mr. Oscar Kirchoff, head of the Department of Biology, is shown examining gorilla skulls which have just been received. The fine collection is unique

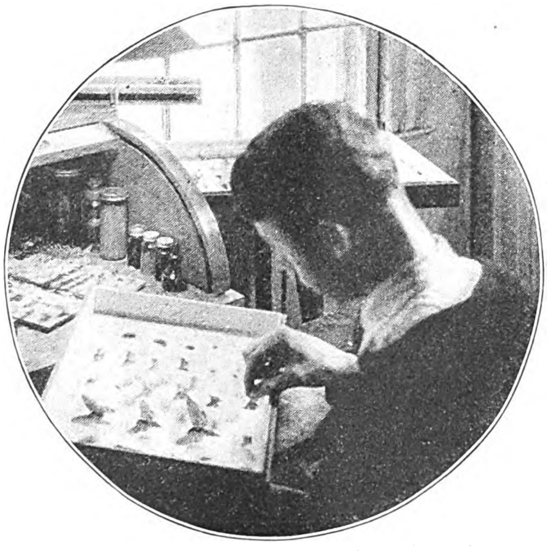
America's Cradle of Natural Science

A Curious Industry Owned by a University to Supply the Needs of Colleges

NESTLING near the University buildings at Rochester, New York, is an interesting group of old buildings where natural science in America may be said to have been cradled. Here was the incubator where many of the leading museum directors and curators of today served their apprenticeship. Among the great names are Carl E. Akeley, Dr. F. A. Lucas, Dr. Wm. T. Hornaday, Prof. James Orton, Dr. Chas. H. Townsend, Dr. Henry E. Crampton, Dr. C. E. Cummings, and a dozen others. The group of buildings are very unpretentious but the interiors are highly picturesque, as will be seen by the illustrations. In the early days taxidermy was in its "upholstery" period. This means that you stuffed an animal the way you would a chair. Akeley changed all this and here is where he learned the art which he was to regenerate.

It might be asked "What is a natural science establishment?" This can be answered best by a quotation from an old circular of the nineties. "This is a serious scientific institution; a great clearing house to which are brought and from which are distributed objects in all departments of nature. These objects we first collect, then prepare, determine, label, and gather into classified series, compiled to suit the needs of museums and educational institutions of all kinds. The general public knows of the establishment as the little village on College Avenue with the whale jaws over the main gateway—where Jumbo was mounted—and where can be seen curios from every clime. To the small boy this is a benevolent institution, where cats, turtles, birds' eggs, snakes and other vermin can be converted into cash. To the naturalist we are a place of terrible temptation, where rare and beautiful specimens of all kinds unite to awaken covetous cravings."

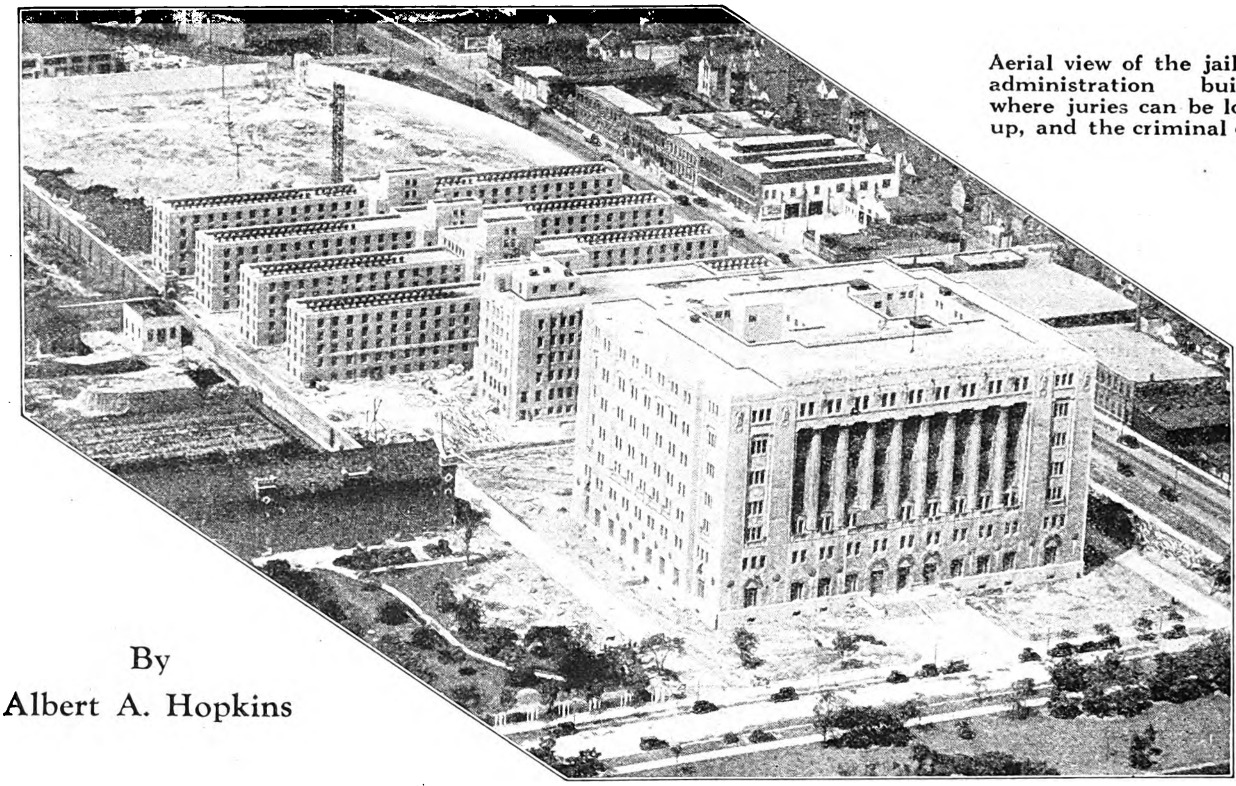
From 1862 this unique establishment, founded by Henry A. Ward, has had no rival. When colleges were indifferent to natural science Mr. Ward held the lamp aloft and kept up interest in the subject. In the period of its existence it has issued 295 circulars and 43 catalogues; the last one (issued only recently) is a valuable reference work of over 200 pages. Among the subjects listed are scientific models, charts, skeletons, zoological material for exhibition and demonstration, entomological specimens and supplies, zoological material for dissection, microscope slides, paleontological specimens, relief maps, geological models, and mineralogical specimens of all kinds.



Mr. Ocorr is transferring to a case specimens of insects which have been expanded

ON January 1, 1928, the ownership of Ward's Natural Science Establishment passed to the University of Rochester, the transfer being made as a gift for a memorial to Mr. Frank A. Ward who for over 50 years directed the affairs of the establishment. In taking over the ownership it is not the intention of the University to conduct the establishment as a money-making institution, but rather to make available all such material as can be supplied at the lowest possible prices.

The writer has visited this institution twice and was reminded very much of Mr. Venus's shop in Dickens' "Our Mutual Friend." Here are boxes of shells, boxes of minerals, boxes of bones, all in great mental order but extremely picturesque to look at. Through the co-operation of Mr. F. H. Ward these pictures were secured.



Aerial view of the jail, the administration building where juries can be locked up, and the criminal court

Copyright by Chicago Aerial Survey Company

By

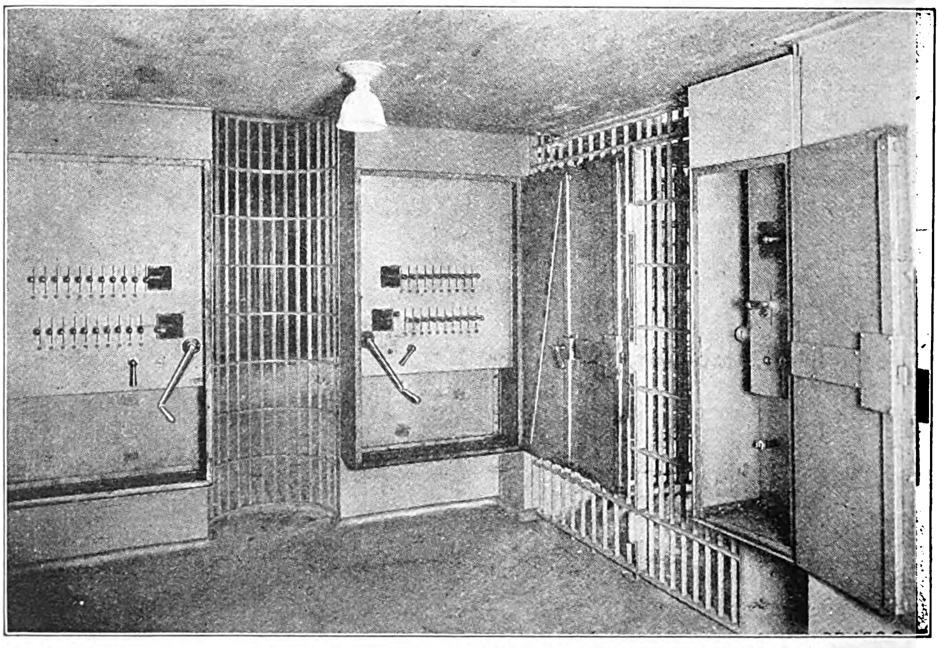
Albert A. Hopkins

Chicago Gets a New Jail

CERTAINLY Chicago was entitled to a new jail and when she got one she got a good one, the cost being 7,500,000 dollars. They tried to build for the future but they can put out the "Standing Room Only" sign right now. Of course we know all about Chicago's crime wave but the new jail seems to be about the only answer that can be made to the gangster, the yegg, and the racketeer. The Cook County jail is the largest jail in the United States, and it is one of the most humane ever constructed. The writer is indebted to Mr. Eric C. Hall, County Architect, of the firm of Hall, Lawrence and Ratcliffe, Inc., who designed the structure and to the engineers of the Van Dorn Iron Works for much assistance in the preparation of the present article.

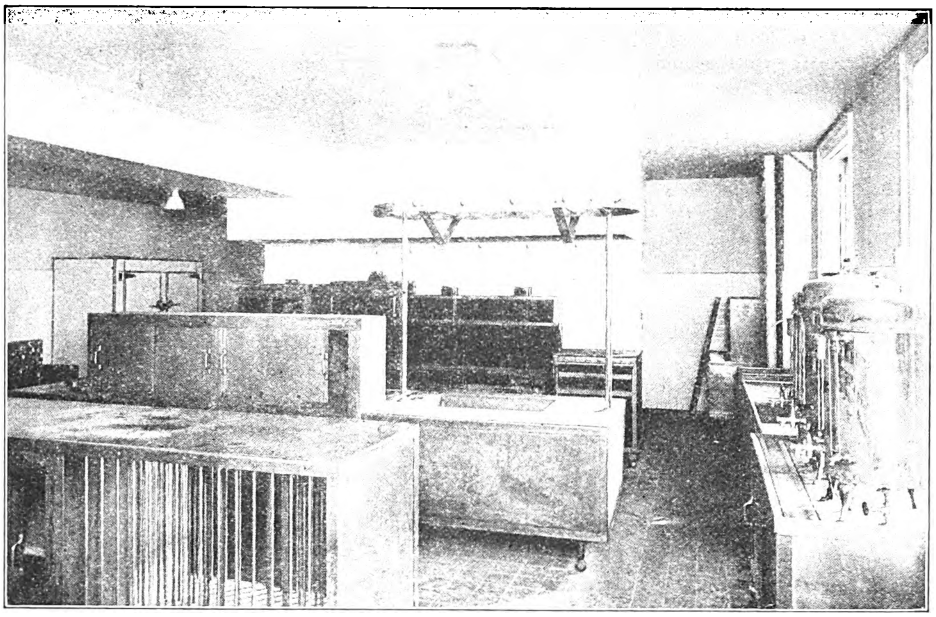
THE site comprises about ten acres and was formerly occupied by a school. It is next to the house of correction, or Bridewell. The group of buildings includes a stately court house, an extremely efficient administration building, and four units of cell buildings. They are all connected by a prisoners' tunnel and prisoners' corridor so that there can be no attempt at rescue. The criminal court building is a beautiful structure 239 feet long, 181 feet wide, and 139 feet high. It contains 14 regular court rooms besides the manifold rooms necessary for the orderly and rapid administration of criminal justice in a large city.

The second building is of considerable interest as it embodies many new features. This administration building also is of considerable size, being 150 feet long and 62 feet wide. It is divided into independent parts between which there is no connection. One is for the accommodation of 12 juries at the same time. Each jury is provided with a three-room suite, two baths, and a separate dining room. There are three rooms in each suite because, although not yet, of the possibility of juries consisting of both sexes. You never can tell when such innovations will take place. There is also a general recreation room for jurors, quarters for jury bailiffs, separate dining rooms, and the jurors' kitchen. The other part of the administration building is for the superin-



Control compartment enables a guard to direct the movements of 39 detained persons. Doors to cells are opened and closed mechanically from this station tendent of the jail and his assistants and contains facilities for receiving inmates. Looking down from the air a "telegraph pole" is suggested by the disposition of the structure.

The remaining four structures are cell buildings, each consisting of four stories and English basement, 343 feet by 32 feet by 37 feet high. These buildings contain a total of 1302 cells. Additional units can be built as required. The cells are classified as receiving, general, hospital, isolation, and debtors'. They are divided among 36 units. Thirty-two of these are typical, two of them being on each of the four floors of each of the four cell buildings. Each of these typical units is complete in itself, permitting of group classification and segregation of inmates.


In the jurors' kitchen in the administration building hot meals are served to jurors who are locked up to deliberate. Twelve juries can be accommodated

THE typical unit contains 39 cells, each five feet by eight feet by eight feet four inches, made purposely so small that it will not provide for more than one inmate at a time, thereby insuring individual segregation. Each of the cells contains a bed, a bench, a drinking fountain, and a push button, with which to signal the guard in the control compartment.

From the administration building access is given to the four cell blocks at the first floor level, and elevators serve to convey inmates, guards, and visitors to the various floors. At each floor there are two guards' rooms facing each other with the public corridor between. Surrounding each of the blocks of 39 cells and separated from it by a grating is the guards' corridor which enables them to walk completely around the cell area. The windows in the outside wall are located opposite every other cell, thus insuring plenty of light and air.

Adjoining the control department inmates can see and talk through glass which prevents passing contraband

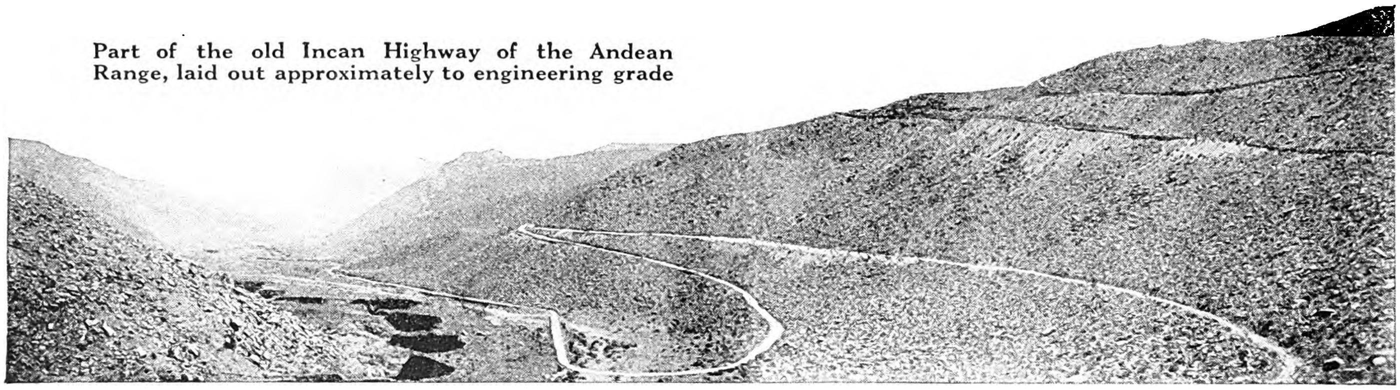
In a cell block 39 cells open into a central cell corridor. One guard controls all doors

The 39 cells open into a central cell corridor and are provided with doors which are unlocked, closed, and locked by means of a mechanically operated locking device. The control is vested in a control box situated in the isolated guards' room. The central corridor on each floor of each cell block leads into the inmates' recreation room, 20 by 31 feet, where the detained persons eat and spend their time when not in their cells. Adjoining is a serving kitchen, the food being supplied by a dumb-waiter from the central kitchen in the basement. In connection with the recreation room, otherwise known as the "day" room, there are toilets and a shower room.

Adjoining the guards' control room is a space where persons who are detained may see and talk with their friends through shatter-proof glass, which enables a conversation to be carried on without danger of smuggling weapons, drugs, or other contraband. Adjoining the guards' control room is a compartment for inmates to consult with their attorneys.

Each cell door is controlled by the guard from his practically armored room. A semi-circular tool-resisting grill enables him to view the entire prisoners' corridor through the recreation room. When a detained prisoner wishes to leave his cell for any legitimate purpose he pushes a button and his call is indicated on an annunciator in the guard's room. The guard then goes to the proper control box (right or left) and by dropping a small lever he unlocks the cell door in question and permits the prisoner to leave his cell. The guard can then lock the door in an open position, if he so desires, so that it cannot be closed without his sanction.

WHEN the prisoner returns to his cell the guard then closes the cell door by means of the large crank shown at each side of the semi-circular grill. The entire operation of opening and closing the door can be accomplished without disturbing any other cell door. All the cell doors in a single row can be opened at one operation at meal time or in an emergency. The steel in the cell blocks is tool-resisting which means that bars cannot be mutilated by the inmates, under prison conditions. The cells are fireproof.


Part of the old Incan Highway of the Andean Range, laid out approximately to engineering grade

America's First International Highway

By A. Hyatt Verrill

Pre-Incan Aborigines Engineered a "Modern" Highway 4000 Miles Through the South American Andes

IN these days of transportation and traffic problems, of the universal automobile, and of the constantly increasing trend of travel to South and Central America, the proposed International Highway is of the greatest interest to the public. But how many of us know that centuries before the first European set foot on American soil an international highway had been constructed and was in daily use?

To be sure, this highway did not link the two continents, but it linked several great nations; it was over 4000 miles in length. Many of the facts regarding it seem incredible, even with our present-day knowledge of road-building and modern engineering, our massive machinery and labor-saving devices.

THE International Highway to which I refer was the "King's Road" of the Incas; a road built by the ancient aborigines of South America; by men who, so far as we know, were entirely ignorant of the use of iron or steel; who possessed no true mathematical instruments, no transits, no compasses, no comprehension of engineering as we understand it. Yet they built their marvelous road through country that presents some of the greatest obstacles. Even the Romans never succeeded in building such a roadway and, compared to the Incan road, the famed Appian Way was scarcely more than a trail.

From Quito in Ecuador, to beyond Tucuman in Chile, the Incan Highway followed the general line of the Andes. At intervals, side roads branched off. A second road 25 feet in width, and almost as remarkable as the first, followed the shore line from Ecuador to Chile.

No one knows when this remarkable road system was started, how much time was required for its construction, what it cost in labor and riches, when it was completed or what man first conceived the idea. Although called the Incan Road, and while unquestionably extended, improved, and maintained by the Incas, yet much of the main highway antedates the Incan Empire by hundreds of years. It is the work of the pre-Incan races. The pre-Incans are shrouded by mystery which no one has yet been able to pierce, and we really know nothing about them, aside from the fact that they were a highly civilized race, were wonderful engineers and builders, and left remains in the form of walls, roads, and buildings that are among the greatest of the world's wonders.

The most outstanding feature of their works are their structures of the so-called "cyclopean type," most of which center in and about Cuzco which, later, became the capital of the Incan Empire. No cement nor mortar was used, the walls and buildings being formed of immense stone blocks, often weighing as much as 20 to 30 tons each, and frequently with many angles—cut, faced, and fitted with such amazing perfection that even today it is quite impossible to insert a knife blade between the stones.

That the same people who erected these titanic structures, by means that have never satisfactorily been explained, built much of the great highway is certain. In many places we find the same type of stone work employed in the road construction, and we know from incontrovertible evidence that much of the material, in the form of giant stone blocks, used in building forts and other edifices near Cuzco,

The old and the new. A motor car and Aimerá Indians, descendants of the ancient, powerful Incans, on the Incan Highway on the Peru-Bolivia border

were transported long distances over the ancient highway.

The road was carried up the stupendous heights of the Andes by accurate, easy grades, by wonderfully calculated hair-pin turns, S-curves and zig-zags. It was carried along the faces of precipices on shelves hewn from the solid rock, or upon masonry abutments built up from far beneath. Ravines and chasms were often filled with solid masonry to form causeways over which the road crossed. Where the canyons were too deep for this the abysses were spanned by suspension bridges supported by immense cables of wool, cotton, or fiber rope. Where the way was barred by insurmountable cliffs tunnels were cut through them.

A bit of the old road where it passes through an Indian village in Peru. Note that it is well paved

FOR a great portion of its length, this wonderful King's Road was paved, much of it was surfaced with asphalt or bitumen, and so thoroughly well built was the highway that long stretches of it are still in use at the present time. Throughout the entire 4000 miles and more of the road, there were rest-houses for the benefit of travelers, and which served also as relay stations for the couriers of the Inca. There were "Imperial Inns" every 40 miles. These served as storehouses for food, supplies, and equipment for the army or for the relief of neighboring villages in case of famine or war; and as eating places for the army when on the march.

There was also a continuous series of sentry stations, forts, and watch-towers. A very complete system of signal-fires or lights was maintained, by means of which the men who were constantly on watch could transmit messages from one terminus of the highway to the other. At the time of the uprising of the *Caras* tribe near Quito, Ecuador, news of the revolt was thus received by the Incans at Cuzco, Peru, within four hours after the trouble broke out. To transmit a message from the Chilean terminus of the road to Quito, 4000 miles away, ordinarily required scarcely more than six hours.

Although of great importance for peaceful purposes, yet to the Incans, their highway was primarily a military road. Over it their well-trained, well-equipped armies marched to their innumerable conquests. Over it, according to Incan records, trudged 250 carriers, each bending under a burden of gold, the whole weighing more than ten tons, to be used in making the immense gold chain that Inca Huayna Kapac ordered made to commemorate the birth of his eldest son, Huascar. Over it, too, was transported that marvelous, inconceivable store of gold, amounting to 7000 loads of 75 pounds each, that was sent from Chuquis to ransom the captive Atahaulpa, but which never reached its destination. Somewhere along the ancient Incan road, that vast accumulation of precious metal lies hidden to this day, for when word of Pizarro's treachery and Atahualpa's death was brought to the toiling, gold-laden Indians, they concealed the treasure in some secret spot near Piscobamba.

But the great highway that served the Incans so well in times of peace and war, the international road that connected the far-flung limits of their Empire, proved of inestimable value to their enemies as well. Over the Incan road the mail-clad Dons marched to Cuzco and their wanton destruction of the Incan civilization. And over it, following it across the vast Atacama desert, marched Pedro de Valdivia to his bloody conquest of Chile.

A wonderful, a fascinating, a romantic tale could this old highway tell if it could speak. A tale of riches, of conquests, of murder, bloodshed, and pillage such as the world has seldom seen equaled. If ghosts walk, then, surely, there should be an endless procession of ghosts over this highway.

An Indian village on the old Incan road, in Peru. The hut in the foreground is built on the remains of one of the Incan rest houses mentioned in the text

BUT even ghosts would find much of it hard going. Long stretches of it have completely disappeared. Many of the bridges have long since rotted and fallen away. Retaining walls have crumbled, letting the road disintegrate. Landslides have bodily destroyed miles of it, and modern roads and railways have cut through it. Still, portions remain in as good condition as ever. Llama trains still plod along it and patter over suspension bridges whose cables were stretched from shore to shore in Incan days. Portions of it also have been improved and incorporated in the splendid system of motor highways being pushed energetically forward. No country in South America has progressed so rapidly in its road work as has Peru. More roads is the watchword, the slogan, of that nation and the system of roads completed is remarkable.

If ever the proposed International Highway reaches South America, we may be sure that Peru will be ready and waiting to do her part of it, if indeed it is not completed through the land of the Incas long before it extends southward to the Peruvian boundary. Unquestionably, much of the great International Highway, where it crosses Peruvian territory, will be laid over the same bed, through the same tunnels made by the forgotten, prehistoric, mysterious pre-Incans. The time may yet come when one may drive a motor car from New York to Lima, or even to Valparaiso.

The Difference Between

The Majority of the Discoveries of Practical the Scientist's Penchant for Prying Into

By F. K. RICHTMYER
Professor of Physics, Cornell University

"TWEEDLE-DEE and Tweedle-dum agreed to have a battle,
For Tweedle-dum said Tweedle-dee had spoiled his nice new rattle."

Louis Carroll, in his famous Alice in Wonderland, has immortalized these celebrated characters and has given a very real meaning to the popular statement that, "the difference between Tweedle-dum and Tweedle-dee is something so trivial as to be entirely unworthy of further notice." When, however, we come to consider the way, if at all, in which this famous phrase is applicable to scientific research, either pure or applied, we realize that the phrase loses much of its popular meaning. Indeed, a glance over the history of physical sciences shows that, so far from being unimportant, "the difference between Tweedle-dum and Tweedle-dee," when carefully observed, has been responsible for a very large number of the striking advances which have taken place in science during the past four or five centuries.

Without discussing this matter in a general way, let us proceed at once to examine certain well known instances in which "the difference between Tweedle-dum and Tweedle-dee" has played an all-important rôle.

WE go back in history to the days of Copernicus, a younger contemporary of Columbus. You will recall that Copernicus, after making a thorough study of the apparent motion of the planets through the heavens, came to the conclusion that the Ptolomaic system of the universe was entirely wrong and that the heliocentric theory proposed by the Greek Aristarchus 15 centuries before was the more nearly correct. According to this latter theory, the planets—Mercury, Venus, Earth, Mars and the others—revolve around the sun in circular orbits. Perhaps the one good reason why Copernicus decided that the orbits were circular was that there was no good reason to suppose them anything else.

Then came the all-important question: What makes the planets move around the sun? The question was not to be answered for many decades, but in the meantime two astronomers made very substantial contributions to the subject. Tycho, the Dane, in the days before telescopes and with only a "sight-tube" containing cross hairs—a telescope without lenses—observed very carefully the positions of the various planets in their apparent motion among the stars. In particular, he made very careful measurements of the planet Mars. A young associate of Tycho was the astronomer Kepler. He was, as we would say today, a theorist and made very careful studies of Tycho's observations on the positions of the planet Mars at various times of the year. He noted that the motion of the planet, as determined from the very careful observations of Tycho, did not quite coincide with the hypothesis of Copernicus that the planets moved in circles. At certain times the planet Mars was not quite in the position which it should be were its orbit circular, the difference being some eight minutes of arc, or roughly one fourth of the apparent angular diameter of the sun. The difference between this predicted position, based on the supposition of a circular orbit, and the observed position was not very much—much less than "the difference between Tweedle-dee and Tweedle-dum." Kepler, however, knew that on the one hand the observations of Tycho could not be in error by even so small an amount as eight minutes of arc and on the other, that his own computations must be correct. *When observation and theory disagree, ever so slightly, theory must be modified.* The orbit of the planet Mars could not be a circle. After much long and tedious computation, Kepler hit upon the happy solution that the orbit of the planet is an ellipse with the sun at one of the foci of the ellipse.

Even so, however, the difference between the two paths, the apparent circular and the actual elliptical, was not very much but it was enough to play a very important rôle in subsequent developments. For, a century later, the fact that the orbits of the planets around the sun are ellipses gave to that great genius Newton, one of the strongest arguments in support of the now famous "inverse square law" of gravitation, a law which every school boy knows by heart and which states, "*Every* particle of matter in the universe attracts every other particle of matter in the universe with a force . . . inversely proportional to the square of the distance between the two particles."

WE who are concerned primarily with physical science, have come to take this law of gravitation for granted. It is an important law applicable in many branches of science—astronomy, physics, chemistry, and so on. But we sometimes forget the even greater philosophical importance of the discovery of this law. Newton saw its terrestrial operation in the falling of the apple. He saw its operation in the solar system in answer to the question: "What keeps the planets in their orbits?" And astronomers came to regard the law as applicable to the most distant stellar universes. For the first time in the history of the world, man came, with the announcement of this law of gravitation, to realize that at least in this one particular there is a common natural law extending and operating throughout the entire universe, a law which governs the motions of terrestrial objects, planets, and stars alike.

Without doubt, we are in large measure indebted for this law to the careful work of Kepler and Tycho in observing *and then interpreting* this small "difference between Tweedle-dee and Tweedle-dum," out of which difference grew the far-reaching law of gravitation as propounded in quantitative form by Newton.

WE pass over something more than a century and come down to about 1825, when many of the best known scientists of Europe were attempting to answer the question which that genius, Michael Faraday, put to himself: Is it possible to "convert magnetism into electricity"? A few years before this, in 1819, Oersted, the Danish scientist, had accidentally found that a magnetic field is produced by an electric current flowing through a wire; or, in the rather loose language of the time, electricity was itself "converted into magnetism."

Numerous observers were attempting the converse: namely, making an electric current by means of a magnetic field. In spite of numerous attempts, by 1830 most scientists had given up the problem as hopeless.

In the summer of 1831, Faraday was working in his laboratory at the Royal Institution of London in one more attempt to solve the problem. He had a hollow helix of many turns of wire, the ends of which were connected to a crude galvanometer; that is, a device for measuring an electric current. Into this helix he was going to introduce a bar magnet, hoping that the presence of the bar magnet would cause a current to flow continuously through the wire of which the helix was made. When, however, he tried the experiment the galvanometer showed no deflection when the magnet was in place.

Tweedle-Dum and Tweedle-Dee

Value to the World Have Been the Result of "Little Things" of Apparent Unimportance

He noted, however, that when the magnet was thrust into place in the helix, there was a very slight, hardly noticeable, motion of his galvanometer; and that when he removed the magnet from the helix there was again a similar slight motion. This slight motion was not what he was seeking and it was exceedingly minute —let us say only 1 percent of "the difference between Tweedle-dee and Tweedle-dum." But Faraday had never heard the couplet at the beginning of this article and to his discerning mind every bit of evidence, however, slight, must be taken into account. He, therefore, made a further study of these slight motions.

In an incredibly short time Faraday had shown that these slight motions of his galvanometer indicated unmistakably "the conversion of magnetism into electricity"; and after further study he evolved the physical laws governing the process.

Some four decades later students of applied science began to understand that these laws had a very important practical bearing. An understanding of them led to the development of electric motors and dynamos for the production of electric power. Out of this development in the seventies grew our whole electrical age of today. Within a year or two we shall be celebrating the centenary of Faraday's discovery and perhaps some eulogizer of this great scientist will again point out the very important fact that "The difference between Tweedle-dee and Tweedle-dum" has played a very important part in making this the age of electricity and thereby in revolutionizing present-day civilization.

WHY should Michelson have spent so much time in making new and ever more accurate measurements of the velocity of light? The discovery of argon answers the question.

In 1894 two English scientists, Rayleigh and Ramsay, were interested in making a more precise measurement of the density of the well-known gas nitrogen. Whatever may have been their reasons for making this measurement, we might at the present time look upon their motives as based upon idle curiosity, if you will. When, however, they had determined this density with a higher precision than had ever been attained before, they observed that samples of nitrogen from different sources and prepared under different conditions had slightly different densities. They may have been suspicious of the unimportance of the "difference between Tweedle-dum and Tweedle-dee," and they sought to find the reason for the difference in densities of these samples of nitrogen. The result of this search was most profound. They discovered that the reason for the differences was due to the presence, in varying amounts, of the hitherto unknown gas argon, which, because of its chemical inactivity, had previously escaped detection although it makes up well toward 1 percent of the atmosphere.

Now, one might say that a gas which makes no chemical compounds, can not be seen or smelt, and makes up only 1 percent of the atmosphere is of no great importance. Nevertheless, the discovery of this gas soon led to the discovery of other similar gases and today we recognize a whole series of them, known as the inert gases: helium, neon, argon, krypton, and xenon. These gases are somewhat similar to each other but differ from each other in certain of their physical properties.

Seldom has a discovery been productive of greater results. In recent years we read much about the question of atomic structure; how the atom is like a miniature solar system with a nucleus containing a positive charge of electricity around which are swarming electrons in various states of orbital motion. It is not too much to say that the starting point of the various modern theories of atomic structure is to be found in certain properties possessed by this series of inert gases and it is doubtful whether, had those gases not been discovered, our concept of the atom would be anything like as definite as it is now.

But we need not confine our discussion of the importance of the discovery of argon to matters pertaining to physics and chemistry. We all know that helium is being used as a much safer gas than hydrogen in dirigible balloons; that neon, as well as some of the other gases, is finding important practical uses in electric signs; and that argon has played a very important rôle in the development of the gas-filled incandescent lamp (by its introduction, the efficiency of artificial light sources was almost doubled). Those who are interested, may compute the value in dollars and cents of this particular use of argon and thereby can place a monetary value on "the difference between Tweedle-dee and Tweedle-dum."

But why elaborate the thought further? Everyone will be able to call to mind numerous illustrations of the fact that minute differences such as those which have been mentioned, play a very fundamental rôle in all branches of human activity. Indeed, machines have been taught to recognize "the difference between Tweedle-dum and Tweedle-dee." For example, one of the important revolutions in modern machinery has been the introduction of the ball bearing and the roller bearing. The very success of the ball bearing depends upon making steel spheres which differ from each other in diameter by not more than one ten-thousandth of an inch. Two Fords—at least as they leave the factory—are much more nearly alike than the proverbial "two peas." The ability thus to duplicate parts is one of the striking successes of our modern industrial life.

ONE catch-phrase definition of a genius states that, "a genius is one who has an infinite capacity for taking pains." Like many another of its kind, this definition contains just enough of truth to make it somewhat dangerous. Many a man has an infinite capacity for taking pains, but he will never be a genius.

I propose an alternative definition: A genius is a man who can observe *and interpret* "the difference between Tweedle-dee and Tweedle-dum." And let us emphasize "interpret." It was not so much Kepler's discovery of the slight discrepancy between theory and observation in the motion of Mars; it was his ability to interpret this difference that brought him fame. It is quite probable that other investigators before Faraday had observed similar "kicks" in galvanometers, but Faraday regarded the minute disturbances as worthy of further study. Had Ramsay and Rayleigh been content merely to point out that different samples of nitrogen seemed to have different density, we might have waited a long time for the discovery of the noble gases, with their important uses in both science and industry.

A very large part of present-day research in science depends on devising instruments and methods for making more and more accurate measurements, for observing minute differences hitherto beyond detection. So frequently has it happened that new phenomena have been discovered when such measurements have become possible, that it is now almost an axiom that "a new discovery is to be found in the next decimal place." Michelson's motive in repeating, each time more precisely, his determination of the velocity of light thus is obvious.

The Scientific American Digest

Conducted by F. D. McHugh

Direct-Reading Light Intensity Meter

ONE of the latest uses of the photoelectric cell is in connection with a meter to measure light intensity, now being built at Newark by the Westinghouse Electric and Manufacturing Company.

This cell, in various special constructions, has already found many uses in industry and is finding new ones almost continually. The present meter, embodying a new application of the photoelectric cell, should render unnecessary the question in a picture studio, "Is it light enough in here?" A photographer need not wonder whether the north light today is as strong as it was yesterday, for the meter always gives the same values for the same intensities. Used in connection with a printing frame it makes possible accurate adjustment of lights when certain special printing is to be done.

The photoelectric cell is an important part of this light meter

The instrument is complete in a case 12 1/2 by 10 by 6 5/16 inches, and consists of a special cell of broad response covering the visible spectrum, in series with the smallest size "B" battery and a microammeter calibrated directly in foot-candles. The light "pickup" or cell, something like a radio tube in appearance, is connected to the meter by a cord and may be moved about a six-foot radius outside the case. Normally directional, so that light from given points may be studied, it may be made non-directional as well.

The sensitivity of the meter is pronounced; used in tests at a motion picture studio, it showed the change in illumination of an actor's face when he lighted a cigarette.

Further suggestion of its value is seen in the studio where Mazda lamps are used with panchromatic film, in color photography where intensity of special colors is desirable, and in cinema houses to measure the screen illumination. It may also be used to determine illumination in factories.

The New Digest

WITH the express purpose of improving the quality—as to selection, preparation, and appearance—of the material heretofore presented in SCIENTIFIC AMERICAN following the major articles, we inaugurate this month what might aptly be called a *super* SCIENTIFIC AMERICAN Digest. This enlarged section of the magazine will contain items formerly segregated and published under various specific heads, but their authorship will remain as before.

Professor Alexander Klemin, in charge of the Daniel Guggenheim School of Aeronautics and Associate Editor of SCIENTIFIC AMERICAN; A. E. Buchanan, Jr., Lehigh University, Corresponding Editor of SCIENTIFIC AMERICAN; and Morris Fishbein, M. D., Editor of the *Journal of the American Medical Association* and of *Hygeia*, and Corresponding Editor of SCIENTIFIC AMERICAN, will be responsible for the articles, signed by their initials, in their respective fields of aviation, chemistry, and medical science.

Fireproof Houses in France

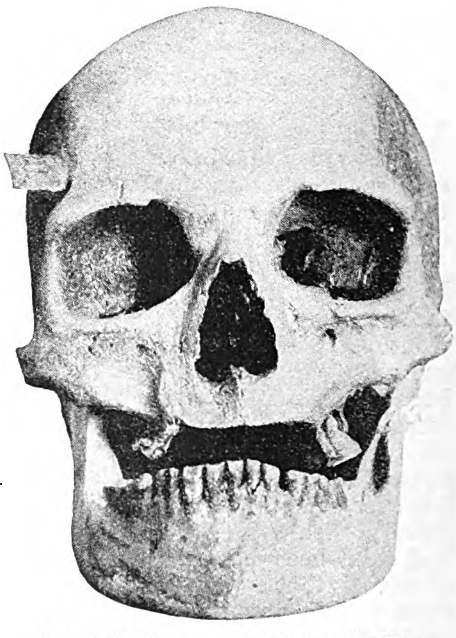
DWELLINGS of fireproof wood are being erected in France by a German concern as part of the reparation payment. Each month 100 five-room houses of this type are being erected at a fixed price of 1500 dollars each.—*Engineering News-Record.*

Arrow Point Injuries

ALTHOUGH the stone arrow-points used by prehistoric Indians are fairly common, yet it is rarely that they are found imbedded in human skulls or other bones. Collectors of Indian relics regard such a find as is pictured on this page as a great prize. Numerous instances of such finds are known among the Indians of the eastern and middle North America, but the one shown here is the first to be recorded from the southwest. It was found on San Nicolas Island, one of the channel islands off the coast of California. The skull was associated with another cranium containing a small, black obsidian point. The present case shows the point firmly fixed in the right temple where its situation shows that a large artery inside the head was cut, and the Indian died of cerebral hemorrhage.

Angleworm Big as Snake

IF you happen to be in the Philippine mountains some day, and see an angleworm as big as a small snake, colored bright blue with pale yellow spots and bandings, don't blame it on something you may have eaten (or drunk) in the last village. It's real, and it's there, although it is a zoological rarity. Dr. M. Michaelsen, of Hamburg, Germany, has just reported to the *Philippine Journal of Science* on specimens collected in Luzon some time ago and forwarded to him by a fellow-countryman, W. Schultze, formerly an entomologist at the Bureau of Science in Manila. The specimens, when living, were over a foot in length and nearly an inch in



A relatively rare find: An Indian **skull retaining the arrow head which killed the Indian ages ago** greatest diameter. They are of a species new to science and have been named *Pheretima ophioides.—Science Service.*

Chemical Warfare Turns to Peaceful Victories

WHILE the chief duty of the United States Chemical Warfare Service is military, it has made numerous contributions to chemical science and industry in peace time. The widespread activities and accomplishments of this branch of the service are described by Lt. Robert E. Sadtler in a recent issue of *Chemical and Metallurgical Engineering.*

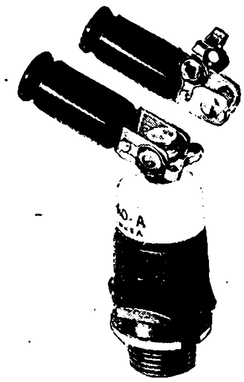
"Among the more important of these," says Lt. Sadtler, "is the development of compounds that will destroy the boll weevil more effectively than the calcium arsenate generally used; it (the Chemical Warfare Service) has demonstrated the use of tear gas in controlling mobs; it has developed gas masks for protection against industrial poisoning and ammonia fumes, and for the use of the public health service in its work of fumigating buildings. It also has assisted the shipping industry by three commercially valuable developments: toxic ship-bottom paints, protection of marine piling, and a safer and more effective method of ship fumigation."

"Anti-fouling paint, according to the estimate of competent authorities, will save the shipping industry from 125,000,000 to 150,000,000 dollars annually in reduced fuel and maintenance costs. The need of a poisonous paint for the exterior of hulls of ocean-going vessels is due to the accumulation of marine organisms, which increases fuel consumption and reduces the ship's working time by the amount spent in dry dock to clean the bottom. Barnacles are the principal marine organism attaching themselves to the ship's bottom. Not only commercial but naval vessels are affected by this growth."

Another interesting discovery made by the Chemical Warfare Service is that of the use of tear gas in controlling crowds and individuals. The effectiveness of this method in comparison with the old one of subduing the mob by the free use of bullets has been demonstrated frequently. A simple tear gas, chloracetophenone, in harmless, non-explosive tear-gas grenades, may be used effectually without permanently injuring anyone who may encounter it. This tear gas is a non-poison in the concentrations obtainable in the open air, and yet is effective even with one part of tear gas to three million parts of air. Its only reaction is to cause smarting of the eyes and the stimulation of the lachrymal gland causing a copious flow of tears.

Attacking the boll weevil from the air. Dusting cotton with chemicals

Still another service which the Chemical Warfare Service has rendered to peacetime America is the development of various kinds of gas masks as protection against the deadly gases employed in many industries, and the detailed study of methods to prevent the fatalities resulting from other forms of poison. Since all of these poisons have at one time or another been brought to the attention of the Service as possible chemical warfare agents, the Service has necessarily made a close study of them and of methods of protection against them, and has been able to offer freely to industry the knowledge thus gained.—*A.E.B.*



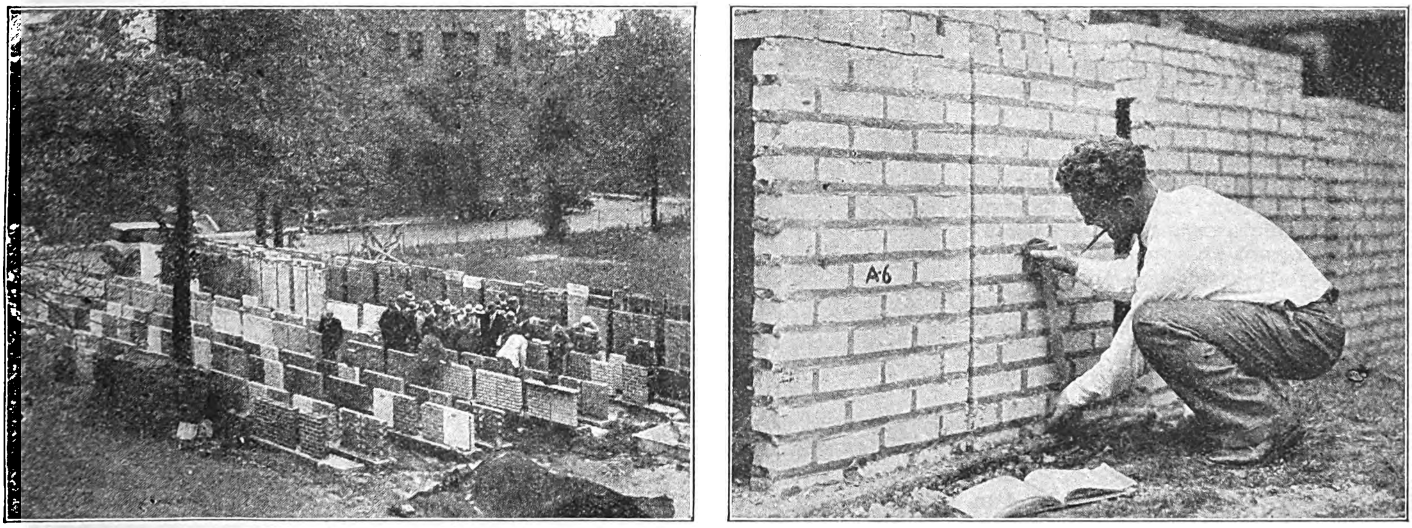
Two views of the new locking terminal for engine spark plug cables

A Locking Cable Terminal

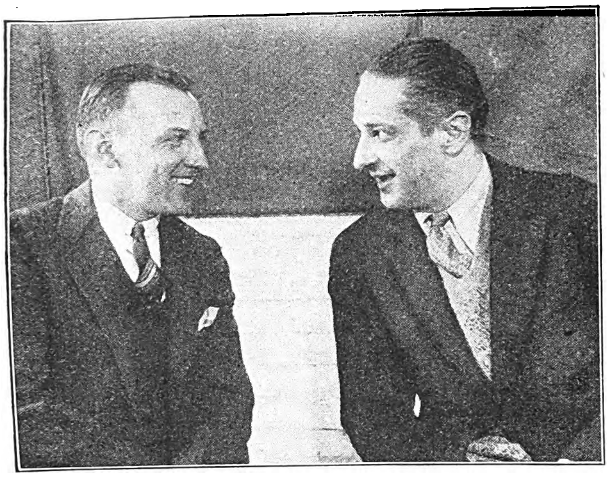
THE accompanying photograph shows an interesting locking spark-plug cable terminal which has been approved by the Army Air Corps for airplane use. Powerful phosphor bronze jaws of this new terminal make firm contact with the spark plug. Then the contact is locked by a hinged bale that swings down across the end of the terminal. Violent air maneuvers, rough landings, sudden propeller blasts, engine vibration, or bumpy roads cannot loosen its firm grip. Yet, in service, the terminal may be removed as quickly as the ordinary kind.—*A. K.*

Scientific Research on Bricklaying

AN interesting example of collaboration between scientist and artisan is found in the broad scientific study of bricklaying recently inaugurated by Mellon Institute of Industrial Research and the Eastern Face Brick Manufacturers' Association. The experiments are being carried out by Dr. F. O. Anderegg, Senior Industrial Fellow of the Institute's Multiple Industrial Fellowship on Portland Cement, and his assistants; architects, building contractors, and masons are aiding the work



Above is shown the group of experimental brick walls that has been built on the grounds of the Mellon Institute. *At right,* an assistant makes use of the strain gage, sensitive to 0.002 inch, for measuring shrinkage



Friendly enemies exchanging reminiscences. Major George A. Vaughan, Jr., second American ace now actively engaged in the aircraft industry, and Captain Franz Carl Schlieff, former war pilot of the German air force. Major Vaughan was credited with 13 enemy planes during the war while Captain Schlieff accounted for 22 before the British shot him down on the Somme. Here he lost his left hand in the crash

by contributing opinions and advice based upon experience.

So many varying factors are involved in the construction of a brick wall that it has been necessary to limit the experimental study to combinations of variables representing the probable range of practical application. Hundreds of thousands of experiments would be required if all possible combinations were to be studied. For this reason the research program has been under discussion for a considerable period of time, and the actual investigation was begun only when a satisfactory plan had been elaborated. Up to the present time some several hundred experimental walls or panels have been erected.

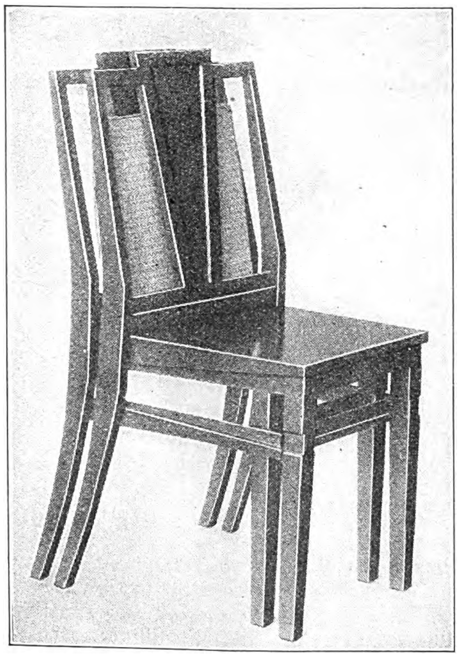
In brief, the investigation will cover certain aspects of all the factors involved in bricklaying. The most obvious points of attack are studies of the characteristics of different kinds of brick and mortar. Problems of special appeal to the practical man are those concerned with different methods of backing and with differences in workmanship. The design of walls and their relative elasticity are subjects which will be of considerable interest to contractors and architects.

Brick and mortar problems under investigation include the absorption and surface characteristics of brick, and differences in mortars due to varying the cementing materials, sand, and pigments. Properties of the mortars which are being studied carefully are workability, compressive and transverse strength, absorption and permeability, shrinkage, durability, staining and efflorescence, and elasticity. Information is being collected to determine whether the 10 percent of lime often specified by architects or the 25 percent or more usually employed by brick masons gives better all-around results.

The problems in backing include a study of hollow tile of different sizes, of brick, of cinder or concrete block, of brick tile, and of metal or other lath on steel frame. Variations in workmanship are most apparent in regard to tapping, pointing, and the filling of head-joints. The first mentioned subject is being studied, not only in regard to the effect of excessive downward tapping into place, but also in regard to plumbing both before and after initial set.

Nested Rigid Chairs Easily Stored

SINCE the time of the Pharaohs of ancient Egypt, there has been but little, if any, improvement in folding chairs. The same scissors-like legs that were used on chairs found in tombs of the Pharaohs are still used in making chairs that are collapsible for storing purposes, for ease in moving them in numbers, and so forth. And they are still as roundly sworn at for pinching fingers and tearing clothes as we assume they were in those olden days.



Two chairs of the type recently invented. They telescope one into the other for storage purposes

A patent has recently been granted, however, to Mr. Louis Dellert, of Brooklyn, New York, on a chair of conventional appearance but of novel design and construction. These chairs are made of sturdy pressed metal, and although they are rigid and non-collapsible, they effectively serve the purpose of folding chairs since they telescope one into the other.

All chairs of a set made according to this design are identical in all respects. Telescoping is possible because the seat frame is open in the rear and the sides of the seat frame, which is formed of metal, converge toward the front legs while the rear legs are securely mounted at the rear of the seat frame on the outer side. The thin metal seat slopes slightly forward. Any number of the chairs may, therefore, be nested, each additional one occupying only two or three inches more space.

They may be made in any period style, may have arms if desirable, and their seats and backs may be upholstered by means of thin removable cushions which may be stored between the backs when chairs are nested. A chair of this new type is well adapted for use in homes, banquet halls, or other places requiring strong, durable, attractive chairs that can be easily stored when not in use.

Tractor Efficiency on the Farm

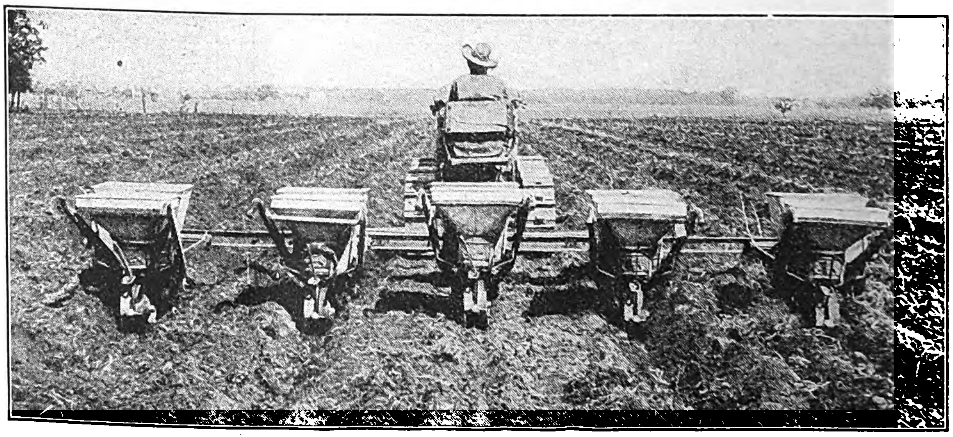
AS the horse is gradually supplanted by the tractor, the American farmer evidences a rapidly developing native ingenuity in the use of this modern time-saving aid to greater efficiency and profits.

On this page we show a tractor of the articulated tread type, equipped with five planters for fertilizing and planting four rows of corn and one row of peanuts. The planters are attached to the beam with a flexible hitch that allows a free up-and-down movement but prevents side movement. Three-inch spacing on the beams allows for any desired variation in the row width.

Chemical Prevents "Fatigue" of Rubber

EVERYONE knows that a piece of rubber can be stretched to several times its original length and will return almost completely to its original form as soon as the force is released. However, when rubber is stretched, released, and stretched again hundreds of thousands of times, it undergoes a form of deterioration which, for lack of a better name, we call "fatigue." When ordinary rubber "gets tired" it cracks; witness, for example, the cracks that develop on a pair of rubber boots where they are folded.

Rubber chemists of E. I. DuPont de

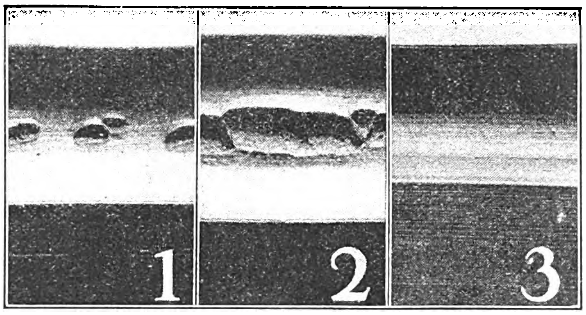


The ever-useful tractor leads to greater farm efficiency

Nemours Company have discovered that a very small amount of certain organic chemicals, introduced into the rubber before vulcanization, prevent "that tired feeling" and the resultant cracks in the rubber. The remarkable action of these chemicals, marketed under the name "Neozone" is described by E. R. Bridgewater in a recent issue of the *DuPont Magazine*. Referring to the use of Neozone in tires, he says:

"Carbon black made from natural gas is used by practically all tire manufacturers to toughen the tread rubber, thereby making it more resistant to abrasion. Most manufacturers use approximately two parts of carbon black to five parts of crude rubber, in high-grade tire treads. Greater amounts would be used if it were not for the fact that when more of this black pigment is used, there is a tendency for the rubber to crack at the points where it undergoes the most severe flexing when the car is in motion. It has been found that when small amounts of Neozone are added to the tread formula, considerably greater quantities of carbon black can be used without causing the rubber to crack at the points of flexing."

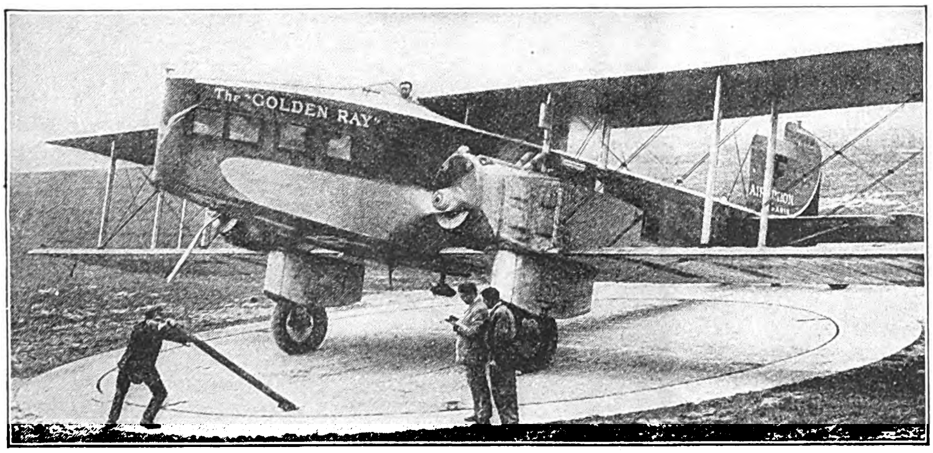
Many other rubber products, such as parts for hydraulic brakes, rubber belts for transmitting power, rubber wire-insulation, and many rubber articles whose purpose is to absorb shocks and vibration, have been improved in this manner.—*A. E. B.*



No Neozone is in sample No. 1 which shows the effect of bending a piece of rubber around a small pulley 1,500,000 times. Number 2 is identical and has gone through the same tests. Number 3 is identical except that it contains 1 percent of Neozone. It has undergone the test 3,750,000 times without cracking

A Compass Turn-Table

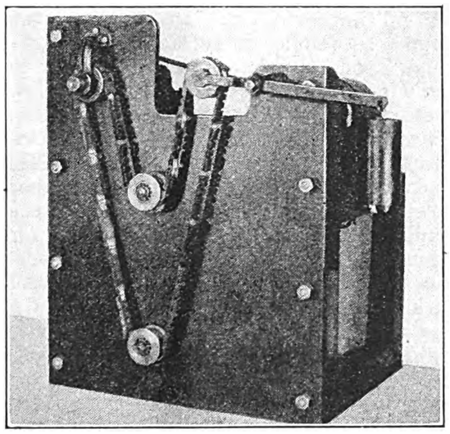
SERIOUS errors in the aircraft compass often occur owing to the magnetic fields of the airplane's steel parts. The process of compensation is termed swinging the compass. For "swinging the compass," Army flying fields are equipped with circular concrete platforms. The platforms are placed not less than 100 yards from any steel structure, such as a hangar. Starting with the magnetic north, radii are laid out every 30 degrees. A dolly is used to elevate the tail so that the airplane is in approximately flying position with the engine running. The airplane is headed to various points of the true compass and deviations are noted and corrected by special compensating magnets, until the errors are reduced to a minimum. A table of corrections is then compiled. A useful wrinkle for expediting this process has been devised at the Croydon Airport in London. A special turn-table is provided on which the airplane is placed. It can then be swung to various directions in a fraction of the time required when the airplane is slowly turned by man power. The turn-table is easily turned by one man.—*A. K.*



At the Croydon Airport, a turn-table for "swinging the compass"

X rays and the Tonsils

THERE are various methods of controlling enlarged tonsils—they may be removed by surgery; they may be destroyed by heat through an electric cautery or through electric heat; or they may be X rayed. As far back as 1913 it was suggested that X rays be used for the control of enlarged and infected tonsils, and since that time numerous papers have been written as to the effects of X rays on these tissues.



The flexing machine developed by the DuPont laboratories for fatiguing rubber. The weight at the right regulates the tension on the V-shaped sample "belt" of rubber

In the last quarter century hundreds of thousands of people have had their tonsils removed and it is now generally understood that removal of the tonsils is advisable in the presence of infection or of extreme enlargement. However, there is also considerable conservatism concerning the removal of apparently normal tonsils.

In St. Luke's Hospital, New York, Dr. Leila Charlton Knox has given special attention to the possibility of treating tonsils with X rays. She does not advise the use of X rays in children, particularly those with rheumatic symptoms. She does feel, however, that X rays provide a useful method in all cases in which operation is not advisable because of some secondary complication, particularly heart disease. Neither do X rays seem to be indicated in cases in which there is acute infection or a complicating disease such as diphtheria or scarlet fever.

X rays seem to be useful in the control of the secondary growth of lymphoid tissue in the form of stumps after the tonsils have been removed surgically. The method is also useful in elderly people who are troubled with chronic or repeated sore throats.—*M. F.*

Man Linked With Ground Sloth

WHILE the part of this magazine containing the article "The Mystery of Gypsum Cave," by Dr. M. R. Harrington of the Southwest Museum (page 34) was in press, the following telegram was received:

"Have found what seems to be the campfire of our sloth hunters: a patch of real charcoal under a layer of unbroken sloth dung capped by more than seven feet of undisturbed strata in the topmost of which are found Basketmaker and early Pueblo artifacts. This find to my mind establishes beyond question the association of man and the sloth.—M. R. Harrington."

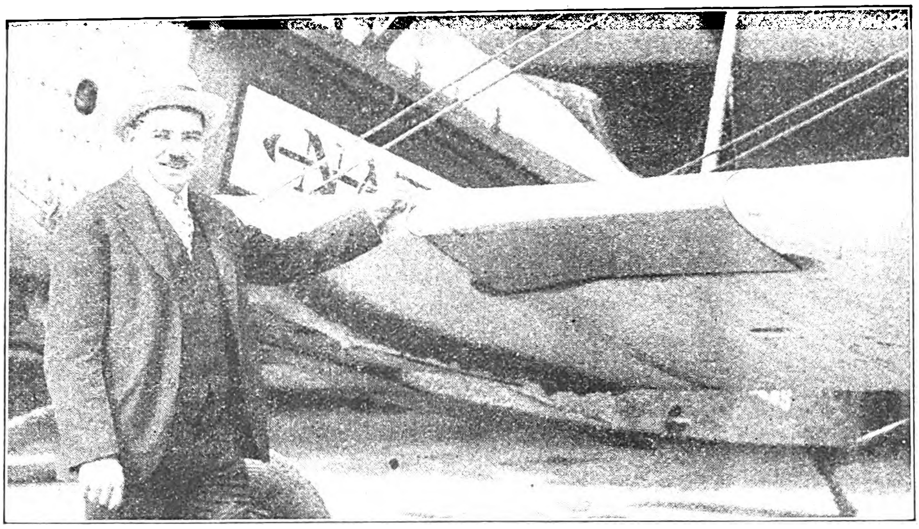
Dr. Harrington's beliefs, as expressed in his article, apparently have been vindicated.

Carbon Remover

IT is a well-known fact that if a gasoline engine of the poppet valve type can be kept relatively free of carbon, the intervals between necessary removals of the cylinder head can be increased greatly. In the article "Your 1930 Car," published in our January 1930 issue, we mentioned a product of the Alemite Corporation, called Carbosolve, which has been installed as standard equipment on Chrysler cars.

This carbon removal system is now available for use on all cars, having recently appeared on the market in "kit" form. Essentially, it involves the use of a valve permanently mounted on the dash, and with a connection to the center of the intake manifold. The valve is so arranged that a can of the special carbon-removing liquid can be attached when it is desired to treat the explosion chambers. The makers recommend that this be done every 500 miles.

When the device is to be used, a can of



Leslie L. Smith of the N. A. T., exhibiting the airplane "overshoe"

the liquid is attached to the valve, the motor is warmed up to running temperature, and the valve knob is pulled out and the motor shut off simultaneously. The liquid is sucked out of the can and is equally distributed to the cylinders. The engine is then allowed to stand undisturbed for at least three hours, or overnight. It is then started and the carbon, loosened by the action of the liquid, is blown out with the exhaust.

Airplane Overshoes

DR. WILLIAM C. GEER'S "airplane overshoes," developed with the aid of a subvention from the Daniel Guggenheim Fund for the Promotion of Aeronautics and with the co-operation of N.A.T. and the B. F. Goodrich Company, give promise of conquering one of the most serious hazards of flying.

The adhesion of ice to metal—polished aluminum for example—is high. The adhesion of ice to other substances varies greatly, and to some it is remarkably low. In previous attempts to solve the problem, the surface of the airplane wing has been covered with oil. The oils used have generally become viscous and sticky at their freezing temperatures, and moreover the wind forces have scrubbed off the layers of oil.

Profiting by these early mistakes, Dr. Geer selected a group of oils the freezing points of which fall below 20 degrees Fahrenheit, and the boiling points of which are high. Such oils would possess mobility at ice-forming temperatures and would be non-drying over long periods of time.

The second difficulty was to prevent the scrubbing off of the oil by the wind. To render this scrubbing off impossible, the oils were absorbed into thin sheets of vulcanized rubber, which can absorb a large volume of oil. To avoid the weakening and deteriorating effects of oil upon rubber, the effects of over 100 oils and oil mixtures were investigated. Finally an oil mixture was found which gave to the vulcanized rubber practically zero adhesion to ice and which left its physical properties unaltered. Moreover, the rubber thus treated showed the property of exuding oil at the freezing temperature. During the course of the intensive research work conducted in connection with this problem, it was found that the volume of ice formed on an untreated rubber sheet is somewhat less than upon other substances.

There then remained the problem of removing ice should this be formed despite the oil impregnation. Ice formed even upon a zero adhesion surface does not remove itself. It shapes itself perfectly to the wing and at the leading edge the low pressure over the wing helps to keep it on. To meet this third difficulty, Dr. Geer invented a simple mechanical device. This took the form of a light-weight thin rubber "overshoe," or pneumatic nose, for the leading edge, with a fabric backing for strength. In the leading edge of this overshoe was placed an air tube strengthened with extensible fabric. This inner tube was connected to a pump, either motor or hand driven. The tube lay flat when collapsed and so altered the curvature of the wing very little. If ice forms in spite of the impregnated rubber, the pilot turns the air into the tube, thus slightly expanding it. This moves the ice and breaks the vacuum. The only precaution to be observed when flying under ice-forming condition is that the pilot should "break the ice" when the layer is still thin. These overshoes are designed to be applied only when bad weather is expected, just like the overshoes of our everyday life.

In a test run in Cleveland in March, an overshoe was attached to a radio mast behind the cockpit. During the flight, ice formed to a thickness of about one half inch over the leading edge. A hand pump was used to expand the tube. When a pressure of two pounds per square inch was applied, the ice suddenly left the overshoes, flying off in chunks. Experiments on a wing and on a strut were similarly successful.

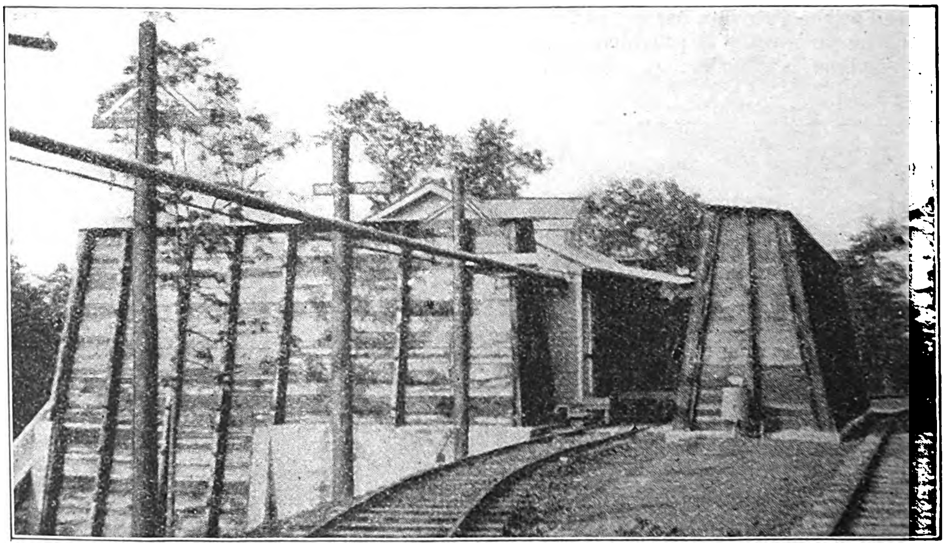
These experiments made in full flight are very encouraging. While pilots and operators always object to the addition of "gadgets" to aircraft, this gadget at least seems well worth while and we shall await further developments with keen interest.—*A. K.*

Measure the Speed of Dynamite Explosion

ONE of the most rapid chemical reactions known takes place when a stick of dynamite is detonated. It has been found that the detonation wave travels along a cartridge of dynamite at speeds as high as four miles a second. These speeds were measured at the Explosives Experiment Station of the U. S. Bureau of Mines, Bruceton, Pennsylvania, in connection with research and testing of mining explosives.

In one type of apparatus, known as the Nettegang recorder, the time elapsing between the breaking of two wires threaded through the explosive is recorded on a rapidly revolving smoked drum. In a method recently developed, the explosive is placed behind a narrow slot cut in a sheet of armor plate and the detonation process is photographed by its own light on a rapidly moving film. This method has the advantage that it records the speed of the detonation wave at every point along the column of explosive. It has been found that the speed of gelatin dynamites is affected by the degree of confinement under which the charge is fired. A charge of gelatin dynamite confined in a steel tube may detonate at a speed several thousand meters per second faster than a similar charge detonated in the open.

The explosion of a charge of dynamite is usually associated in our minds with a deafening concussion, but this is true only of dynamite fired in the open air. Charges of dynamite are exploded in massive steel bombs at the Pittsburgh Experiment Station of the Bureau of Mines, with only



Gelatin cartridge house, Mineral Springs plant of the DuPont company, showing earth barricades which serve as protection in case of explosions a metallic "click" to indicate that the charge has exploded and that pressures of 10,000 to 20,000 pounds per square inch have been produced inside the bomb. These bombs, known as Bichel gages, are used to measure the actual pressures produced by detonating explosives when fired in a borehole. The magnitude of the pressure is a measure of the ability of the explosive to do work.—*A. E. B.*

Dictaphone-radio hookup used in Oregon for recording market reports. As the prices are broadcast, they are" caught" on the machine's wax records

Trees Must Have Water

TREES need enormous quantities of water to keep them in a healthy condition, says the United States Department of Agriculture. An apple tree 30 years old gives off approximately a barrel of water a day in summer, and a good-sized birch tree gives off nearly two barrels of water on a hot day. A single oak tree is known to have given off into the air in the form of vapor more than 100 tons of water in a single growing season.

Chromium Poisoning

CHROMIUM is one of the chemical elements most commonly used in many industries. In etching zinc and aluminum plates in lithography, a mixture consisting of gum arabic, chromic acid and phosphoric acid, is applied to the plate with a brush or sponge and almost invariably comes in contact with the hands of the user. In another lithographing process, chromic acid or ammonium bichromate may be applied in other ways.

Drs. Carey P. McCord, Hobart G. Higgenbotham, and J. C. McGuire made a study of the hands of 37 workers, of whom 25 were lithographers and 12 were tanners. The application of the chromium mixture to the unbroken skin resulted in inflammation of the skin in 20 out of 25 cases among lithographers and in 10 out of 12 cases among tanners. The reactions included the inflammation of the skin and in some cases blisters.

It has for some time been realized that chromic acid or chromium compounds could bring about severe conditions when coming into contact with the broken skin, but it has been believed that chromic compounds would not attack the unbroken skin. Recent experiments indicate quite certainly that this belief is not supported by scientific evidence.

In studying eruptions of the skin it is important to keep in mind the occupation of the worker. Numerous irritants are employed in household work and in various trades. A condition called "photographer's eczema" is due to some of the chemicals used in developing pictures. Electrotypers and stereotypers and foundrymen get eruptions from the substances with which they work. Bleaching preparations of all sorts, hydrochloric acid and bichromate solutions used in the tanning trade, aniline dyes, shellac, and various plant extracts may cause irritations of the skin which must be studied carefully in order to be sure that the eruption comes from an irritant applied on the outside rather than from something in the blood developed inside the body.—*M. F.*

Spot-News via Telephone-Dictaphone

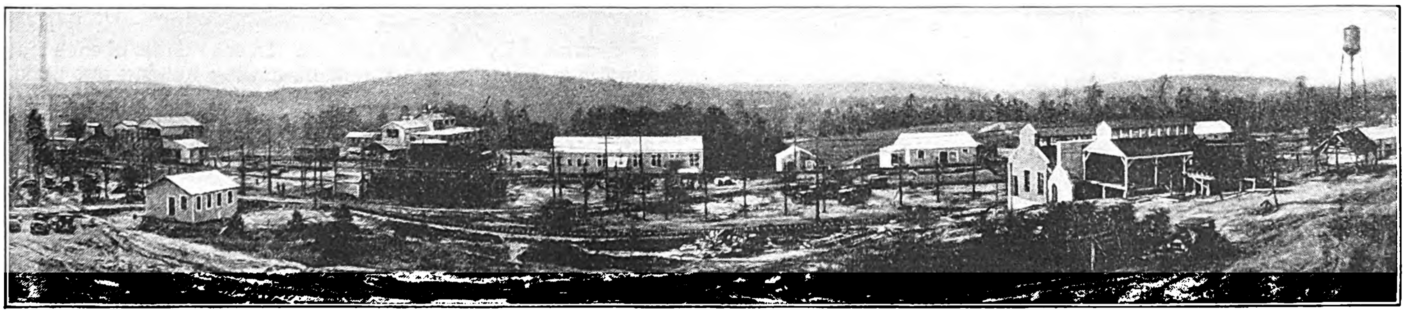
FROM the king's palace to the newspaper office may be a thousand miles, but the city editor of 1929 can look in on the coronation and be back at his desk in a few minutes. He can flash a question into the air and within 10 minutes have a reply from an explorer in the far jungle. And the wonders of news transmission are being perfected steadily to even higher efficiency. Already one of the marvels of this machine age, the modern newspaper is still concentrating effort on improving its speed in covering news. Within the past two years, the city editor has taken on another mechanical assistant. Dictaphone-telephone hook-ups are now being used to cut down the time and expense of transmitting news over long distances.

This new mechanical combination is now an accepted, regular means employed by leading Australian newspapers for reporting news from distant points. Long distance telephone lines are used at prearranged times by the newspaper's correspondent. Dictaphones with amplifier mouthpieces are attached to the telephones at the receiving end in the newspaper offices. The reporter speaks in an evenly timed voice, at the rate of 100 words a minute. An attendant "listens in" to the voice coming in over the wires, and when the machine's wax cylinder is filled, he signals the sender, who pauses while the cylinder is changed.

The cylinders containing the news material are transcribed by a corps of operators, with the regular transcribing machine and earphones. The copy is then passed directly to the sub-editor. Formerly news from distant correspondents had to be rewritten before it was turned over to the sub-editor for copy-reading, since the sentences were in choppy, abbreviated form for economical telegraphing.

The new method of news transmission, according to the *Rockhampton Bulletin*, has shortened the former all-night period for receiving news to about one hour daily. Because the correspondent can be certain of sending in all his material in one hour instead of three or four, he can now take time to organize his news carefully to present it in finished style, so that the work of the copy desk in handling his copy is reduced practically to punctuation and headline writing. The *Bulletin* estimates that the cost of receiving 15,000 words per week by telegraph, working six nights, was 30 pounds, or about 150 dollars. The cost of the same service by the new hook-up is 12 pounds a week.

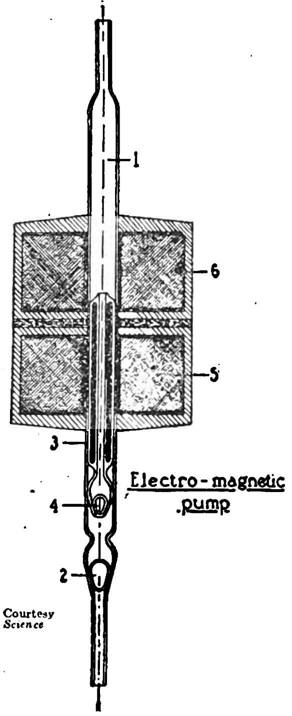
In the United States, as might be expected, this new combination of machines to speed up news has been applied first to market reports and sports news. Dictaphone-radio hook-ups last fall kept Oregon poultry raisers in close touch with pre-Thanksgiving market news, so that they were enabled to sell to the best possible advantage. Their hook-up was made in the office of the county agent, where were recorded market reports broadcast during the working hours when it was impracticable for the farmer to listen in at his radio. The cylinders which caught the news from the loud speaker were tran-



A section of the new dynamite plant at Mineral Springs, near Birmingham, Alabama

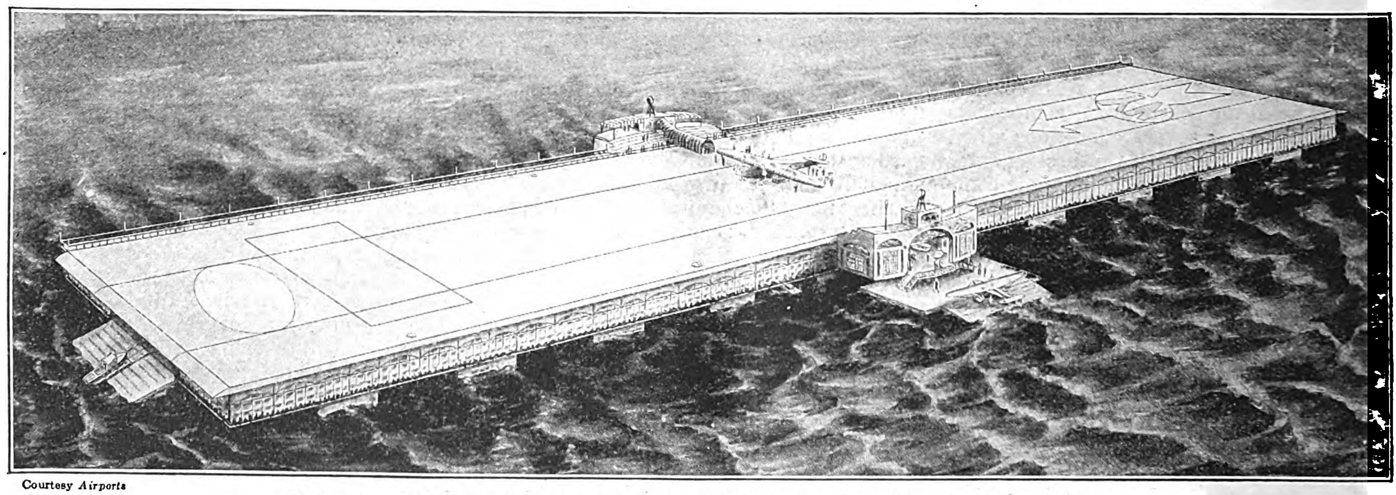
scribed into reports which reached the farmer within a few hours. This meant that he could plan his marketing from reports much less than a day old.

When the American derby took place last summer Clem McCarthy, nationally known turf authority, reported the racing classic minute by minute over the radio. A receiving set in the composing room of the *Chicago Herald and Examiner* was hooked up for recording, and as the derby progressed, the story of each race was recorded on dictation cylinders in the newspaper office within the minute that it took place hundreds of miles away. This method of reporting, used in connection with the Sharkey-Stribling fight in Florida, speeded up the news so that newsboys crying the outcome of the fight met the homeward bound fans.



Courtesy *Science*

Fluids passing through this pump make contact with glass only



Courtesy *Airports*

Drawing of the marine airport designed to be anchored in shallow water

Huge Week's Sales of Airplanes

SALES of airplanes, engines, and gliders amounting to three quarters of a million dollars in a single week is the record established at the New York Air Show, which closed May 10, according to the Aeronautical Chamber of Commerce of America, Inc., sponsors of the show. The authenticity of the sales reports was vouched for in signed statements filed by exhibitors at the show. More than 120,000 people are said to have passed through the doors of Madison Square Garden while the show was in progress—another high record.

Flying school operators reported their biggest sale of flying school courses during a single week as a result of contacts made at the air show. Furthermore, thousands, inspired by reports of the show and by the flight of a fleet of 140 Navy planes, a number of Army planes, and 77 commercial planes over the city, took their first airplane rides from several of the flying fields near the city during the week of the show.

The sponsors of the show announce that another gigantic show will be held in the city next year.

An Electromagnetic Pump

DURING the course of some investigations in the Laboratories of the Rockefeller Institute for Medical Research, it became necessary to devise a pump which could be used to circulate sterile fluid in a system free from any rubber, metal, oil, grease, or cement. To fulfill these requirements, a pump has been constructed entirely of glass, in which the motion of the piston is actuated by electromagnetic forces.

The diagram shows the pump in cross section. The pump cylinder (1) is a glass tube which has a carefully ground valve (2) at its lower end. The piston (3) consists of two tubes with a soft iron core fused between them. The lower end of the piston has a valve (4) which is identically the same as the cylinder valve (2). Both valves close by gravity. The pump cylinder is surrounded by a lower solenoid (5) and an upper solenoid (6). Both solenoids are hooked up in separate circuits. By means of a three-pole, automatic mercury switch actuated by a rocking device, the electric current flows through the solenoids periodically in such a way that they are switched on and off, one after the other, with an intermediate state in which both solenoids are magnetized for a short time. Thus, a magnetic field is created inside the solenoids. The center of this field travels up and down periodically.

The iron core inside of the piston is attracted into the center of the magnetic field. The piston moves up and down continually, like the plunger of any pump. The up-stroke of the piston opens the cylinder valve (2) and closes the piston valve (4), while the down-stroke closes the cylinder valve and opens the piston valve. By this means, any fluid can be circulated or transferred.

The pump has many practical applications, especially where it is necessary to maintain sterility. It can also be employed for blood, and for strong acids, alkalis, or other dangerous fluids.—Heinz Rosenberger, in *Science.*

A Marine Airport

THE Engineering Service of the American Institute of Steel Construction has worked out a very interesting design of a floating marine airdrome for use near a big city. It was described in a recent issue of *Airports.*

Utilizing the experience of builders of steel railroad-car barges, the flotation principle has been applied to serve as the foundation for the drome. Although the structure weighs 7500 tons, its draft of water is but seven feet.

With this shallow draft the marine airdrome could be used near large cities, as for example in the waters of the upper bay of New York. It would then be comparatively near the center of the metropolitan area. The great problem of accessibility to large cities would be at least partially solved.

The top deck of the airdrome would have dimensions of 1000 by 200 feet. Since the airdrome could be so anchored as to head into the prevailing wind at any time, these dimensions would provide sufficient landing and get-away runs for all but the most heavily loaded aircraft. These dimensions would be greater than those available on the Navy's aircraft carriers. The deck would be entirely clear of obstructious. In the middle of each side there would be a wing bulging out about 25 feet for the convenience of passengers and visitors. The flood-lighting system would be such that the beam would be thrown into the wind or following the direction of the landing plane. The approaches for a mile or two in both directions would be illuminated by a series of lights that could easily be mounted on buoys 500 feet apart.

Aside from serving as floating elements, the pontoons are to house the heat, light, and power machinery. To keep the decks clear and to hasten take-offs, two heavy-duty elevators are to connect the two decks of the airdrome. The lower or service deck is to have an area of approximately 180,000 square feet, with an overhead clearance of 21 feet. Across the middle of the service deck there is to be a terminal building providing every airport facility including a hotel, waiting rooms, restaurant, offices, and other facilities. At each end of the structure a wide terrace is to be provided which would connect with a seaplane float below. Seaplane or amphibian facilities would thus be provided.

A novel and simple form of anchorage has been designed permitting a dual control, so that the airdrome can be headed into the wind at all times. The primary anchorage is arranged so that the structure will revolve within a radius of 600 feet.

While the marine airdome is still only in the "idea" stage, it seems feasible and plausible.—*A. K.*

Talkies for the Hard of Hearing

THE person who is hard of hearing has a most difficult existence, since he can not indulge in any form of entertainment or human activity in which the sense of hearing plays a prominent role. Recently a campaign has been undertaken in this country by the American Federation of Organizations for the Hard of Hearing to cause theaters, churches, music halls, and motion picture houses in which the talkies have replaced the silent pictures to equip some of the seats with plug-ins for hearing devices. Several theaters have already installed such plug-ins.

In the device installed in one London theater by L. E. Coussell, an engineer, a microphone is placed slightly in advance of and immediately below one of the loud speakers. There is a cable lead at the back of the screen which is taken from the microphone to a plug point on the stage, and further telephone cable is then connected with a special three-valve amplifier. A second line runs from the amplifier to a block of seats in the auditorium. This block is wired with armored cable and each seat hsa a telephone jack under the arm rest. The listening set consists of a single ear phone on a handle with a local volume control. The flexible cord of the ear phone terminates in a telephone plug, which lifts into the jack already mentioned. Each hearer can control the volume of sound to suit his own needs. The results were so satisfactory that similar equipment has been installed in other theaters.

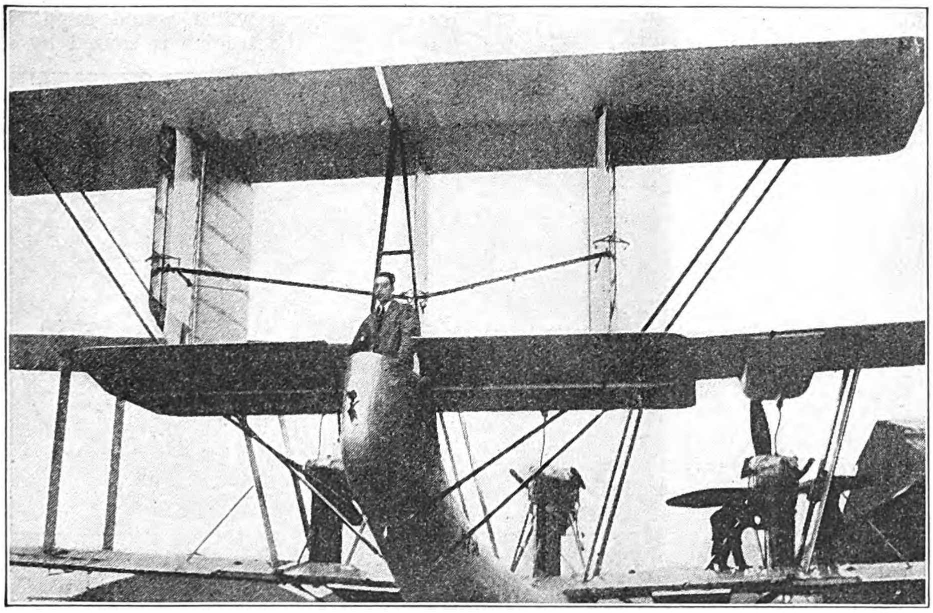
In this country the need of hearing devices is much greater and the campaign now being lead by Mrs. Louise Pelton of the Chicago League for the Hard of Hearing is tending toward the establishment of plug-ins. Already 25 out of 100 churches in Chicago are equipped and several motion picture houses are installing equipment.—*M. F.*

Cooling Transformers with Fans

A RECENT development in increasing the capacity or rating of a transformer involves the placing of fans about the radiators. The accompanying photograph shows one of a bank of three Westinghouse transformers installed at the Plymouth Meeting substation of the Philadelphia Electric Company. Each conical shaped projection houses a fan, or blower, which keeps a draft of air circulating through the radiators. The rating of this bank of transformers without the fans was 100,000 KVA; the capacity with fans as shown is 130,000—an increase of 30 percent.

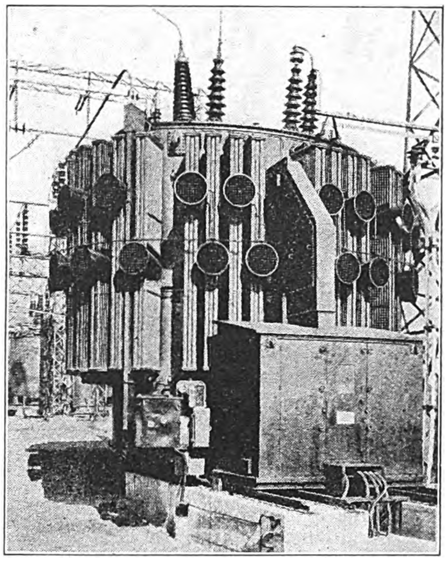
A Gunner at the Tail

THE large reconnaissance flying boats of the American and British navies are airworthy and seaworthy craft, capable of cruising long distances without the support of surface vessels, and are well equipped and well armed. Nevertheless, a large flying boat with many guns may be no match in single combat with a small combat machine, because the latter is so maneuverable and so fast. The best protection for the large and less maneuverable craft is to be able to fire in every direction.



Protecting the vulnerable point. A machine gun in the tail of a bomber

The Blackburn Company of England, has recently built a large all-metal boat, equipped with three Rolls Royce engines of over 600 horsepower each, in which an attempt has been made to give perfect fire range in the rear—where a large plane is most vulnerable—by installing a gunner's cockpit in the extreme end of the hull, aft of the tail surfaces. It is to be hoped that the gunner can easily make his way through the hull to a more central location. All the oscillations of the plane are so magnified at this distance from the center of gravity that even a hardened aviator might at times feel "squeamish.—*A. K.*



The conical projections on the side of this transformer each contain a cooling air fan or blower

To Destroy Poison Ivy

LOW-grade kerosene or crude oil, sprayed on the poison ivy vine, suffocates the plant tissues and causes destructive chemical action so that the plant dies. High-grade kerosene is not so good for it volatilizes too rapidly. Best results are obtained in hot weather. If possible, it is also advisable to cut the stems near the ground and repeat the cutting frequently until the plants are starved. Through lack of foliage, the plant, once it has used up the food stored in the roots, cannot manufacture more food for re-growth.

Loss of Hair Attributed to Deficient Diet

IF your hair is falling out it may be a sign that your diet is deficient in Vitamin G, the latest addition to the recognized family of diet principles introduced to a recent meeting of the American Chemical Society by Professor H. C. Sherman of Columbia University. Although Vitamin G has been identified for only about one year, physiological chemists at Columbia have conducted elaborate experiments of the effects of its presence or absence in the diet of rats. In these animals the vitamin is directly connected with growth. Lack of it, said Dr. Sherman, may retard growth, stop it, or in extreme cases cause death. In some rats the shortage caused premature old age. Loss of hair is one of its most commonplace danger signals. Its lack is suspected as a cause of pellagra.

"The growth requirements of rats," he said, "presumably apply to other mammals also. Vitamin G must play a prominent part in any adequately comprehensive conception of food values from now on."

Still another member of the vitamin family is suspected to be hiding behind "G." Dr. Sherman called it the "new factor" stating that it, too, is important for growth, and that evidences of its presence have been detected by several other laboratories in addition to Columbia's. This new factor is abundant in milk and presumably in meat. Vitamin "G" is abundant in milk and leaves, such as spinach, kale, and cabbage. It appears moderately, Dr. Sherman said, in meat and eggs.—*A. E. B.*

The Redrup Axial Engine

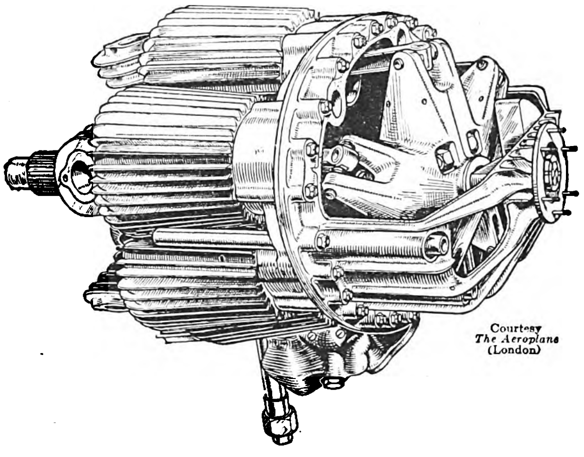
THE air-cooled engine of the star, or radial, type is always being criticized on the grounds that it impedes the pilot's vision because of its large over-all diameter and projecting cylinders, and because its head resistance is large. To make the engine more compact and to reduce the head resistance, the suggestion has often been made that the cylinders should be so arranged as to be parallel to the crankshaft, and quite near to the crankshaft center. The great difficulty in such an arrangement is the mechanical one of converting the reciprocating motion of the piston into the rotary motion of the crankshaft. The Redrup-Level axial engine, recently described in *The Aeroplane* (London), seems to offer an ingenious and successful solution of the difficulty, avoiding excessive rubbing velocities and highly-loaded bearing surfaces.

It can be seen from the drawings that the crankshaft, which lies along the axis of the engine, is carried by two roller-bearings and one ball-bearing. The crankpin is one of the special features of the engine. Instead of being eccentric and parallel to the shaft, it is set at an angle and actually crosses the center-line of the crankshaft, and is called a Z crank.

On the Z crank is a five-pointed star-member, each point of which is attached to the connecting rods of the five cylinders through a neat form of universal joint. The connecting rods carry a universal joint at their piston ends also. The star-member has two white metal bearings in which the Z crank revolves.

The easiest way to understand the motion of the star-member is to consider the instant when the top cylinder has just fired and the piston has completed half its down-stroke. There is obviously a compression force along one side of that particular arm of the star, tending to push the crank down and around.

The star-member must be allowed to oscillate but be prevented from turning. This is accomplished by a stabilizing fork or torque rod. This rod has a fork at one end which is hinged to the inside of the star-member. The axis of the hinge passes through the middle of the crank-pin and is always at right angles to the axis of the pin as the torque-tube is carried in a self-aligning journal bearing at the bottom of the crankcase.



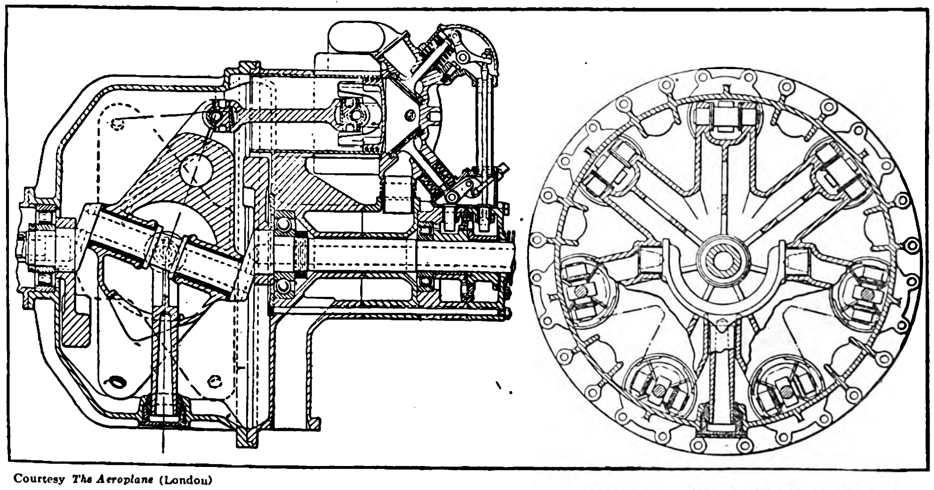
Courtesy *The Aeroplane* (London)

In this view of the Redrup axial engine for aircraft, the five-pointed star member which rotates on the Z crank (the special form of the crankshaft) may be seen at the right end. The cylinders lie parallel to the center-line of crankshaft rotation, as explained in the accompanying text

By this arrangement, the star-member is free to oscillate about the hinge of the fork, and, as the fork can twist in its journal bearing, the star-member can also twist about a vertical axis. Thus it can follow the wobbling motion caused by the rotation of the crankshaft and yet allow the full torque-reaction of the engine to be taken through the torque-rod to the crankcase.

There are three valves in each head, one exhaust and two inlet. They are of normal type and are operated by rocker-arms on the cylinder heads. These rockers are moved by push-rods with hardened steel balls at both ends.

The rods are operated by roller-ended tappets which are moved up and down by two-lobed cams running at one quarter engine-speed and driven in the direction reverse to that of the engine by epicyclic gearing off the crankshaft.



Courtesy *The Aeroplane* (London)

Cross-sectional views of the axial engine, side and front. At the left will be noted the manner in which the novel star member "rides" on the Z crank

In other respects the engine is normal in design.

The frontal area for the 60 horsepower engine has a diameter of only 18 inches. This opens many possibilities for use in a twin-engine machine, with engines mounted on the wings. The weight of the engine will be about 160 pounds or 2.6 pounds per horsepower.

The further development of the Redrup axial engine will be watched with considerable interest.—*A. K.*

Would "Perfume" Gas to Deter Suicides

"SOMEBODY is always taking the joy out of life," and now the chemist threatens to take the comfort out of dying, by mixing formalin with illuminating gas so that suicide by asphixiation will be less attractive. The interesting suggestion that formalin might be mixed with coal gas as a deterrent to suicides was made by Dr. F. J. Waldo, the London city coroner, recently. Dr. Waldo declared that the formalin admixture would make the would-be suicide's eyes water and perhaps also cause him or her to sneeze. As suicide is so often the result of a momentary brainstorm, the delay thus caused would probably give the would-be suicide time to think better of the idea.—*A. E. B.*

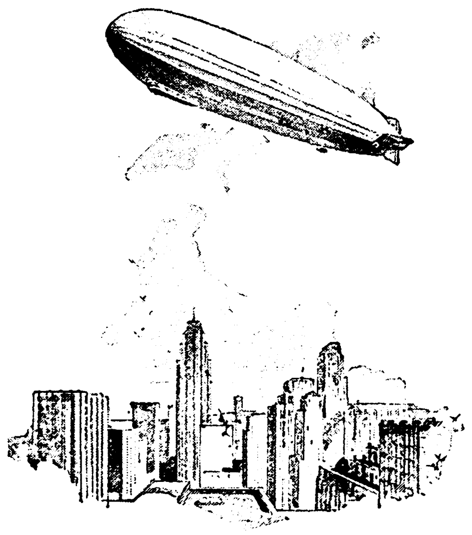
If You Ever Wash Dishes You've Wondered About This

EVEN editors have to wash the dishes occasionally, and it was in the performance of this domestic chore the other evening that we got to wondering what makes those silvery black marks on the china that simply will not wash off. By a queer coincidence, we picked up a *Technical News Bulletin* of the United States Bureau of Standards the next day, and learned that others have wondered about the same thing, and that the Bureau has investigated the phenomenon with interesting results.

It is reported that when such objects as silver-plated knives are drawn across tableware, a mark results which can not be removed by washing. The bureau has carried on certain work which would seem to indicate that the trouble is caused by a slight, almost inappreciable roughening of the surface of the ware because of its being fired in the presence of gases from sulfur in the kiln.

This was shown to be the case by taking some pieces of ware from a manufacturer which did not show any cutlery marking and giving them a firing in an electric muffle into which measured amounts of sulfur dioxide were introduced. When as little as 0.0625 percent by volume of this

CONQUERING THE FOE . . . that turned back a Zeppelin

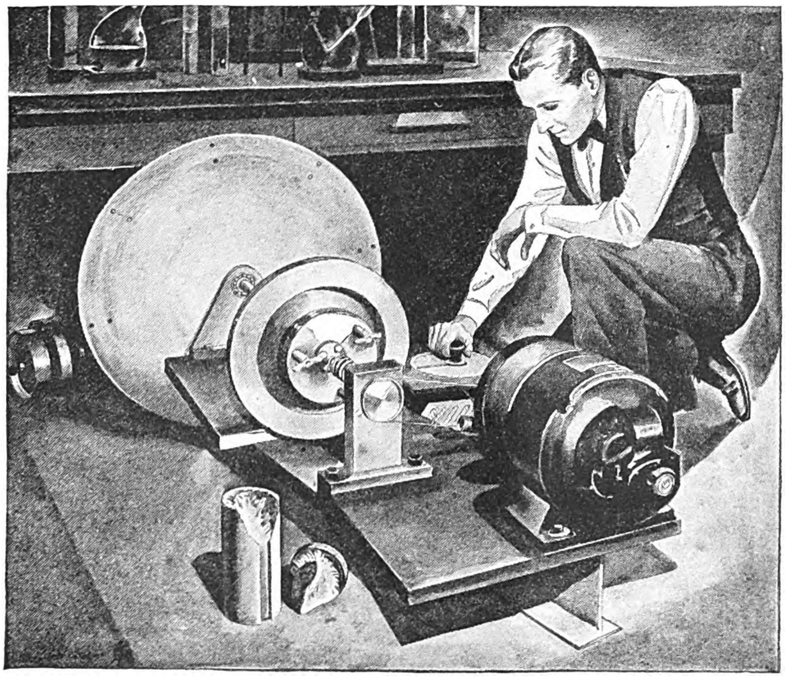


A giant Zeppelin not long ago started across the Atlantic. Hardly was it well under way, when, one by one, the drive shafts of four of its five engines cracked and went out of action. The great air ship turned back and landed—reaching its port just in time, as mechanics soon discovered, for the fifth shaft was then almost at the breaking point.

Vibration which turned back this huge Zeppelin is a foe to every modern high speed machine. In the Westinghouse research laboratories at East Pittsburgh vibration has been put on the stand to disclose its own secrets. Its ways have been charted. Its behavior has been reduced to mathematical formulas which engineers can now use in designing machinery to operate safely and reliably at the high speeds which modern industry demands.

Not only in electrical details of modern machinery, but in mechanical details as well, Westinghouse carries on its work of research and improvement—helping you to have more by making machines capable of doing more.

The results of Westinghouse research actively serve you in mines and factories, theaters, homes, stores, and offices—wherever the work or recreation of the modern world is carried on.



Westinghouse Electrification
Appliances Apparatus
Wiring
W

Tune in the Westinghouse Salute over WJZ and the coast-to-coast network, every Tuesday evening.

Westinghouse

gas was introduced into the muffle the ware, on removal, gave ready evidences of cutlery marking.

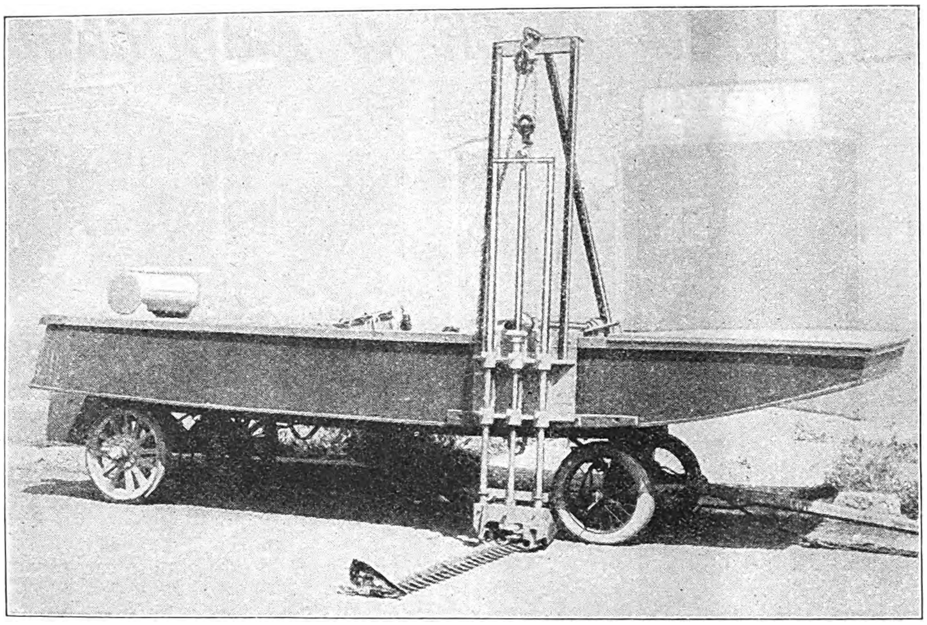
It was further found that on treating the ware, fired as described above, with solutions of ammonium acetate, lead sulfate was dissolved from the surface of the glaze. On the removal of this material by such a process as buffing, the ware no longer would mark. Samples of enameled iron similarly fired also developed a condition which resulted in cutlery marking. Commercial practices would seem to confirm the above result. One manufacturer, in substituting an electric muffle for firing his decorated ware, obtained a product that was no longer susceptible to cutlery marking. The fact, however, that this trouble was due to the formation of an extremely thin layer of lead sulfate seems not to have been noted previously.—*A. E. B.*

Steel Industry Consumes Most of Our Manganese

ABOUT 95 percent of the manganese consumed in the United States is used in the manufacture of steel, the principal base alloys being ferro-manganese and spiegeleisen, according to the United States Bureau of Mines. There is considerable manganese in many varieties of steel, including spring steels, plate steels, structural bar types, rail steels, and various steels used in the manufacture of wheels, tires, axles, armor plate, and other products of a similar nature.

Formerly manganese steels containing 1 to 1.5 percent manganese were classed as good-grade Bessemer steel, but recently they have been classified as alloy steels and have been put on the market under various trade names. Such steels have excellent tensile strength and ductility with high resistance to abrasion, and are used extensively in Caterpillar shoes, truck wheels, and other appliances where relatively low cost and high quality are required.

A manganese steel containing 12 to 14 percent manganese is used in castings for ball mills, pulverizing machinery, and rock-crusher jaws because of its resistance to impact wear and because of its hardness. Manganese is also an important constituent of nickel and molybdenum steels. Molybdenum steels usually contain 0.2 to 0.4 percent molybdenum and 1 to 1.5 percent manganese. Nickel-manganese steel usually contains approximately 1 percent nickel, 1 to 1.5 percent manganese, and 0.3 to 0.4 percent carbon. The nickel adds ductility and toughness but increases the cost.—*A. E. B.*



The lily mower which cuts the stems of these plants under water. It consists of a boat (here shown on wheels) with an adjustable mower attachment

Underwater Lily Mower

THE problem of mowing a heavy growth of pond lilies from a 50-acre reservoir in Earlington, Kentucky, resulted in the ingenious "boat mower," shown in the accompanying illustration. The growth of lilies was satisfactorily eradicated with the machine shown and a knotty problem thus was solved.

The flat-bottom scow is driven by a 35 horsepower Universal motor, which operates the cutting mechanism as well as propels the boat. The flywheel of the engine was removed and replaced by a spur gear. Between the cutter bar and the motor were placed an automobile clutch and transmission gear so that the boat could be propelled without the action of the cutter, and also to permit different speeds without having to operate the cutter bar.

The cutter bar is adjustable for different depths of water and performs at varying depths of from 18 inches to 60 inches below the surface. The middle bar on the carriage is the driving shaft on which the bevel bar slides up and down to drive the shaft by means of a key which fits in a groove. The bottom shaft is connected to an eccentric and connecting rod which gives the necessary oscillating motion. The entire gearing was arranged to drive the cutter at a slightly slower speed than the normal speed of such a bar on an ordinary mowing machine. The cutting mechanism is raised and lowered by a differential pulley.

The strange craft has been christened "The Lily Nipper."

Page From This Magazine Does Duty as Wall Paper for 78 Years

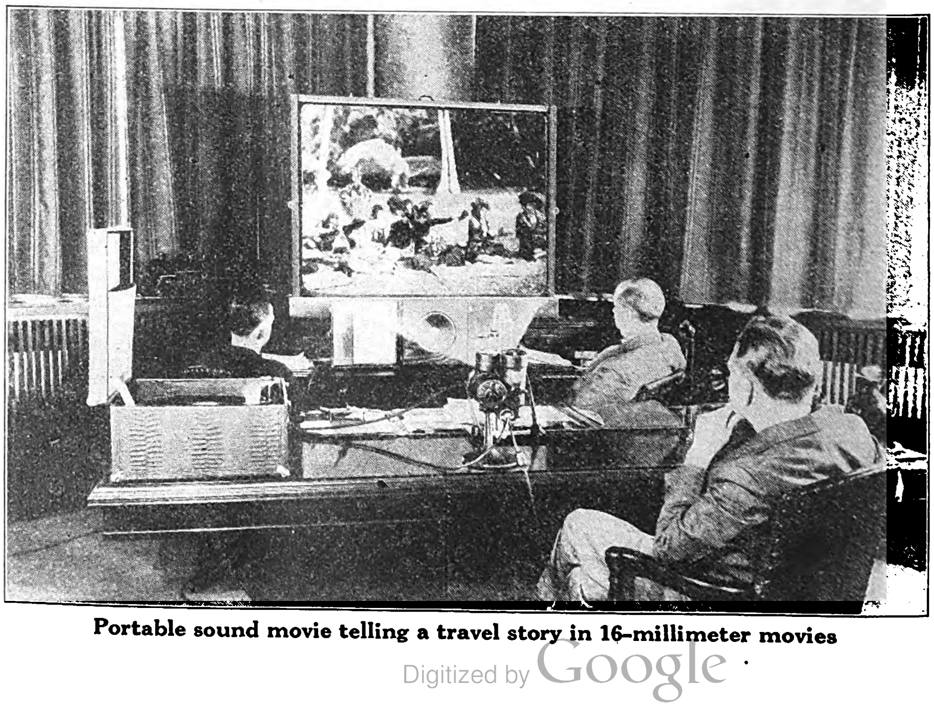
THE following item was clipped from a recent issue of *The Arcata Union*, of Arcata, California:

"While tearing down an old wall in the Vassaide Building a few days ago, carpenter Collins came across a board with a piece of newspaper attached to it which had been doing duty as wallpaper. The fragment was a portion of the SCIENTIFIC AMERICAN dated 1852 and was put in use when wall paper was scarce in Arcata."

Portable Sound Movie

A DISTINCT innovation in the motion picture field—a thoroughly practical portable equipment for the presentation of sound movies—was recently announced by the Bell and Howell Company. Amateur projectionists will be particularly interested to know that 16-millimeter films are exclusively used with this newly developed equipment.

The complete outfit consists of three small units which can be easily carried from place to place. Any Filmo projector



Portable sound movie telling a travel story in 16-millimeter movies

can be adapted for use in this equipment. A standard 16-inch phonograph record of the 33⅓ revolutions-per-minute type, is synchronized with the projected pictures. The projector, player unit, and a dynamic speaker each are contained in a separate case, and can be quickly set up and easily operated.

The Filmo projector and playing unit are driven by separate motors, each motor designed for its special purpose. The two units, the projector and the playing unit, are then coupled together mechanically by means of a flexible shaft so that positive synchronization is assured, regardless of the length of the picture or record.

Diesel Engined Ford Tri-motor Plane

SEVERAL airplane manufacturers are offering their planes equipped either with a gasoline motor or the Packard airplane Diesel engine, the purchaser to have his choice. Of these, according to *Barron's*, The Ford Motor Company, in its advertising pamphlets of the Ford tri-motor plane powered by Packard Diesel engines, says fuel consumption for each engine runs about 10 gallons an hour, which at nine cents a gallon brings total fuel cost to around 3 dollars an hour, a saving in fuel cost of more than 60 percent. Diesel engines decrease both cost and quantity of fuel necessary and use about 20 percent fewer gallons per horsepower than gasoline engines, it is pointed out.

Paper Mulches for Growing Plants

"ONE thing leads to another" may be a conversational platitude but it certainly describes the process by which one enterprising home gardener profited. A recent letter from Mr. B. K. Smith, of Newcastle, Indiana, states that he read the article "Farming Under Paper" in our August, 1928, issue and then during the summer of 1929 experimented in a small way with paper mulches. Inasmuch as his experiences may prove of benefit to others, we quote below a letter which he sent to the *Newcastle Courier:*

"We have worked out a method that can be used for garden mulch around the plants. Last year we were growing green beans. When the drought came, their leaves began to wilt and were doing no good. The first row we tried soaking the ground around them thoroughly in the evening, then taking the first or second section of the *Indianapolis News* or a whole *Newcastle Courier*, folding them to fit between the rows, thus making packs of eight to 12 or more sheets thick. We laid them close to the plants on each side of the row like shingles, only reverse, commencing at the top of the grade, so that when it rained the water would run under the packs instead of over and off. We soaked the papers thoroughly and put dirt, stones or bricks on the upper corners to prevent wind from blowing them away.

"The first week this row began to thrive and bloom. The other rows not so treated began to die.

"We also tried medium asphalt roofing cut in strips. This did not do so good as the paper packs but better than none. We find several sheets of thin paper to be better than one heavier or roofing. Also the water runs off the roofing instead of

(*Please turn to page* 68)

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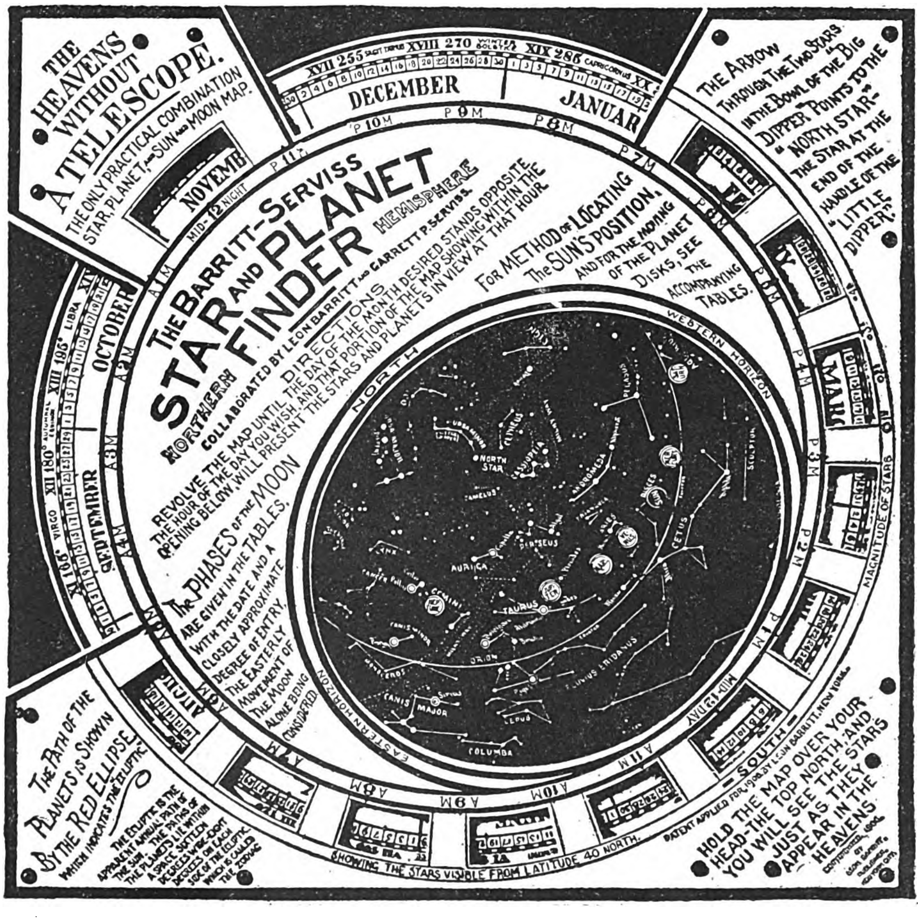
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FOR METHOD OF LOCATING THE SUN'S POSITION, AND FOR THE MOVING OF THE PLANET DISKS, SEE THE ACCOMPANYING TABLES.
THE PHASES OF THE MOON ARE GIVEN IN THE TABLES, WITH THE DATE AND A CLOSELY APPROXIMATE DEGREE OF ENTRY, THE EASTERLY MOVEMENT OF THE MOON ALONE BEING CONSIDERED.
THE ARROW THROUGH THE TWO STARS IN THE BOWL OF THE "BIG DIPPER" POINTS TO THE "NORTH STAR" THE STAR AT THE END OF THE HANDLE OF THE "LITTLE DIPPER."
THE PATH OF THE PLANETS IS SHOWN BY THE RED ELLIPSE WHICH INDICATES THE ECLIPTIC.
THE ECLIPTIC IS THE APPARENT ANNUAL PATH OF THE SUN. THE PATHS OF THE PLANETS LIE WITHIN A SPACE SIXTEEN DEGREES WIDE, EIGHT DEGREES ON EACH SIDE OF THE ECLIPTIC WHICH IS CALLED THE ZODIAC.
HOLD THE MAP OVER YOUR HEAD—THE TOP NORTH, AND YOU WILL SEE THE STARS JUST AS THEY APPEAR IN THE HEAVENS.
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MID-12 DAY
MAGNITUDE OF STARS
XVII 255
XVIII 270 WINTER SOLSTICE
XIX 285 CAPRICORNUS
XIII 195° LIBRA
XII 180° AUTUMNAL EQUINOX
XI 165° VIRGO
NORTH STAR
CASSIOPEIA
ANDROMEDA
PEGASUS
PERSEUS
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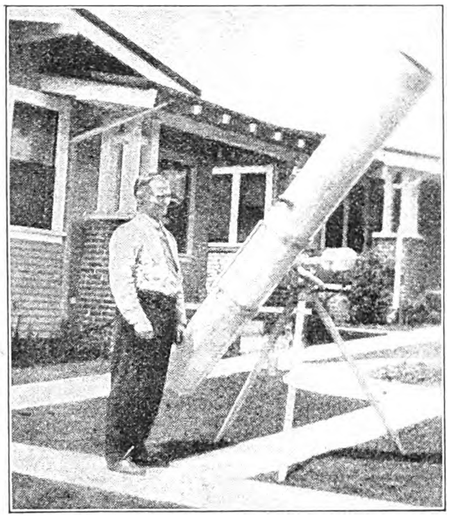
The Amateur Astronomer

A Monthly Department

THE amateur who aspires to make his own telescope is advised to begin on an instrument having a diameter of not more than six inches, as this is the most suitable size on which to get one's initial experience. Sets of materials, ready to use, may be had in this size for ten dollars, and the interesting work of grinding, polishing and figuring the mirrors should not occupy more than a dozen evenings.

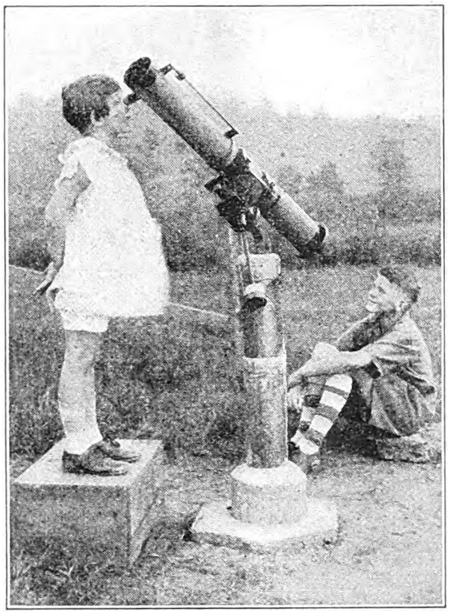
When a worker has completed a six-inch telescope, though it should magnify from 50 to 200 diameters and be the equal of a refracting telescope four inches in diameter and costing 300 dollars or more—a real astronomical telescope—he is ready to tackle something larger. A 10-inch is about the ideal size for the average amateur ultimately to possess, representing a compromise between skill, pocketbook, and pipe dreams.



Nettell and his 10-inch

MR. RICHARD NETTELL, 155 North Boylston Street, Los Angeles, California, sends us a description and photograph of his 10-inch reflector. "I have made four or five telescopes before," he writes, "but this last effort of mine was made since I got the SCIENTIFIC AMERICAN instruction book 'Amateur Telescope Making.'

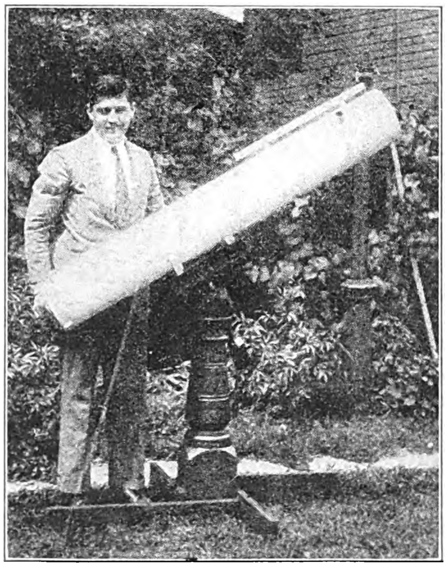
"The point I wanted to stress in my design was convenience and ease of observation and operation. The observer stands on the ground level, which is a great convenience for elderly or nervous people. The telescope is a tripod, take-down affair, as I have no room to keep it set up. The mirror is 10 inches in diameter, with a focal length of 130 inches. The tube is 11 inches in diameter and is eight feet long. At the upper end of the tube there is a three-inch flat, reflecting the rays back to the diagonal located opposite the eyepiece; making three reflecting surfaces in all. I appreciate the fact that by this design I lose some of the light, besides the loss through adding another reflecting surface, but I thought the convenience of standing on the ground more than compensated for that loss.



Lambert's four-inch

"The grinding and polishing were all done in the evenings, within three feet of our cook stove. The curve of the mirror, when I got through with polishing it, was as perfectly spherical as I could determine by the knife-edge shadow test; this with a room temperature drop of two degrees per hour. It showed in a slight degree the oblate spheroid form when the room temperature was even. All my previous mirrors had been more or less hyperbolical, and I wanted to avoid this if possible, so I estimated that the drop in temperature out-of-doors would give it the necessary parabolic form if I left it spherical.

"In performance, my mirror, when testing it on distant bright terrestrial objects, gives fairly sharp definition when using a ⅕-inch focus eyepiece. That means a magnification of 650 diameters.

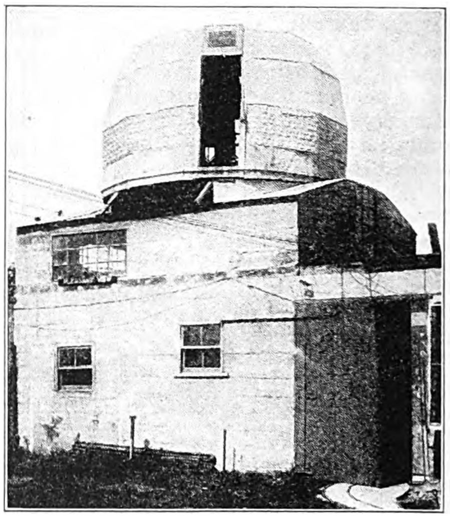


Staffa—Pyrex mirror

"The mounting is an equatorial, on a collapsible tripod, with a clock and weight drive. The pipe handle to carry it by, is also the finder."

Mr. Nettell evidently has succeeded in producing a good mirror despite proximity to a stove. Usually mirror making is done in the cellar, because there the temperature is most nearly uniform. Yet if the kitchen were also held uniform, and were about the same each night, the difficulty might not be great, for it is changing, not changed, temperature that causes trouble, as Ellison states (page 95, "Amateur Telescope Making"). One point to be considered is that ordinary pitch is too soft when used in a warm room. However, it may be boiled down to greater hardness, or resin may be mixed with it. At any rate, nothing succeeds like success, an adage which Mr. Nettell seems to have proved. He gets results from his telescope; it suits him; and that's that.

MR. ARTHUR W. LAMBERT, JR., Arcadia, Missouri, started on a four-inch mirror which he made from a disk of half-inch plate glass. His telescope is shown in one of the illustrations. Later he made a six-inch. He suggests that two mirrors should be started at the same time and "leap-frogged." He writes, "Let the worker get the first one ground and polished. Then mount it, silver it and begin to observe. He ought to get good results, at least intriguing and inspiring. Then let him try his hand on glass No. 2 and bring this to some kind of figure. He will improve on his first, then can switch mirrors, and can begin again on No. 1. By the time he has it again in the mount, he will know something more than he did, and can begin again on No. 2. This can go on indefinitely, until perfection is attained.



Pleasant View Observatory

"Another thing really surprised me. That was the real pleasures you can get from a poor glass. My first mirror, a four-inch made of windshield glass, is a very poor mirror. It brings a bright star to a sort of cock-eyed focus. Yet it splits double stars, sees the moon very well, and performs in a surprisingly good manner. I have it mounted in the telescope shown in the enclosed picture. With this little fellow I easily find the ring nebula in Lyra."

COMMERCIAL polished plate glass is the material almost universally used for the mirrors of reflectors less than 12 inches in aperture, but a finer material, though a more costly one, is Pyrex. It has the advantage of a low coefficient of expansion—about one third that of glass. Where the amateur is skilled enough to produce a nearly perfect figure he may use this material to good advantage. Mr. George Staffa, 32 Front Street, Schenectady, N. Y., used it, and reports as follows:

"The mirror was ground according to instructions in 'Amateur Telescope Making', from two 7½-inch by ¾-inch disks of Pyrex, to a focal length of 54 inches. The polishing was done on a lap made of resin, beeswax, and paraffin which, while hot, was impregnated with rouge. This took only a short time, as the grinding had been done very thoroughly; in fact, the whole process of polishing and figuring took only about four hours. The mirror was polished to the very edge, as is shown by a microscope. I experienced none of the troubles described in 'Amateur Telescope Making.'

"The figure appears just the same after standing for half an hour as it was right after removing from the lap. Very good results were obtained on Saturn; also Jupiter, on which the markings can be seen quite in detail. There are a number of other telescope enthusiasts in Schenectady who have made mirrors of Pyrex."

MR. GEORGE H. CHASE, 28 Washington Square, Newport, Rhode Island, has erected an observatory on the roof of his shop. He writes:

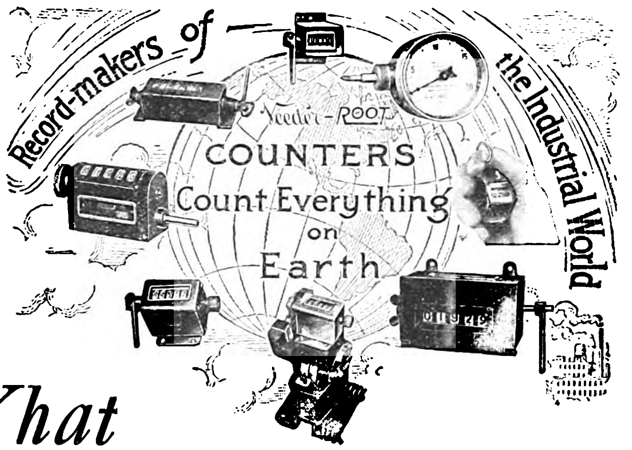
"The observatory shown in the photograph was built by Milton H. Chase and myself. The tower is built on top of a concrete workshop and is 14 feet in diameter. It rests on steel channels, and rolls around on eight wheels, being moved by an electric motor through a chain drive which passes around the outside of the tower.

"The electric motor control is on the post near the observer's seat. The framework of the tower is built of two-by-four joists and is covered with corrugated galvanized iron on the outside. The inside is covered with wall board. The present telescope is a six-inch, but provision has been made to take a 12-inch. This observatory is located at my home in Portsmouth, Rhode Island."

Speaking of amateurs' private observatories, *Popular Astronomy* (Northfield, Minnesota) began in January publishing an interesting series of descriptions of these, which is to run through the present year.

HOW about making a spectrohelioscope? Since Dr. Hale contributed instructions for the job, ("A. T. M.," pages 180-202) a disappointingly small number have tackled it. One big obstacle is undoubtedly the cost of the grating, 125 dollars, but the remainder of the materials can be made by the amateur. In a recent letter Dr. Hale states, "You will be glad to know that spectrohelioscopes of the

(*Please turn to page* 70)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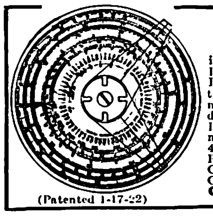

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The Scientific American Digest

(*Continued from page 65*)

under, as with the papers, and the packs will hold more moisture than the one sheet of roofing.

"We tried the paper packs on most of our garden last year on flowers, beets, onions, parsnips, cabbage, and tomatoes with good results. Probably we would have had better growth had we commenced using the papers before the ground dried out. As it was, however, the paper mulches proved their value.

"This year we expect to plant the seeds through the paper packs by using a sharp stick piercing the packs for plants to come through, first making a depression at the row so that the water will run to the plants."

Wood Impregnated with Metal

THERE has been developed during the last years by the German Institute for Steel Science in Duesseldorf a new procedure by which it has been made possible to fill the pores of wood with metal. The material which is thus produced combines to a certain degree the properties of metal as well as of wood. The new procedure is carried through by immersing wood in molten metal under pressure. The duration of this treatment and the temperature and pressure applied are of importance. All parts of the wood that are not filled by metal remain unchanged.

In a small trial plant, wood pieces 15 by 24 by 12 inches were thoroughly impregnated with metal. Infiltration may be limited to any desired depth. It has been found that the new material may be machined like ordinary wood. It is scarcely inflammable and does not enlarge its volume by taking up moisture. The appearance of the metallized wood is unique and it is expected that it will lend itself especially well to decorative purposes. It may also be suitable for lining journals and bearings, if a suitable metal is used for penetrating the wood. The new material was shown for the first time at a recent wood and timber exhibition in Berlin.—*A. E. B.*

New Solvents Eliminate Textile Problems

NUMEROUS textile problems have been greatly simplified or completely eliminated during the past year by the availability of certain of the new synthetic organic chemicals which formerly were not available on a commercial scale. Diethylene glycol has proven an almost ideal lubricant for wool spinning. Impregnation of the fiber with this chemical makes unnecessary the use of oils and as a consequence eliminates the costly operation of scouring for oil elimination after spinning. The glycol remains in the fibers of the spun yarn or fabric until the first treatment with either wash water or dye solution. At this point the glycol, which is water soluble, is removed without the necessity of another operation. New possibilities in the printing and dyeing of textiles have been made available by the use of Cellosolve and its derivatives as the medium for making solutions or pastes of dyes and colors. This group of solvents first developed for use in nitro-cellulose lacquers has thus found an extensive new application in textiles.—*A. E. B.*

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Abrasive Materials in 1928, by Oliver Bowles. Grinding and polishing processes are of great importance. This pamphlet deals with the production of natural and artificial abrasives. *Superintendent of Public Documents, Washington, D. C.—5 cents (coin).*

Studies on the Fall Army Worm in the Gulf Coast District of Texas (Technical Bulletin 138-T). Make application for this bulletin to the *Office of Information, Department of Agriculture, Washington, D. C.—Gratis.*

Foaming of Milk and Cream (Circular 108, United States Department of Agriculture) by C. S. Leete. Foaming often causes much loss of both product and labor and the present pamphlet is a practical treatise on the subject based on experiments. *Superintendent of Documents Washington, D. C.—5 cents (coin).*

Architectural Acoustics (Circular of the Bureau of Standards No. 380) are not yet generally understood even by those who design auditoriums. In this circular the principles are stated and an example is worked out showing their practical application to the planning of a new auditorium. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Chemistry and Analysis of the Permitted Coal-Tar Food Dyes (Department Bulletin No. 1390) by Joseph A. Ambler, W. F. Clarke, O. L. Evenson and H. Wales, deals with a subject in which there have been recent changes. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Automatic Line Voltage Regulation is a folder containing practical information on this subject as related to radio receiving set operation. *Clarostat Mfg. Co., 285-7 North Sixth Street, Brooklyn, N. Y.—Gratis.*

Wall Diagrams of Electro-Magnetic Waves. A heavy paper chart 22 inches high by 72 inches wide, presenting in clear diagrammatic form the 62 known octaves of ether waves, including cosmic rays, X rays, ultra-violet rays, visible light, infra-red rays, and Hertzian waves, with summarized data on each—frequency per second, wavelength, how generated, and how detected. Just the thing for the student of the new physics. *John Murray, publisher, 50 Albemarle St., London W 1, England.—Unmounted 4/6 net. On linen, with rollers, 12/6 net.*

PHOTO CELLS. A loose-leaf pamphlet which will be added to from time to time. First release includes photoelectric effects, operation of cells, applications, and circuits.—*Jenkins Television Company, 346 Claremont Ave., Jersey City, N. J.—25 cents.*

MARKETS FOR FUEL-OIL BURNERS IN THE EASTERN HEMISPHERE (Trade Information Bulletin No. 679, Department of Commerce). *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

PREPARING SHIPMENTS TO CANADA (Trade Promotion Series No. 91, Department of Commerce) deals with documentation and customs entry. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

AMERICAN UNDERWRITING OF FOREIGN SECURITIES IN 1929 (Trade Information Bulletin No. 688). Compiled by Paul D. Dickens. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

FINANCIAL DEVELOPMENTS IN THE FAR EAST (Trade Information Bulletin No. 680, Department of Commerce) gives a brief survey of financial happenings in the Far East during 1929. It is based almost entirely upon the first-hand reports of field officers of the Departments of Commerce and State. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

THE SOCIAL PHILOSOPHY OF PENSIONS WITH A REVIEW OF EXISTING PENSION SYSTEMS FOR PROFESSIONAL GROUPS (Bulletin No. 25. The Carnegie Foundation for the Advancement of Teaching) by Henry S. Pritchett, President of the Carnegie Foundation. *The Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, New York City.—Gratis.*

FINLAND. AN ECONOMIC REVIEW (Trade Information Bulletin No. 681, Department of Commerce) deals with the most densely wooded country in Europe, where 80 percent of the population is rural, affording an expanding market for United States goods. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

THE MOTORIZATION OF NORTH AFRICA is the title of Trade Information Bulletin No. 689, by the Department of Commerce, dealing with the rapidly growing market for automotive products in North Africa. In 1929 it took nearly 2,000,000 dollars worth of American automotive products, an 85 percent increase over the previous year's figures. Any branch office of the Bureau of Foreign and Domestic Commerce, or *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

PULP-WOOD CROPS IN THE NORTHEAST (Leaflet No. 57, United States Department of Agriculture) by M. Westveld. Illustrated. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

THE WEATHERWOOD HANDBOOKS: 1. For Plasterers; 2. For Contractors and Carpenters; 3. on Sound Deadening Construction; and 4 on Industrial Roof Insulation; and How You Can Make Your Farm More Profitable, and The New Standard of House Construction constitute a useful series on the application of Weatherwood, an insulating board fabricated from hardwood. *Chicago Mill and Lumber Co., Chicago, Ills.—Each gratis.*

GLOSSARY OF TERMS USED IN FIRE CONTROL (Miscellaneous Publication No. 70, United States Department of Agriculture) has been prepared by the Forest Service. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

THE APPLICATION OF SILVICULTURE IN CONTROLLING THE SPECIFIC GRAVITY OF WOOD. (Technical Bulletin No. 168, United States Department of Agriculture) by Benson H. Paul, describes some interesting results which show that the specific gravity of the woods studied may be modified by controlling local factors which affect the growth either of forests or individual forest trees. *Superintendent of Documents, Washington, D. C.—15 cents (coin or money order).*

CAESIUM, RUBIDIUM, AND LITHIUM, Information Circular 6215, details the history of discovery of these minor alkali metals, their various odd uses, alone and in alloys, their sources, and the markets for them. *United States Bureau of Mines, Department of Commerce, Washington, D. C.—Gratis.*

PRINTING AND PUBLISHING AND ALLIED INDUSTRIES. (Census of Manufactures, 1927) gives full information in tabular form as to the industries relating to printing. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

CELLULOSE. A new trade paper devoted to cellulose, its derivatives and products. *The Cellulose Publishing Co., 114 East 32nd St., New York City.—$3.00 a year, not $3.50 as previously stated. 35 cents a copy.*

ANALYSIS BY MOVIETONE OF A CRICKET'S CHIRP. By Doctors Lutz and Hicks. Scientists apply the Movietone principle to the analysis of insect music, with rather surprising results. *American Museum of Natural History, 77th St. and Central Park West, New York.—15 cents, postpaid.*

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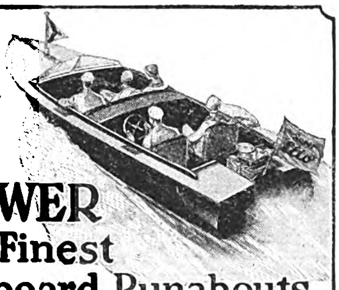

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The Amateur Astronomer

(*Continued from page* 67)

type shown in my article are already in use at Pomona College, California; the University of South Dakota; the University of Michigan; Yerkes Observatory; Ohio State University; Vassar College; the Royal Observatory at Greenwich; the Astrophysical Observatory at Arcetri, Florence; the American College at Beirut, Syria; the Government Observatory at Canberra, Australia; and the Observatory at Samoa. Others have been ordered for use in Chicago, England (2), and China, and two native Indians in Madras (one an amateur) are building outfits for themselves." Isn't it time more amateurs jumped into this interesting game? Thus far, five American amateurs have nibbled at it, and of these some are believed definitely to be "hooked." The blueprints cost only a dollar and a half. Reread Dr. Hale's chapters, also the *Astrophysical Journal* for December, 1929, and see whether these do not make you want a spectroheliscope.—*A. G. I., Tel. Ed.*

Our Point of View

Analyzing the Naval Treaty

(*Continued from page* 16)

of the Japanese delegation was buttressed by three very solid factors; first, they attended a conference jointly arranged by Great Britain and the United States, and as guests were under no obligation to make the party a success; secondly, since 1922, in submarines, they had outbuilt both Great Britain and the United States and possessed more modern submarines than any other state at the Conference, nor had they weakened their position by advocating the abolition of submarines as weapons of war; thirdly, during the same period they had outbuilt the United States in cruisers, had built up to a 9 to 6 ratio in destroyers with Great Britain, and were fast attaining a 5 to 3 ratio with us in destroyers, the only category in which we had full strength.

The continuous and comprehensive naval program of Japan since 1922 has only one modern counterpart in time of peace, that of Germany prior to 1914, and it has been carried out despite financial difficulties and the destruction of Yokohama and part of Tokio by earthquakes. This vast naval program would be no proper concern of ours except for the fact that in Washington, in 1922, we scrapped our capital ships and agreed to limit the fortifications of our Far Eastern possessions when we believed the 5 to 3 ratio with Japan would be extended to all categories of ships. Now, by the provisions of the London treaty we concede parity to Japan in submarines, a 10 to 7 ratio in destroyers, and a 10 to 7 ratio in six-inch gun cruisers. As a climax, Japan expressly reserves the right, at the end of the treaty period, to reopen the question of further increasing her ratio of eight-inch gun cruisers to 10 to 7.

At present we have only a 5 to 3 ratio in capital ships because, although granted a 5 to 3 ratio in aircraft carriers, actually we have built only 66,000 tons of modern aircraft carriers against 61,270 tons for Japan, and we have authorized one more carrier of 13,800 tons while Japan is building one of 7600 tons. Thus, unless we accelerate our building program from now until 1936, we will be practically equal to Japan in modern aircraft carriers, and inferior in cruisers. We will have only a 10 to 7 ratio in destroyers, and all of Japan's destroyers will be modern post-war tonnage, while the bulk of ours were designed and hurriedly constructed during the World War to meet the German submarine menace.

Our position relative to Japan during the life of this treaty may be recapitulated: in capital ships we will have a 5 to 3 ratio; we will have a 10 to 7 *tonnage* ratio in destroyers, but our destroyers are all over 10 years old, while Japan's are all under 10 years, and one half are less than five years old; Japan has eight eight-inch gun cruisers in commission, we have one; by the end of 1931 we will have eight, Japan will then have 10; by the end of 1932 we will have 11 and Japan will have 12; by 1936 we will finally attain a 5 to 3 ratio in eight-inch gun cruisers. In six-inch gun cruisers, Japan today has 20 of 95,000 tons against our 10 of 70,500 tons. By the terms of the treaty if we build 18 eight-inch gun cruisers we can build six-inch gun cruisers only in the ratio of 10 to 7. Provided Congress acts promptly and we lay down four six-inch gun cruisers per year, it will be 1935, one year before the treaty expires, before we will attain a 10 to 7 ratio in six-inch gun cruisers. In modern aircraft carriers we have a scant margin on Japan at present, and unless we accelerate our building program during the life of the treaty, it will remain about 8 to 7. In modern submarines we are at present inferior to Japan and by the treaty she concedes us parity.

THUS, by resolutely carrying out her comprehensive building program between 1922 and 1930, Japan was able to send to the London Conference a delegation in a position to insist upon her demands. This position was rendered impregnable by the solid support the Japanese government and people gave their delegation. No group of Japanese pacifists weakened the arguments of their delegation with demands for naval reduction. As a result, Japan obtained practically every item in her demands, and yet following an ancient custom, the leader of her delegation, in his report to the Emperor, deplored his unworthy talents that so inadequately represented his country's case; while our delegation returned almost jubilant because the Japanese did not insist at this time on a 10 to 7 ratio in eight-inch gun cruisers.

The Japanese press states that Admiral Kato, Minister of Marine, strenuously opposed any concessions, and made at least one personal appeal to the Emperor to overrule the decision of the Government. This effort failed, but to placate the Navy Department, the Cabinet promised to find money for the following new projects:—

(a) An increase in the air force from 17 air battalions to 20 battalions.

(b) Building of some special service ships (types unspecified).

(c) Strengthening of fortifications.

(d) Increase of expenditures on account of the upkeep and repair of ships.

In short, the Japanese government will divert to other naval and military measures the money saved by the Conference.

The Japanese press also explains to the Japanese people that their government felt obliged to yield to Great Britain and the United States, lest the resulting estrangement between Japan and these two countries produce serious effects on Japan's international position, both politically and economically. One paper emphasizes the important fact that if the Conference failed and replacements of capital ships began next year under the terms of the Washington Treaty, Japan would have to find 75,000,000 dollars for building purposes which would necessitate still higher taxes. Finally the Foreign Office reminds the Japanese public that although under the compromise plan Japan's ratio was fixed at 62 percent, Japan's actual ratio up to 1936 would be 72 percent and that she had specifically reserved the right to restate her demands at the next conference.

It seems patent, therefore, that the small abatement Japan made in her total claims was due to her apprehension of the political and economic consequences if she offended both Great Britain and the United States, to her belief that a total failure of the conference would start battleship replacements in 1931 which she could not afford, and to the knowledge that during the life of the treaty she would actually have a 70 percent ratio in big cruisers. Having made this small concession it is significant that her government, to appease her Navy Department, authorized the Finance Minister to promise increased expenditures in the categories not limited. It seems plain, therefore, that just as Japan diverted the money saved by the limitation of capital ships in 1922 into cruisers, destroyers and submarines, she now intends to devote the money saved by the limitation of the smaller categories into increasing her air force, building special-type vessels, expending more money on the upkeep of vessels already built, and, finally, increasing her fortifications. There is a little irony in this last item, for on the presumption of a 5-to-3 naval ratio we have promised not to increase any of our fortifications west of Honolulu.

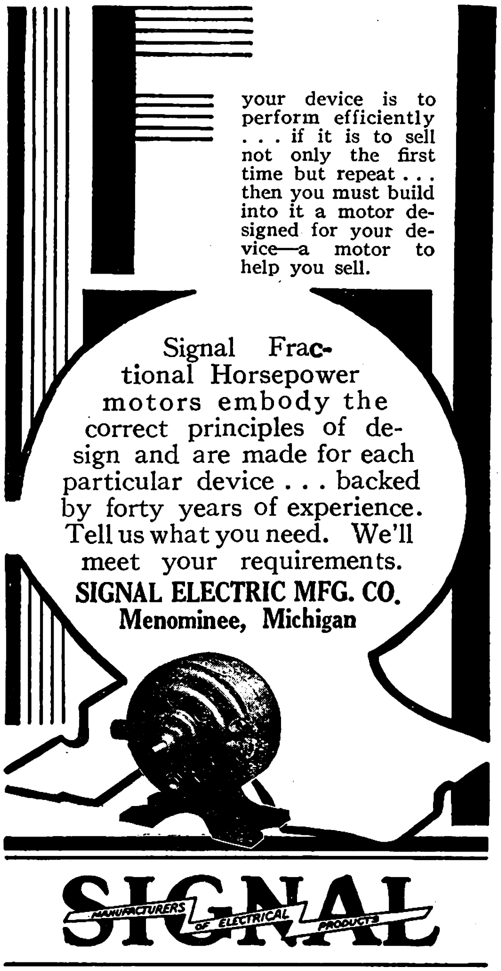
WE can find no fault with Japan for nicely adjusting her foreign affairs and her naval strength, nor for supporting as large an army and navy as her finances will bear. Many Japanese still alive can remember their two wars with China and Russia whereby Japan established her present proud position in the Far East; it is natural they should prefer to trust their future to their own military strength rather than to international agreements. For this reason they patiently submit to severe taxation before they will reduce the efficiency of their armed force. We would remind Americans, however, that the 5-to-3 ratio with Japan exists only in capital ships, that opulence is not military strength, and commercial supremacy is no safe substitute for armies and navies.

On the credit side of the Conference, we place the removal of much of the previous friction between Great Britain and our country. We believe the great majority of the people of Great Britain have finally reconciled themselves to a naval parity with the United States and, while Americans properly regard that action as due our position and responsibilities as a world power, we should remember that for the first time since attaining sea supremacy, Great Britain has peacefully conceded another nation naval parity. Our relations with Great Britain during the next decade can be stabilized better on the basis of parity than on any other ratio. We have fought against her in two wars; we have been to the brink of war with her on at least two other occasions; during the World War we fought shoulder to shoulder with her; and we know better than any other nation that she can be a formidable foe or a faithful friend on land and sea. We have no conflicting interests with the British people that cannot be arbitrated and we have a common background of language, literature, and self-government. The manful manner in which they are meeting their post-war difficulties deserves all praise, and Americans do not enjoy haggling with them over cruisers or disputing over the technicalities of gun power.

Great Britain cannot ignore the European situation; the simple solution is for us to obtain parity upward to the minimum of her necessities and to cease our insistence that she reduce her building program to satisfy the wishes of our pacifists. This statesmanlike procedure would not only benefit our relations with Great Britain, but it would enable us to safeguard our world-wide commerce and meet our responsibilities in the Far East—and the few million dollars per year additional cost will be well spent.

REGARDLESS of its imperfections, the treaty should be ratified, unless the Senate discovers some technical clause that may need a clarifying reservation. The Congress and the Administration should then promptly inaugurate a six-year building program that will place our fleet on a parity with Great Britain and in its allowed ratio with Japan. Unless Congress does this, we are in the untenable position of demanding that other nations restrict their building programs because we are too penurious to spend money on our fleet. Now is an excellent time to begin building, for it will stimulate the steel and shipbuilding companies and give work to the numerous skilled artisans whose services are necessary to create a modern man-of-war and all its accessories. Practically every industry in the country would benefit.

We repeat that Congress should adopt a continuous and comprehensive naval program that will raise our fleet to the maximum treaty strength by 1936 and maintain it at that position without the frequent fluctuations that prevent economy and efficiency in our naval establishment; for, having settled their continental interior, Americans are returning to the ocean that nourished and sustained their seafaring ancestors until the forests were cleared and farming commenced. Shipbuilding was our first great industry; our merchantmen carried the commerce of Europe and Asia when our factories were still in our homes and our railways unbuilt. Our factories now produce more than we can consume; an extraordinarily efficient railway system deposits our enormous foreign trade on our wharves to load upon *foreign* merchantmen. We are taking measures to revive our merchant marine so that we will no longer be dependent upon foreign carriers, and we should not delay providing and maintaining a navy that will protect our citizens and our foreign trade in all parts of the world. This done, Americans can continue to go about their peaceful tasks, envying no other people their prosperity, avoiding foreign political entanglements, and developing friendly commercial ties with the whole world.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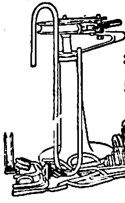
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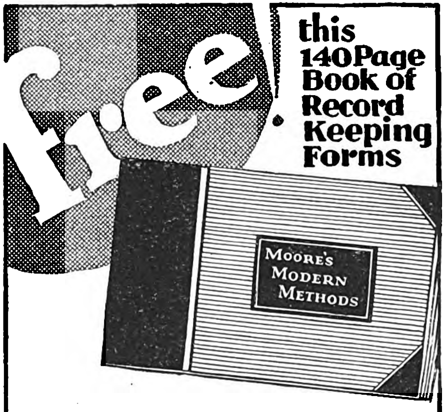

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BEGINNING with the search for the northwest passage and continuing down through the heroic attempts to reach the poles, culminating in Admiral Byrd's recent spectacular accomplishment, here is a comprehensive account of high adventure which fires the imagination and stirs the blood. Maps showing the course of each major effort, with 32 reproductions of photographs, make this one of the most interesting and historically valuable of any of the titles on polar exploration. A chronology completes the text. $2.15 postpaid.

LAUD, STORM CENTRE OF STUART ENGLAND—*By Robert P. Tristram Coffin*

WILLIAM LAUD (1573-1645) lost his head in two senses. If he had been less of a tyrant he might have escaped the block. He was a powerful factor in Caroline England and brought down ruin all about him. Oxford owes much to him and he really did accomplish a great many reforms as he was all-powerful both in church and state. He was the Man of Thunder who became the storm center of the Civil War, but he preserved much of the ceremonial beauty of the Anglican communion. As Archbishop of Canterbury he wielded great power. An implacable enemy of the Calvinists, he even tried to reach the Colonists of New England; he tried to force his ecclesiastical system on Scotland, but failed. His infatuated policy at last brought on his impeachment, imprisonment in the Tower of London, and finally his sentence to death when he had some difficulty in getting the axe substituted for hanging. His mutilated body rests in his beloved Oxford but his best monument is the very fabric of the Anglican Church. $3.65 postpaid—*A. A. H.*

MAHATMA GANDHI'S IDEAS—*By C. F. Andrews*

GANDHI has been much in the limelight by reason of his civil disobedience campaign to secure Indian Independence. His mass disregard for the salt laws is front page news and when we last heard of him he was on tour in an automobile and having tire trouble in the cactus regions. Wherever he goes he spreads discontent, for he has an uncanny faculty for casting a spell by the sheer force of his personality. He is a powerful thorn in the Indian government's side but they were wise enough not to martyrize him by hurrying his arrest. We have often wondered what this Indian Moses really wants. He seemsal most as bewildered as anybody else. It is the mission of this book to try to make known the principles for which he stands, giving his thoughts and aspirations in his own words as far as possible. Gandhi is a legend, but a personified legend. The author has been with him on recent tours, therefore the information outside of Gandhi's writings is authentic. $3.15 postpaid—*A. A. H.*

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SCIENTIFIC AMERICAN
24 West 40th Street, New York City

Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Secrecy of War-Time Inventions

GREATER secrecy for inventions useful in the national defense is proposed in the draft of a bill submitted to the House by the Acting Secretary of the Navy, Ernest Lee Jahncke, reports *The United States Daily*.

The proposed measure was prepared, he said, by the interdepartmental Patents Board as a substitute for one originally submitted by the Navy Department, and has the concurrence of representatives of the War and Navy Departments on the Patents Board.

"The efficiency and international superiority of all armament, equipment, appliances, and facilities for the Army and Navy," he added, "are of primary importance and are always the subject of first consideration on the part of the War and Navy Departments. Constant effort towards improvement and unremitting vigilance in the pursuit of it are practiced at all times by both departments.

"The only source from which the maximum of efficiency and the possibility of superiority may be hoped for is continuous invention. Of course, many inventions of military value are made in other countries and never come to light in the United States. Also many inventions that are offered to and are acquired by one or the other of the two military departments become public beforehand.

"However, a large number of valuable inventions, and sometimes fundamentally important inventions, are made by persons connected in some way with the government service and in numerous instances by patriotic citizens in private occupations, and are brought to the knowledge of one department or the other before any information concerning them becomes public. During such time as it is desirable to keep inventions secret, it is necessary that patents on them be not issued, because as soon as a patent is issued it becomes public. But for the proper protection of the government's rights in and to such inventions it is necessary that they be filed in the Patent Office with applications for patents thereon.

"While in the Patent Office, in the status of 'patent applied for,' an invention is a secret so far as the inventor and his assignee do not divulge information concerning it. In these circumstances, a legal method of maintaining for a proper time the secrecy of an invention of value to the Army or Navy is a vital need. This can be accomplished in the way that seems most feasible, all this considered, by filing applications for patents and holding back the allowable patents at the discretion of the department concerned."

Standardized Bottles

WITH the purpose of promoting exports, regulating distribution and standardizing types, the leading bottle manufacturers of Germany have formed themselves into a syndicate to be known as the German Bottle Sales Company, according to a report received in the Department of Commerce from Assistant Trade Commissioner A. Douglas Cook, at Berlin.

Both domestic and foreign sales will be handled by the syndicate. It is estimated that between 500,000,000 and 750,000,000 bottles (colored glass only) are produced annually in Germany. Exports, which before the World War amounted to about 35 percent of the output, have declined to approximately 20 percent. It is expected that the combine will be able to increase exports again.

The bottles concerned are especially beer, mineral water, wine, liqueur, and alcohol bottles. Under the new arrangements, all patented manufacturing processes will be pooled for the benefit of all members of the syndicate, thus avoiding competition between the different manufacturing processes.

British Tire Importation Decreases

BRITISH imports of rubber tires and tubes recorded a further extensive decrease (except as regards solid tires) in 1929, while exports in the same commodities, following a decline in 1928, evidenced considerable recovery, according to a report from Consul General John J. Davis, London, the Department of Commerce anounced recently. The announcement follows:

Imports of pneumatic outer covers were valued in 1929 at 2,143,739 dollars, against 12,808,555 dollars in 1927; inner tubes at under 400,000 dollars contrasted with more than 1,574,000 dollars; and solid tires at 455,000 dollars, compared with upwards of 800,000 dollars, but this last-named description rose by about 10,000 dollars above the value in 1928.

The cause of the marked decrease in imports of tires and tubes, the report stated, can be traced mainly to factories for these goods having been set up by certain foreign firms, in consequence of the imposition of an import duty as from April 12, 1927.

Oil Trademark Upheld

IN the case of Vacuum Oil Company versus Walter and Company, First Assistant Commissioner Kinnan held that Walter and Company, of Rio de Janeiro, Brazil, is entitled to register, as a trademark for lubricating oils, a mark consisting of the pictorial representation of a griffin with the word "Griffin" appearing thereabove and the notation "Domina Attricto" therebelow, notwithstanding the long use by the Vacuum Oil Company of New York and registration of a mark for the same goods consisting of the pictorial representation of a gargoyle, with the word "Gargoyle" thereabove.

The ground of the decision is that these marks are not so similar that their contemporaneous use would be likely to cause confusion.

In his decision, after noting that applicant had taken no testimony and that it appeared from the opposer's evidence that it was long prior in the field and had carried on a very extensive business and consequently doubt, if it exists, must be resolved against the applicant, the First Assistant Commissioner said with respect to the marks:

"Both parties have adopted a pictorial representation of a fictitious or fanciful creature, that of the opposer being only somewhat similar to an eagle as to the body although the head is quite dissimilar to such a bird, while the griffin simulates the head and wings of an eagle with the body, feet, and tail of a lion. The similarity of the two pictorial representations is very remote. The names of such fanciful creatures are likewise wholly dissimilar in spelling, sound, appearance, and significance. Unless it be held that the opposer is entitled to such an interpretation of its trademark rights as would preclude any rival in business from using any pictorial representation of a fanciful animal, however distinct from that used by the opposer, in connection with a name of such fanciful creature, it is believed the applicant is entitled to registration of its trademark."

With respect to the testimony as to the dress of applicant's goods and certain activities in connection with their sale and the former commercial relations between the applicant and the opposer, he said:

". . . but all these matters refer to activities in another country, Brazil, and are immaterial and irrelevant to the issue to be determined in the case at bar. The opposer has alleged that the applicant has not used its mark in interstate or foreign commerce in this country, but has submitted no evidence to support such allegation and it is thought the opposer is not entitled to raise such a question in the instant proceeding."

Patents and Trademarks In Panama and China

PATENTS and trademarks, of which the certificates of registration already have been granted, must be recorded in the mercantile register of Panama regardless of whether or not the company owning the registered patents or trademarks is doing business in Panama, according to information received from Assistant Trade Commissioner Fred C. Rogers, Panama City, and published in *Commerce Reports*.

As a result of the inclusion of such matter in the office of the Secretary of Agriculture and Public Works, and according to the provisions of the Commercial Code which became effective on July 1, 1917, all factory and trademarks and patents for inventions, for which certificates of registration have been acquired since that date, must be recorded in the mercantile register.

The provisional regulations for the promotion of industrial manufactures in China, promulgated by order of the National

Government on June 18, 1928, apparently limit to persons of Chinese nationality the right to apply for and obtain patents. According to these regulations, Americans, as well as other foreigners, will be unable to protect their patent rights, for under the clauses of encouragement which are intended to promote industry only Chinese may make application for permission to exploit new inventions and industrial processes.

It is understood that this matter has been brought to the attention of the Chinese Government on behalf of American citizens in order that their rights in patents may be protected against infringement.

Centrifugal Casting Process Claims Allowed

CLAIMS defining a process for the centrifugal casting of hollow bodies of steel have been allowed by the Board of Appeals of the Patent Office, *ex parte* John Chapman Bell. The claims had been rejected on the ground that they merely set forth the obvious way of using the apparatus disclosed, or one equivalent thereto. It was pointed out by the Board of Appeals that a process of treating matter to produce a given result, and a machine suitable to perform the process, constitute distinct entities, and if new and useful, each may form the subject matter of a patent independently of the other.

The applicant stated that the essential novel features of his process lie in two manipulations. The first consists in maintaining the nozzles through which jets of metal are delivered into the rotating mold at a constant distance from the surface upon which the metal is deposited. The other consists in maintaining constant the pressure in the spout through which the metal is delivered to the mold.

While it is undoubtedly true that the mere function of a machine is not subject matter for a patent, yet it is equally true that a process consisting of certain operations upon matter to change its form or condition constitutes patentable subject matter, if new and useful. This is true, even though such an operation may be performed by an apparatus devised to practice the process and such apparatus may have no other function.

Deceptive Advertising Discontinued

THE practice of advertising a concern as occupying an entire building in the conduct of its business when it only utilizes a part of the building, creates an erroneous impression upon the public trade, according to announcement by the Federal Trade Commission, stating that an individual so advertising had signed a stipulation agreeing to discontinue the practice. The Commission's statement follows:

Manufacturing and selling toy airplanes, an individual circulated advertising matter containing illustrations of what purported to be a picture of the building in which his business was carried on.

On the front of the building, as shown in the picture, appeared in large display type the following: "World's Largest Manufacturers, Model Airplane Sets and Supplies," and over the door of what seemed to be an annex of the building appeared the words "Shipping Department."

However, the business was limited to the manufacture and sale of miniature toy airplanes and repair parts for them. The volume did not exceed 10,000 dollars a year. The enterprise was carried on in two small rooms of the upper story of a small building and no separate space was utilized for shipping.

Signing a stipulation agreement with the Federal Trade Commission, the individual agreed to stop circulating advertising matter which tended to create the erroneous impression that he occupied all the space in the building, and which contained the representation that he was the world's largest manufacturer of model airplane sets and supplies.

(Names of individuals or firms signing stipulation agreements are not mentioned in the Commission's press releases or publications, but the facts in the proceedings are presented to show methods of competition condemned by the Commission as unfair, for the guidance of industry and protection of the public.)

"Must Sell" Must Not Be Used

TWO individuals in different parts of the country, engaged in selling and distributing diamonds in interstate commerce, signed stipulations with the Federal Trade Commission agreeing to cease and desist from use of the words "must sell" in an advertisement when there were no emergencies compelling the immediate sale of their products.

They advertised as follows: "Diamond ring. Must sell. Beautiful lady's setting. Large blue-white perfect cut diamond. For quick cash, 100 dollars."

Rural Electrification

ELECTRIC utility companies and the State administration in Ohio are cooperating in plans to extend rural electrification on a basis that will insure the widest possible use of electricity on the farms, was a recent oral statement of Governor Myers Y. Cooper, according to *The United States Daily*.

Conferences between the governor, representatives of the electric companies, the public utilities commission, the Ohio Farm Bureau Federation, and officials of the Ohio State Grange have been held on the subject and are producing results, the governor said.

One of the principal plans is to have the utilities provide lines to rural territory without cost to the farmers. Heretofore the subscribers have had to pay for the line, which in many cases made the cost prohibitive, the governor said. Further conferences are planned by the governor in which it is expected that a basis of mutual agreement will be reached.

"The administration feels that rural electrification is one of the most important social and economic benefits which possibly can be extended to the farmer and is bending every energy in bringing together a meeting of minds of the farm groups and the utilities interested on the basis of fairness and equity, making the program attractive to the farmer from the standpoint of costs."

Frozen Fresh Meat

THE rapid development of the quick-freezing process of preserving fresh-cut meats to be sold in packaged form is said to be one of the most revolutionary developments in food merchandising since the advent of canned foods, according to a recent oral statement on behalf of the foodstuffs division of the Department of Commerce.

The new system, it was said, calls for butchering the carcass promptly into individual cuts, which are frozen solid in airtight wrappers and chilled to 50 degrees below zero. It is claimed that the quick-freezing process brings the meat to the consumer with the weight, flavor, texture, and appearance unchanged.

The present cost is about 2.45 cents per pound, which is expected to be reduced under large-scale production. Savings will be realized in the elimination of waste. Transportation savings are expected, since the space taken up by packaged meats is less, it was pointed out. (A similar method of preserving fresh fish was described in our issue of March, 1929.—*Editor.*)

Roofing Trademark Upheld

IN respect to the case of The Duro Company versus Central Paint and Roofing Company, First Assistant Commissioner Kinnan held that the Central Paint and Roofing Company of Louisville, Kentucky, is entitled to register, as a trademark for smooth surface and slate surfaced composition roofing, a mark consisting of the notation "Dur-A-Bull" and the pictorial representation of a bull, notwithstanding the prior adoption and use by The Duro

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co.; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

AIRPLANE—Having rotatable members operating independently of the wings, and adapted to adjustably receive air under pressure for increasing the lift, and acting as stabilizers for retarding rolling, pitching and slipping of the plane in the air. Patent 1753112. George R. Engledow.

Pertaining to Apparel

GARTER—Wherein a plurality of disengagable supporting members are connected with the shirt and hose in order to provide supports at

Company of Dayton, Ohio, of the notation "Duro" as a trademark for various goods used in connection with houses.

The ground of the decision is that the goods of the two parties are not of the same descriptive properties and the marks themselves are not deceptively similar.

In his decision, after noting that the opposition had been dismissed on the grounds above stated, the First Assistant Commissioner said, with reference to the goods:

"I am of the opinion that the decision of the acting examiner of interferences is without reversible error. Obviously the applicant's composition roofing is not of the same descriptive properties as any of the goods enumerated in the opposer's trademarks."

With reference to the marks, he said:

". . . it is equally true that the applicant's mark, consisting of the word 'Dur-A-Bull' and a pictorial representation of a bull, does not so nearly resemble the opposer's mark 'Duro' as to be likely to cause confusion or mistake in the mind of the public."

And then, after citing certain registrations to show that the term "Duro" did not originate with the opposer, he said:

"In view of the prior adoption and use by others of the word 'Duro' both as a trademark and as the whole or an essential part of the names of companies or corporations, it is believed that the opposer is not entitled to such broad protection of its mark as to exclude from registration the applicant's mark."

Type Font Patent Granted

THE Commissioner of Patents was in error in refusing to grant a design patent on a font of type known as "Cooper Black," the District Court for the District of Maryland has ruled, in ordering a decree entered requiring the issuance of the patent.

The plaintiff, in his action under section 4915 of the Revised Statutes, also sought to require the issuance of design patents on two other fonts known as "Cooper Old Style" and "Cooper Italic," but the court dismissed the action as to these, holding that it lacked jurisdiction under section 4915, as it read before the 1927 amendment, since an appeal had not been taken from the action of the Commissioner.

The question of jurisdiction was held to be governed by the statute as it stood before the amendment, since appeals were pending before the Commission when the amendment became effective. The court explained the jurisdiction under section 4915 both before and after the amendment in 1927.

A design for a font of type was held by the court to be a proper subject for a design patent. The claim for the "Cooper Black" font was not anticipated by the prior art, it was also ruled.

The court in dealing with the requisites for a design patent held that the tests of invention for such patents are the same as for mechanical patents, and there must be originality and exercise of the inventive faculty; in the former novelty and utility, in the latter novelty and beauty. In designs, it was stated, invention is measured by the appearance as an entirety when judged by the taste and fancy of an average person. The design must disclose at least a rudimentary esthetic appeal, it was pointed out.

distant points, without causing any undesirable pinching of the leg, and holding the shirt against rising. Patent 1753125. Max Lederman.

Toe-Dancing Shoe—A ballet slipper of the usual sandal type which will not pucker at the sides and is so constructed as to obviate the use of ribbon fastenings, but to draw the upper in hugging engagement with the foot. Patent 1754054. James Selva.

Heel Pad—For use between the heel of the foot and the inside of the shoe, an inexpensive elastic cushion pad for supporting the body and relieving the jars incident to walking on hard floors. Patent 1756107. Tomizo Tanigawa.

Chemical Processes

Granulated Product and Process for Making Same—A process for granulating dust resulting from the metallurgical reduction of arsenic bearing ores and material which comprises mixing said dust with sulphuric acid and water, agitating and at the same time drying the mixture. Patent 1755985. Harry C. Gardiner.

Process for Treating Animal Hair and Wool with Chlorine—A process for carroting comprising applying to the hair or wool an aqueous solution of hydrogen chloride and a chlorate and oxalic acid and causing the substances to react with each other in contact with the hair and wool. Patent 1756723. Erich Bohm.

Designs

Design for Lace—The inventor has been granted seven patents on ornamental designs for lace. Patents 80820, 21, 22, 23, 24, 25 and 80826. Ben A. Ball.

Design for a Dress—The inventor has been granted two patents, 80845 and 80846. Dorothy Long.

Design for a Combination Airplane and Thermometer—Patent 80873. Frank Alessi.

Design for a Carton or Similar Container—Patent 80909. Frederick W. Peterson.

Design for a Coat—The inventor has been granted two patents for ornamental designs. Patents 80899 and 80900. Dorothy Long.

Design for a Mirror or Similar Article Patent 80956. Edwin B. Langsdorf.

Design for a Dress—The inventor has been granted two patents, 80957 and 80959. Dorothy Long.

Design for an Ensemble Suit—Patent 80958. Dorothy Long.

Design for a Coat—Patent 80960. Dorothy Long.

Design for a Bracelet or Similar Article—Patent 81019. William Reichert.

Electrical Devices

Electrical Plug and Socket—Whereby the plug when its lead or contact arms are inserted in the socket will have an engagement with the socket in a manner to prevent accidental withdrawal of the plug. Patent 1753064. William Nonnenman.

Electric Measuring Instrument—A modified form of volt meter, for use with secondary batteries, primarily for giving indications to the driver of a motor vehicle the amount of energy in the battery at any particular time, or when recharging will be necessary. Patent 1753043. Howard Butler.

Trolley-Wire Splice Joint—A two piece interlocking splice for resisting longitudinal separation, is particularly useful in splicing broken wires, providing a proper electrical contact and mechanical strength, and a smooth path for the trolley wheel in passing thereover. Patent 1754991. Samuel J. Evans.

Vegetable Oil Trademark

IN the case of The Southern Cotton Oil Company versus Globe Grain and Milling Company, First Assistant Commissioner Kinnan held that Globe Grain and Milling Company of Los Angeles, California, is not entitled to register the term "Westola," as a trademark for shortening for frying and baking foods, in view of the prior adoption and long use by The Southern Cotton Oil Company of the term "Wesson" as a trademark for a vegetable-oil product used as a shortening in the same processes.

The ground of the decision is that the goods are of the same descriptive properties and the marks confusingly similar as applied thereto.

In his decision, after noting that the testimony showed long and extensive use by the opposer and therefore, doubt, if any, must be resolved against the later comer, and noting applicant's argument that since its product is normally about the consistency of lard and sold in large quantities, whereas the goods of the opposer are usually sold in liquid form and in small containers, there would be no likelihood of confusion, the First Assistant Commissioner said:

"There is some attempt on the part of the applicant to show that the opposer's goods are not used for the same purpose as are the goods of the applicant but the evidence seems fairly satisfactory that the uses of the goods of both parties very largely overlap. Even if the applicant generally sells its goods in bulk to bakers, there is nothing to restrict its activities to this class of customers, or to prevent a considerable expansion of its business in connection with small quantities of its product put up in small containers sold to a different class of customers."

"Both marks employ the initial syllable 'Wes' while the remaining portions of the marks are quite dissimilar. It may be conceded that the first syllable of the applicant's mark is 'West' but when the entire mark is pronounced it is quite likely that the second syllable would be regarded by the public as made up of the letters 'to.' The first portion of a fanciful mark is more likely to be retained in the memory of a casual purchaser or observer than the other part of the mark. It would seem there is at least some probability that purchasers would confuse the two marks since they seldom have both marks before them at the same time for comparison but decide from memory and without much reflection."

With respect to the argument that although applicant's mark had been in use since 1920, no confusion had been shown, the First Assistant Commissioner, after noting that the testimony showed that applicant's sales had largely been on the Pacific Coast and in Honolulu, that it had never advertised its goods and that applicant, prior to the adoption of its mark, was familiar with opposer's goods and trademark, said:

"In view of these facts there is no showing upon which to base a holding that the goods of the applicant have appeared to any considerable extent in the same market and in competition with the goods of the opposer. No inference can, in consequence, be drawn that had the goods been in the same market with those of the opposer for nine or ten years no confusion would have arisen and, therefore, none would be likely to arise in the future

Electric Service Tray—Whereon different electrically operated units, such as a toaster, boiler, perculator, etc., can be removably disposed on the tray and electrically connected with a source of current; the tray is composed of two parts, the upper part being washable. Patent 1755247. John S. Fielding.

Of Interest to Farmers

Harrow—Adapted for removing roots of plants from the soil by means of a plurality of ground engaging teeth carried along a horizontal path by chains operated by the usual traction wheels, stationary at will, or with movement retarded. Patent 1754103. John M. Hjermstad.

Agricultural Device—A mechanism which may be used for various operations, such as seeding, discing, plowing, harrowing or cultivating, dispensing with labor ordinarily necessary, working the field backwardly and forwardly without supervision, other than starting and stopping, the operations being automatic. Patent 1755247. John S. Fielding.

Feed Grinder—Having a plurality of concentric rows of teeth projecting from oppositely disposed plates, movable in an inter-fitted relation so that the feed passing between the teeth will be thoroughly ground and ejected at the plate periphery. Patent 1755037. Tom Tamen.

Of General Interest

Ship's Pilot Ladder—A foldable portable ladder, the steps having roughened surfaces, and being of durable construction, consisting of but few parts which are interchangeable and readily assembled without requiring the employment of skilled labor. Patent 1753060. Andrew Myerstuen.

Disappearing Lawn Sprinkler—A casing, with water actuated means for raising the nozzle into operative position above the ground and automatic means for lowering the nozzle and closing the upper end of the casing to prevent manipulation by unauthorized persons. Patent 1751723. Charles A. Borgeson.

Adjustable Top for Type Cabinets—As used by compositors, consisting of a separate top above the type draws, and means for vertically raising and securing the top, at any desired elevation in accordance with the height of the user. Patent 1753048. Merritt W. Haynes.

Refrigeration Coil—With the tubes so arranged and spaced as to prevent icing of the coils to such an extent that the plant must be shut down long enough to defrost the coils. Patent 1753042. Charles M. Brenner.

Movable Camera Support—Comprising a frame or platform, constructed to encircle a column, mechanism for raising or lowering the platform, a camera mounted thereon and adapted to move in spiral convolutions for taking pictures of the column surface. Patent 1751774. William L. Trullinger.

Phonograph Construction—Provided with novel means for reproducing a plurality of tones in unison but from separate sound reproducing units. As for example a separate sound reproducing unit for each member of a quartet. Patent 1752357. Hugo Wiener.

Crochet Needle—Having the usual hook at one end, but a needle point at the other, instead of being blunt, thus permitting other forms of work, a zig zag portion between the ends preventing slipping or turning over in use. Patent 1751796. Charlotte I. Denner.

Powder Puff—The back of which is formed of a plurality of members suitably joined, with a handle extending from the center and secured by novel means, the face-contacting surface having no out-stitching, thereby avoiding any roughness. Patent 1754090. Leonard Friedberg.

Match Package—Wherein a single or double arrangement of matches may be carried and the matches properly protected, while permitting the ready removal at any time and the ignition of the match as it is removed. Patent 1754036. Roman A. Novinsky and Edward O. Barton.

Compass—A marine compass, including a bowl, two liquids of different specific gravity, and a compass card having turning movement, and located approximately at the line of junction of the liquids, said card being supported solely by the liquid of heavier specific gravity. Patent 1754055. Frank G. Senter.

Egg Rack—Or shelf provided with a plurality of openings for supporting eggs in spaced relation and constructed to occupy a minimum of space, may be in "dead space" yet clearly exposed to view the articles carried. Patent 1754020. Albert J. Hyde.

Window Construction—Wherein means are provided by which each sash may be completely reversed into the room, for cleaning or reglazing, without removing outside screen or the like, adapted for use with standard window sashes and frames. Patent 1754316. Fred Hamilton.

Camera Attachment for Making Artificial Reflections—By means of an angularly disposed reflecting surface in a hood, attached to the end of the lens barrel, on which the object to be photographed is reflected, giving the impression of the mirror effect of still water. Patent 1755036. Jacob H. Sussman.

Umbrella Guard—In the form of a permutation locking device, connecting the staff and canopy of an umbrella, and locking the same, whereby the opening of the umbrella by all others than the rightful owner will be prevented. Patent 1755039. Harold M. Vandenhove.

Tile-Roof Closure—An interlocking metal plate which is easily applied to the lower end of a slanting roof, to fill the usual openings of standard tiles, and thus prevent the inconvenience caused by birds roosting under the corrugations. Patent 1752593. John Giordano.

Sewing Wire for Flat Rope—A composite sewing strand or lacing for metal rope composed of hard and soft wires, the soft wires being positioned outside the hard wires, to protect them from cutting contact with the strands of the rope when in use. Patent 1755018. Richard Nitsch.

Basement Circulator—A hose nozzle which may be lowered into and suspended in the hold of a ship, or basement, for fighting a fire, the water being thrown from the nozzle in an apron-like spray, substantially at right angles. Patent 1753686. Charles A. Borgeson.

Safety Apparatus for Oil-Storage Tanks—A fire extinguishing apparatus for preventing the oil from being ignited by lightning, by drawing off and condensing the vapors which arise in the air space above the oil, also providing an emergency steam pipe as a last resort. Patent 1753401. Henry J. Bucking.

Milk-Container Holder—For tapering paper milk bottles, the construction being such that when the handles are grasped part of the holder will grip the container and hold the same against movement while being tilted or carried. Patent 1755335. Max Roman.

Merchandise Package and Display Rack Therefor—In which a number of packages may be associated with the rack in such a manner as to require the tearing of the package to effect its release, whereby to thwart pilfering, particularly adapted for displaying handkerchiefs. Patent 1755927. Louis N. Levinsohn.

Window-Cleaning Device—A thin flat pad of absorbent material adapted to contain a washing fluid, together with a handle member detachably connected, which obviates the necessity of leaning out when cleaning the outer surfaces of the window panes. Patent 1755881. John J. Kilbride.

Demonstration Device—An educational apparatus for symbolically representing certain allegorical passages of the Bible descriptive of some of the views and visions of certain of the prophets, the primary purpose being for use in Sunday schools and similar assemblies. Patent 1755952. Charlie Gant.

Citrus Fruit Juice Extractor—Which is manually operated, extremely simple in construction and in which the parts are so assembled that they may be removed for cleaning and oiling, the device is compact and durable. Patent 1754591. Guy B. Baker.

Humidistat—Adapted to supply water to any evaporating medium to maintain proper humidity in the air in a room or house, the device is provided with novel means for automatically regulating and indicating the humidity. Patent 1755276. Roy B. Somers.

Glove - Drying Rack — Whereon rubber gloves used in hospitals, or other places, may be quickly and thoroughly dried inside and outside after each washing, all the fingers being held open with the closed ends extending upwardly. Patent 1755902. Salvatore Tascarella.

Scale and Attachment for Reducing and Enlarging Cameras—Wherein means are provided whereby the scale and associated parts may be adjusted to take care of any slight variation in the focal length of the lens used, without being made especially therefor. Patent 1755177. Arthur Fruwirth.

Animal Trap—More particularly a trap for catching rats, which operates automatically by the weight of the animal as it enters, killing and removing the prey, and re-setting itself, ready for the next victim. Patent 1755947. Walter G. Baker.

Nonspillable Container—An automatic closure for a glass or container for liquid, which will permit the contents to be poured therein, or withdrawn therefrom, while preventing spilling if accidentally tilted, or during transportation, thus preventing soiling of clothes, etc. Patent 1756249. Solomon Kaufman.

Key Case—Of the type having individual key holders connected with a carrier plate, the latter being attached to a flexible and foldable cover adapted to enclose the keys and render each key conveniently accessible when the cover is opened. Patent 1756627. Joseph Brewer.

Handle-Adjusting Means—For connecting a handle with a brush head by means of a threaded hole, and permitting the handle to be readily swung laterally at various angles, spring pressure securing the handle assemblage to the base. Patent 1756801. Charles S. Trippeda and Anthony J. Dichiaro.

Hardware and Tools

Regulator for Windows and Doors—A rotatably mounted shaft, particularly adapted for use with outwardly opening casement windows having inside screens, whereby the window may be readily opened or closed from within the room, without moving the screen. Patent 1751718. Eric Sodergren.

Rotary Core-Drill Attachment—Employing a greatly simplified gyroscopic element which will operate to determine the exact direction in which an inclined stratum of earth dips, so that the crest of an anticline may be determined by a series of drilling operations. Patent 1751678. Arthur L. Armentrout and Elwin B. Hall.

Blade Holder and Handle—For safety razor blades, formed from a single sheet of metal providing a pair of arms defining blade clamping jaws, so constructed that pressure effects a limited separation to allow the removal or insertion of the blades. Patent 1753459. James A. Gafney.

WIRE SPLICERS—Specially constructed for carrying out wire-splicing operations quickly and easily, and which is especially useful for splicing the ends of fence wires closely arranged with respect to each other. Patent 1754023. Sidney J. Jones.

DRAW-PUNCH—By means of which holes may be cut into sheet metal of any thickness, is especially adapted for electrical work for cutting holes in metal boxes, or for cutting in places where little room is available. Patent 1754568. John C. Nischan.

Heating and Lighting

INCINERATOR—Wherein articles may be dropped from above into the oven, while a blast of air acting as a damper, prevents gas or smoke from escaping through the opening by which articles are fed to the furnace. Patent 1755027. Aatto P. Saha.

Household Utilities

COMBINATION STOOL, LADDER AND KITCHEN BLOCK—Comprising a stool about the proper height for working at a kitchen sink, a stepladder higher than an ordinary kitchen chair, and the top forming a meat block adapted for conveniently chopping or cutting meat. Patent 1753372. Richard G. Gober.

CARD TABLE—Composed entirely of metal, having hollow legs constituting ash receptacles, the corners of the table having depressions and openings registering with the hollow leg tops, the depressions being convenient for the support of glasses. Patent 1756777. Frederic E. Wright.

Machines and Mechanical Devices

FLOTATION MACHINE—Whereby the pulp is thrown in the form of a film or attenuated condition into a gaseous medium for maximum aerating effect, producing flotation with a minimum of energy and a maximum of aeration. Patent 1752434. Albert L. Howard.

GUIDE DEVICE—Which may be readily installed in position on the pump rod of a windmill to maintain the same accurately in line and thereby reduce loss of power by eliminating undue friction and wear. Patent 1753126. Arthur L. Ligon.

SEWING-MACHINE THREADER—An attachment for sewing machines comprising a swingably mounted bar, having a semi-conically shaped end formed of a pair of spring-pressed members which provides a guide for the thread to the eye of the needle. Patent 1753114. Allan McC. Fluharty.

APPARATUS FOR THE REDUCTION OF IMPURITIES CONTAMINATING MOLTEN METAL—Comprising an open vessel formed of a metal shell and a refractory lining, in which the improvement of the metal, by the reduction of certain impurities, is brought about by forcing air upwardly through the molden charge. Patent 1753891. Llewellyn Jones.

DEVICE FOR EXPANDING AND MOUNTING PISTON RINGS—Whereby piston rings may be expanded, and positioned in expanded condition in juxtaposition to their piston groove, into which they may be forced by hand, breakage through over-strain being practically eliminated. Patent 1755044. Kenneth J. Bailey.

BAGLE-FORMING MACHINE—Which receives a batch of dough, forms the same into strips, cuts it into sections, and rolls the sections into rings, ready for cooking, the entire treatment being automatic, without the dough touching the operator's hands. Patent 1755921. Louis Gendler.

METHODS OF PITTING FRUIT—A machine particularly adapted for pitting dates, having in view the removal of the pit from the fruit without unduly mutilating the fruit, as well as insuring precision and reliability in operation. Patent 1755872. Anthony Gotelli.

GRINDING MACHINE—Characterized by a novel form of means whereby the grinding elements and the holder thereof may be readily adjusted to the proper size for grinding worn engine cylinders of varying bore diameters. Patent 1755862. Alvin R. Berck.

BELT REPLACER—Which may be readily handled by a single operator for replacing a belt on a pulley, and operated from an advantageous position without danger from the usual revolving shafts and pulleys, and without stopping the machinery. Patent 1755876. Frank L. and Wilson R. Homstead.

FRUIT PITTER—Which will sever the flesh from the stones of peaches, apricots, etc., the flesh being cut into two halves, and removed from the stone, which is held while the flesh is severed therefrom and then automatically released. Patent 1754636. Alvan B. McCollom.

APPARATUS FOR APPLYING A SOFT-METAL SURFACING TO HARD-METAL PLATES—By flowing said substance while in a fluid molten state onto the plate over a heating medium, while automatically smoothing off the coating substance to a uniform thickness prior to cooling off the medium. Patent 1756739. August Gunthard.

Medical and Surgical Devices

BIPROXIMAL TOOTH AND INTERLOCKING KEY —A substitute for the natural tooth, and device for attaching the substitute tooth or teeth to any of the recognized abutments, characterized by the fact that it can be used in fixed or removable bridgework and dentures. Patent 1753644. Fred E. Burden.

Musical Devices

METHOD OF AND APPARATUS FOR EMPLOYING TUNING FORKS TO GENERATE AUDIO FREQUENCY CURRENT AS A MEDIUM FOR SOUND—A musical instrument, a tuning fork, and an electromagnet positioned in space relation between the prongs, an electro-mechanical sound reproducer and means for amplifying the current in a suitable form of telephone or loud speaker. Patent 1753069. Max Schumm.

Prime Movers and Their Accessories

PISTON FOR INTERNAL-COMBUSTION ENGINES —Consisting of a metal having a great coefficient of expansion, and cross members of a metal having a small coefficient of expansion fitted at one end into the peripheral part of the piston thereby eliminating danger of gripping. Patent 1756884. Charles Schaeffer.

Pertaining to Recreation

BOXING GLOVE—Constructed with a novel form of grip which is disposed within the glove permitting an unobstructed palm portion, thereby obviating danger of injury such as would be occasioned by grips protruding beyond the palm surface of the glove. Patent 1752977. Frank Dieterle.

FISH LURE—Constructed of such material as to be always bright and shiny, having the proper balance and weight to be useful for trolling or casting, and when used in casting will not be unduly impeded by the resistance of wind. Patent 1755047. Chester A. Braidwood.

FISHING GEAR—In which one or more attractors, in combination with a sinker, are disposed slidably relative to a fish hook, so that the attractors will freely recede from the hook when the fish is hooked, thereby facilitating landing. Patent 1754567. Gwendolan Newell.

DOG-RACING APPARATUS—Wherein a mechanical rabbit is caused to travel around a track and maintain its position ahead of a pack of dogs, a novel form of trap being provided for the ultimate disappearance of the rabbit. Patent 1755676. William R. Twiford and George Oehler.

AMUSEMENT DEVICE—A combination merry-go-round and see-saw which may be conveniently used on play grounds or beaches, whereby a plurality of persons may oscillate or see-saw and at the same time revolve about a vertical axis. Patent 1756854. August de Freitas.

Pertaining to Vehicles

COLLAPSIBLE KIDDY CAR—In which the supporting legs and steering handle can be folded into substantially parallel position with respect to the seat, when collapsed will take up very little room, and may be shipped in a small container. Patent 1751765. Thomas G. Shannon.

HOOD LEDGE PLATE AND MULTIPLE-COMPARTMENT HOOD FOR AUTOMOBILES—Whereby a large percentage of the space not reserved for the machinery, may be formed with separate compartments for storage purposes, yet the hood may be reduced in weight and at the same time strengthened. Patent 1754086. Earl Feilcke.

APPARATUS FOR MEASURING AND INDICATING EFFICIENCIES—Having means whereby the operator of an automobile or aeroplane, may know the speed at which his machine has the highest efficiency, whereby he may become aware of the best adjustments, and the best fuel suited for the machine. Patent 1754039. Otto A. Pawlick and Raymond C. Giese.

RELEASING COUPLING—For use in connection with pulling vehicles, such as tractors, and drawn vehicles, such as plows, for releasing the plow should it encounter a rock or other obstruction, to avert injury or breaking of parts. Patent 1754048. Fred W. Reimold.

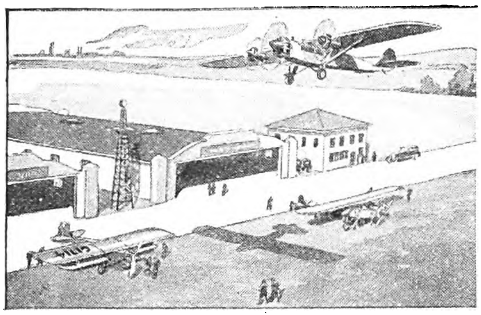
CLUTCH-PROTECTING DEVICE—An attachment designed to protect a clutch mechanism from undue wear and tear, incident to the habit of "riding the clutch pedal," which causes the clutch parts to wear unnaturally, the attachment is capable of being easily installed. Patent 1755002. Charles M. Hibbets.

SPRING BOOT—Comprising a sheet of flexible and liquid-proof material constituting a liner, adapted to embrace a spring, for the protection, retention of lubricants, and permanent preservation against deterioration by exposure to the elements. Patent 1753257. Alfred R. Ulp.

VEHICLE SPRING—Which permits greater vertical play, adds to the length of the working wheel base, transmits less vibration, prevents distortion of the frame, counteracts momentum in rounding corners, and can be adjusted to meet varying loads. Patent 1753420. Joseph N. Johnson.

AUTOMOBILE RADIATOR CAP—Having an outwardly-closing, inwardly-opening valve which permits the filling, or addition of water to the cooling system, without the necessity of removing the cap, thereby eliminating the danger of scalding or injury to the car finish. Patent 1755316. Francisco O. de Alcocer.

BERRY-PICKER'S VEHICLE—An argicultural machine whereon a number of persons may be drawn over a berry patch supported in a convenient leaning seated position, with their hands free to pick berries, and their backs relieved of strain. Patent 1756803. Jacob D. W. Williams.



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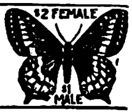

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Across the Editor's Desk

WE'RE quite aware that the call of the outdoors, of sports, and the like is stronger than the appeal of science right now, but this month we've given you some absorbing features you won't dare pass up and others that will add scientific interest to your vacation trips. Take, for example, Dr. Russell's article on the green flash. Maybe you've never heard of the green flash, but here's your chance to see it—if conditions where you are going are just right—or to see the mirages which he also discusses. They are never-to-be-forgotten sights. During the past year Dr. Russell has been traveling here and there in Europe and the Levant but expects to return to his duties at Princeton soon.

And those insects which you see walking on water while you're in the country—another article tells how they do it. The secret is in the surface film of the water. Now if this surface film were so tough that human beings could emulate the water skipper, how would you like your high diving then? Another article is an "appreciation" of the hoary old man of the meadows: the sycamore; still another warns you to "be careful with fire while in the woods" but it also tells of the extensive system of forest fire protection and fire fighting necessary in this careless country. Summer heat may make you wish that you could, when traveling, sleep in the refrigerated dining car described on page 108, but it just isn't being done. You may dine in such cars soon, however.

"Zoogenesis" doesn't sound like light summer reading but it concerns a subject that concerns all of us: the new theory of evolution. Whichever side you're on, you will want to know this theory. The article was written by Dr. Austin H. Clark, a note about whom you will find on page 87. When his theory was first announced months ago, it was sadly distorted by the newspapers but we went straight to the source and got Dr. Clark's own story.

Unlike the daily press, you know, we don't try to give last minute news just because it is new; we choose our features carefully and then get the man who has made the theory or performed the experiment to write it up for us, but only after it has simmered a bit. "Basic Patents in Evolution," for example, was written by invitation after a member of our staff heard Dr. Gregory give a talk on the subject before the Explorer's Club. By the time he could put into writing the substance of his talk, he was on his way to Africa, and the manuscript of his series was written on the deck of a steamer in the Red Sea.

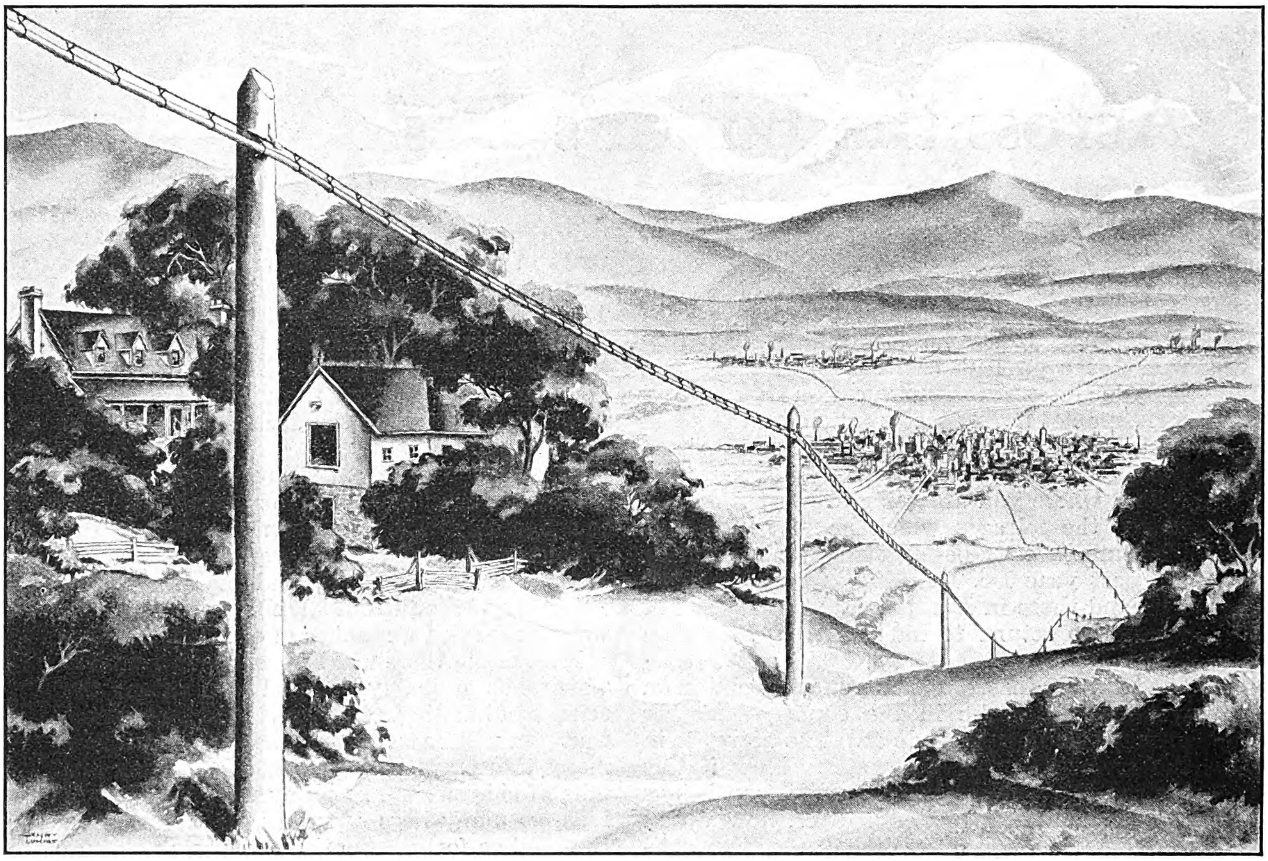
But enough of this. There are other good features in this issue—on the burying of a river in a gigantic sewer, on industrial fatigue by the well-known Dr. Laird, on perfumes, a home-made cheap microscope, and many others—but what of the future? Well, for next month we've scheduled a number of excellent articles.

First of all, there will be one about a subject which has probably puzzled you often: the science of building a railroad. And we warrant that you will be surprised when you learn how many thousands of dollars it takes to lay one mile of shiny rails—so many thousand feet of rails, so many kegs of spikes, so many cross-ties, and so forth. Another discusses volcanology. As you have surmised, the word simply means the study of volcanoes; and the article is as interesting as volcanoes are mysterious. Dr. Jaggar, who wrote it, has been the next door neighbor of so many volcanoes that he can, and does, let us in on many of their secrets. He now lives and works in a little house on the rim of the crater of Mount Kilauea, Hawaii.

You may expect an absorbing story of the Indianapolis race which was run on May 30. This will cover the scientific aspects and give some of the highlights of the spectacular performance. Water sports come in for their share of space also, for the building of the yachts to defend the America's cup is a highly specialized science. You'll be treated to a story of the races for which these yachts were built.

Of course we can't begin to go into detail regarding all that is to come. The foregoing articles are simply a few samples. There will be others in true Scientific American style; and that naturally means that your interest was considered when we scheduled them. We hope you'll enjoy them all.

Orson D. Munn



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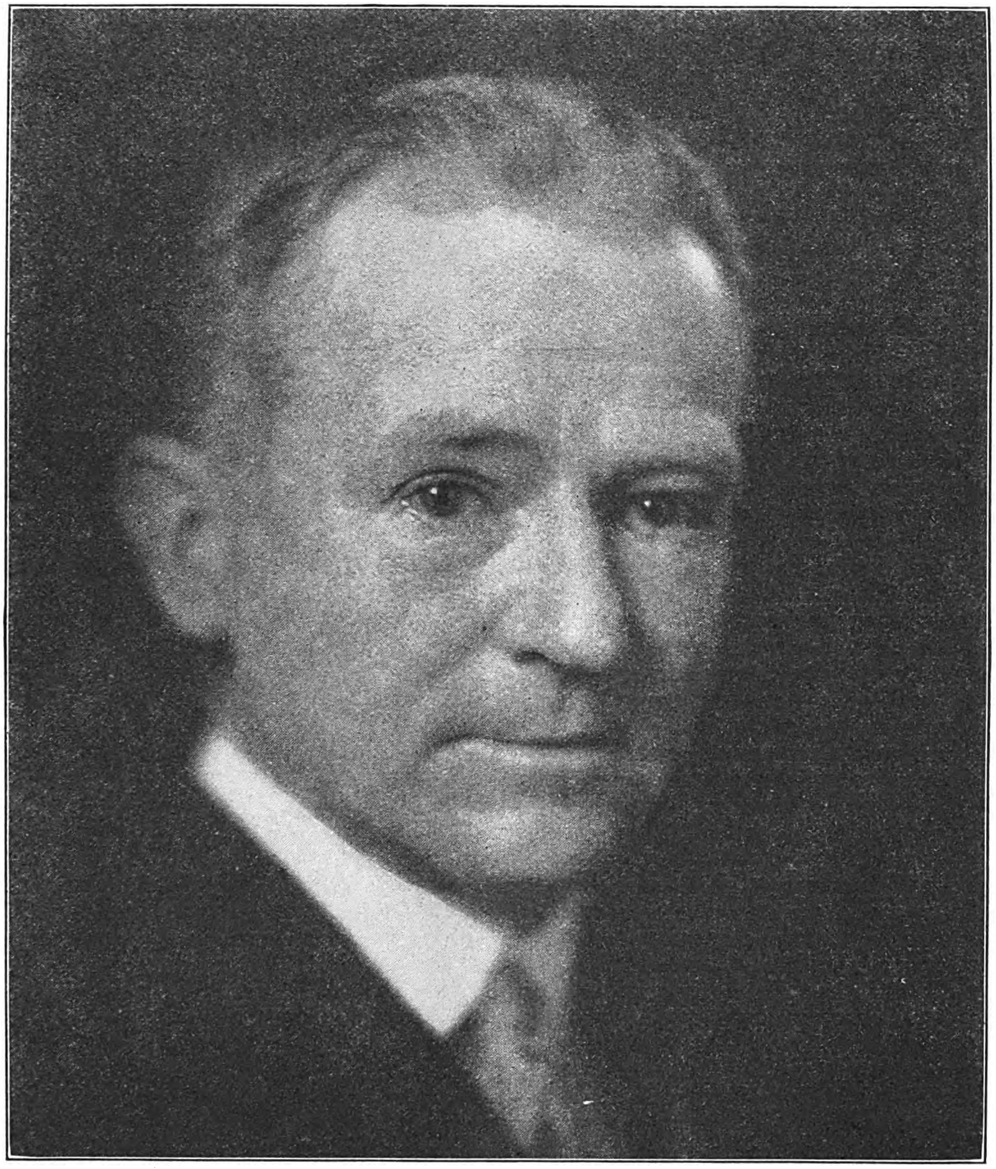


Austin H. Clark

ABOUT a year ago, as many will recall, newspaper accounts, some accurate and some not, concerning a new and rather extraordinary theory of evolution proposed by Dr. Austin H. Clark, widely known zoologist of the United States National Museum, attracted the attention of the scientific world. "Zoogenesis" is the general name Dr. Clark employs to cover his theory about which he has just published a semi-popular work "The New Evolution—Zoogenesis." He also has prepared for this journal the article on the same subject, which starts on page 104. Since the new theory of evolution was announced it has been discovered that Dr. Clark's career in science parallels that of Charles Darwin, the famous proponent of another theory of evolution which has made history. Like Darwin, Clark never was a "closet student"; for 30 years he has traveled widely and observed actual things in Nature. Both scientists spent many years studying at first hand a wider scope of material than the average zoologist finds accessible. Clark specialized in the study of birds and insects and then, to enlarge his point of view still more, he spent some years specializing in oceanography—as did Darwin. Both also made long cruises on specially equipped sea vessels, Darwin on the *Beagle*, Clark on the *Albatross*. Only after so catholic a study of the interrelationships of the different forms of animal life can a man of science feel equipped to synthesize a broad theory such as Clark's theory of evolution—Zoogenesis.

The fighting front line. Bringing up a hose from a water tank

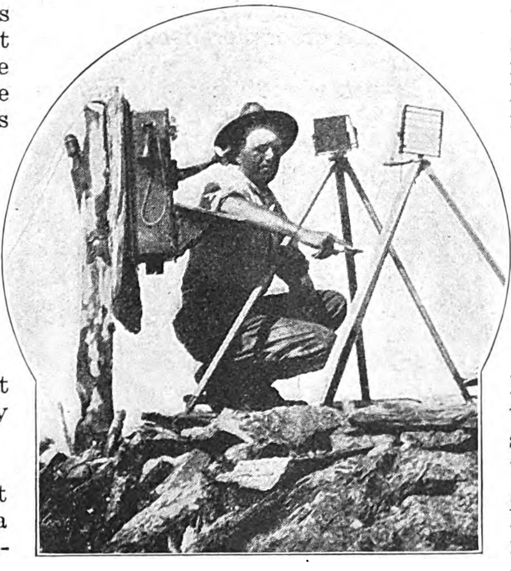
Fire: the Enemy of Our Forests

By CHARLES W. GEIGER and WALLACE HUTCHINSON

PERCHED on the top of a rugged mountain peak stands a small square house with steep sloping roof to shed the heavy winter snows, and with long windows on all four sides. From this elevated lookout point during the fire season, sharp-eyed sentinels scan the vast expanse of green forests stretched on all sides below them, searching, always searching for the telltale wisp of smoke that marks the newly started forest fire.

This scene, common enough in the great forested areas of the west is somewhat rare in the east, but the disastrous fires of the past spring have brought home to many people the fact that the east needs many more lookouts. In the west a forest fire as a rule rages through woods without endangering very many habitations; in the east many farms and villages have been wiped out by fires that began in the forests. In either case, the monetary loss often runs into millions of dollars and yet it is a strange trait of human nature that very little thought is given to forest-fire prevention, and it has always been difficult to obtain appropriations necessary for such work.

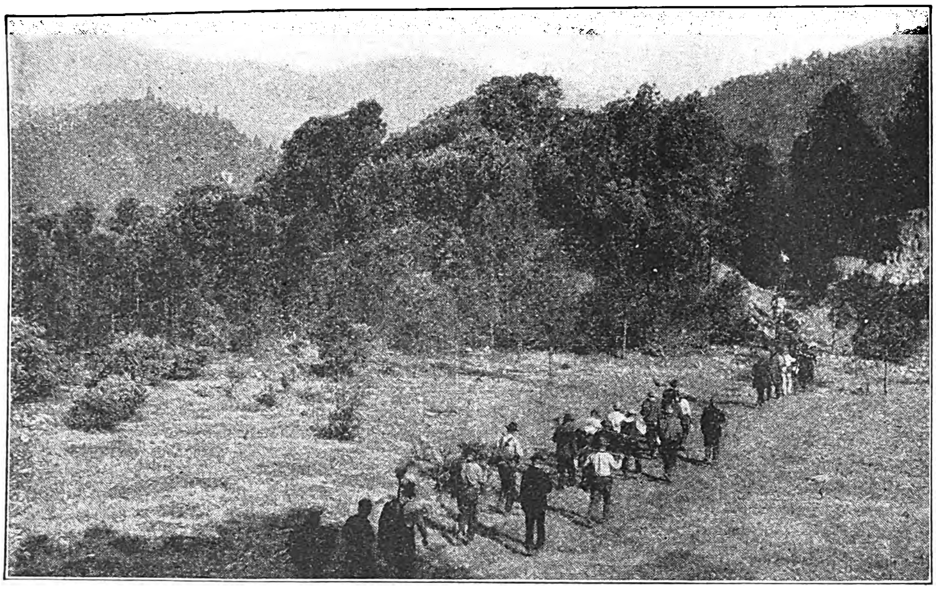
OUR forests are one of our greatest natural resources. They furnish a playground for thousands of vacationists and nature lovers and are the storehouse of waters that feed our lakes and rivers which make year 'round hydro-electric power possible. They furnish lumber, pulp for our paper, and many other necessities of life. The people of the United States use in house-building and otherwise, two fifths of all the wood consumed in the world. To perpetuate the source of supply, federal and state governments are practicing reforestation and have expended every effort to save our forests from the fire menace. In carrying out this huge task the most modern equipment is used whenever possible.



The guard may report a fire by either telephone or heliograph

In cities and towns fires are usually discovered shortly after breaking out. In the mountains, however, extensive areas of our forests are so thinly populated and afford such obstructed views because of mountain ranges and deep canyons, that fires might become very large before they were discovered if some special means of detection were not employed.

IN California and many other states, a careful watch is maintained over forested areas by United States Forest Service men stationed on high peaks, who act as fire lookouts, and by fire guards or patrolmen who travel along ridges and other routes where they have a good view of areas in which fires are likely to occur. The lookout men go to their stations in the high mountains early in the summer and remain constantly on duty, from daylight to dark, until the first rains come in the fall. Food supplies and mail are sent to them by the rangers. These lookout men occupy small buildings or observatories with windows on all sides. Many of these houses are set on steel towers 30 to 60 feet above the ground, so that the lookout man can see over the surrounding trees or other obstructions. In addition to the fire lookouts, everyone within or near the forests (miners, stockmen, hunters, campers, motorists) is constantly on the watch for any fires that may occur.

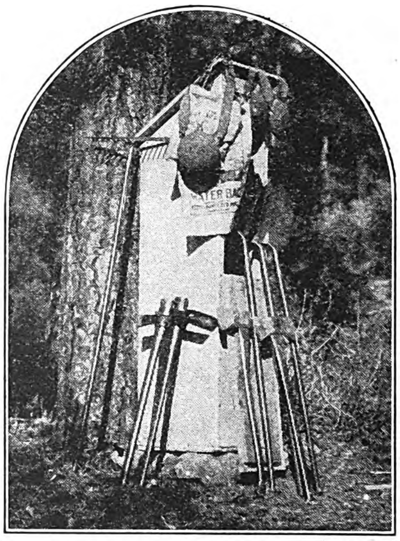


Fire fighters on their way to a fire, carrying their tools

Throughout the Pacific coast states, in addition to lookouts, airplanes are used to discover fires. A man in an airplane flying at 5000 to 10,000 feet above the ground can look down upon a wide expanse of country and quickly detect the smoke of a small fire which may be hidden by mountains or forests from the lookout men. The airplane, however, does not fly daily over the forest. It is used largely as a scout for making air surveys of large fires that are burning, in order that the forest officers may know how best to fight them, and for forest patrol after lightning storms and during hazy or smoky weather. Under such conditions the airplane is a valuable aid in forest protection.

At the side of the lookout in the tower mentioned in the first paragraph, stands a telephone, one of the nerve ends of the efficient system of telephone communication lines that play such an important part in combating the fire menace in our great national and state forests. There are other instruments of the magneto type located at intervals along the forest trails and roads. These latter telephones enable the forest guards to keep in touch with the central ranger station at all times.

If the guard discovers a fire, he goes to the nearest telephone, calls the ranger station, and reports the location and the extent of the fire. Men with fire fighting equipment are immediately dispatched to the scene of action and if the fire is likely to assume large proportions, one or more fire camps may be established. Temporary telephone lines are quickly stretched between these camps and the central station so that the men engaged in fighting the fire may keep in constant touch with the supply base to report progress and order more men, food, or equipment.



Fire fighting tools stored on the trail ready for future use

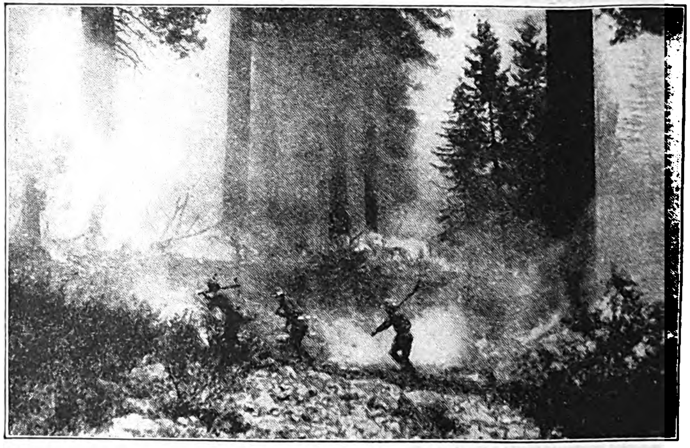
In districts where it would be impracticable to maintain a permanent fire fighting force, volunteer fire fighting units have been established under the direction of a fire leader. This man designates an individual to act as local "dispatcher" whose duty it is to take care of the lines of communication during a fire.

Since forest fire prevention is so largely dependent upon telephone communication, forest rangers must be efficient linemen. A course in telephone construction and maintenance is given each ranger during the training period and he is furnished with a manual giving specifications and details of telephone line construction. This construction is unique because it would be difficult to construct a pole line in thick timber, high underbrush, and rocky ground. Therefore, lines are strung along on trees, usually following trails or paths. In brush country where fire damage to wooden poles would be heavy, iron tubing is used.

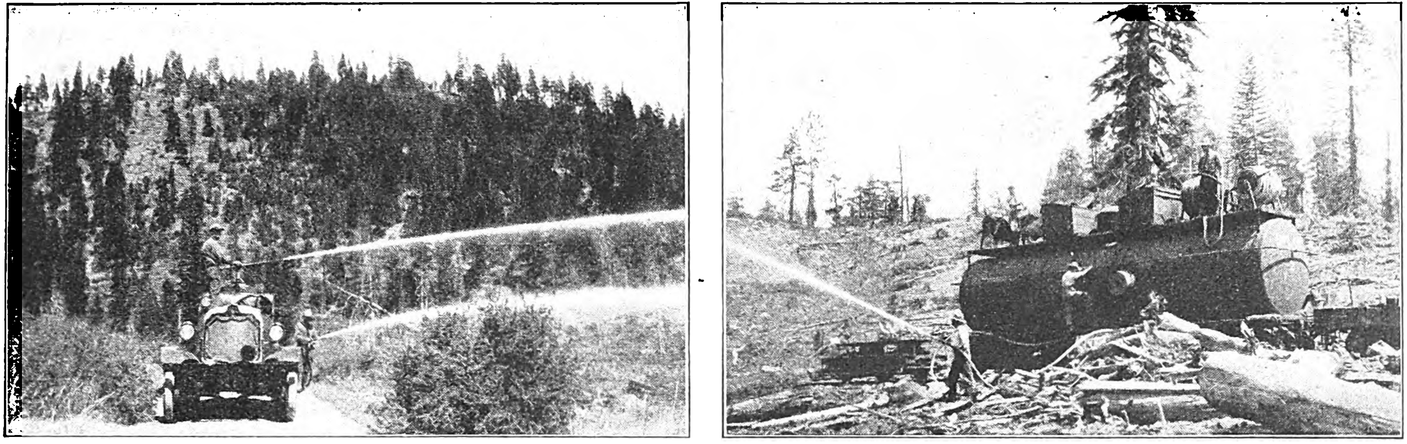
Before the beginning of the fire season a careful check is made on the communication system and the damage done by weather during the winter months is repaired. Thereafter, all lines are tested daily. Most of the forests are situated in high altitudes and the forces of nature combine to make this job of maintaining perfect communication more difficult. It is said that over 1500 telephones directly constitute the service of communication between the extensive system of forest protection in California alone.

In a few localities where there are no telephone lines, the heliograph is used. This instrument sends messages

A camp in the path of the flames



Advancing to meet the roaring enemy



A water tank on a motor truck and a railroad tank car

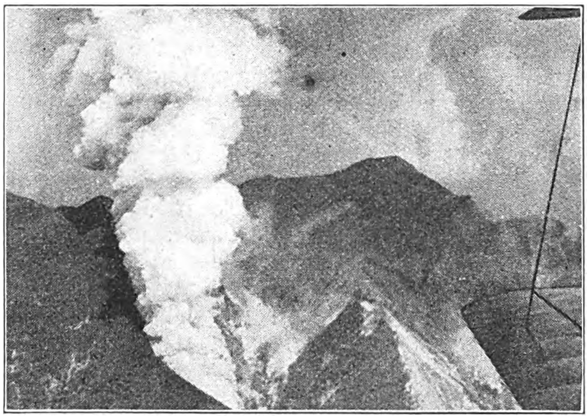
in telegraphic code by means of a small mirror which reflects the sun's rays. This method is therefore valueless in cloudy weather, or when the sun is obscured by the haze and smoke from a fire.

Inasmuch as weather conditions have much to do with the prevalence of forest fires, an intensive fire-weather service has been in operation in California since July, 1926. The principal object of this service is to aid all fire prevention and suppression agencies in their efforts to reduce losses from forest, grass, grain, and brush fires. This fire-weather service works in close co-operation with fire-agencies, federal, state and private.

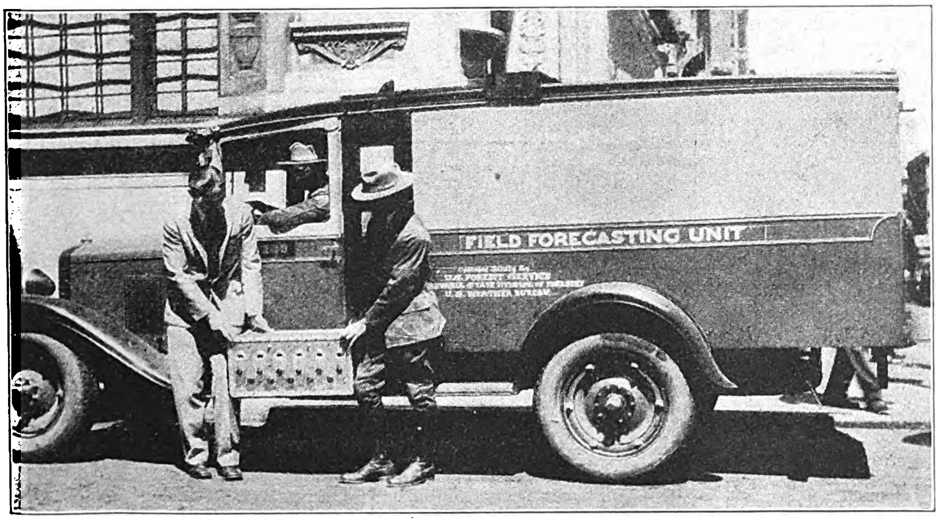
THE term "fire-weather" aptly describes those combinations of weather conditions which cause fires or which favor their rapid spread when once started. Lightning, for example, causes as high as 45 percent of all the outdoor fires in California, depending upon the season. Severe lightning concentrations in the state have caused more than 350 lightning fires in national forests during a single thunderstorm period of two and a half days.

Hot, dry, windy weather constitutes the fire-spreading phase of fire-weather. Thus a knowledge of atmospheric relative humidity, and of wind direction and velocity, have a very important bearing upon both fire prevention and fire fighting work.

The service rendered by the Weather Bureau is primarily a forecast service. Systematic fire-weather forecasts are issued by the district forecaster of the Weather Bureau at San Francisco based on the usual synoptic weather reports and charts, supplemented by daily telegraphic reports from especially established fire-weather observing stations in various areas in the state.



Airplane view of a fire in a distant canyon



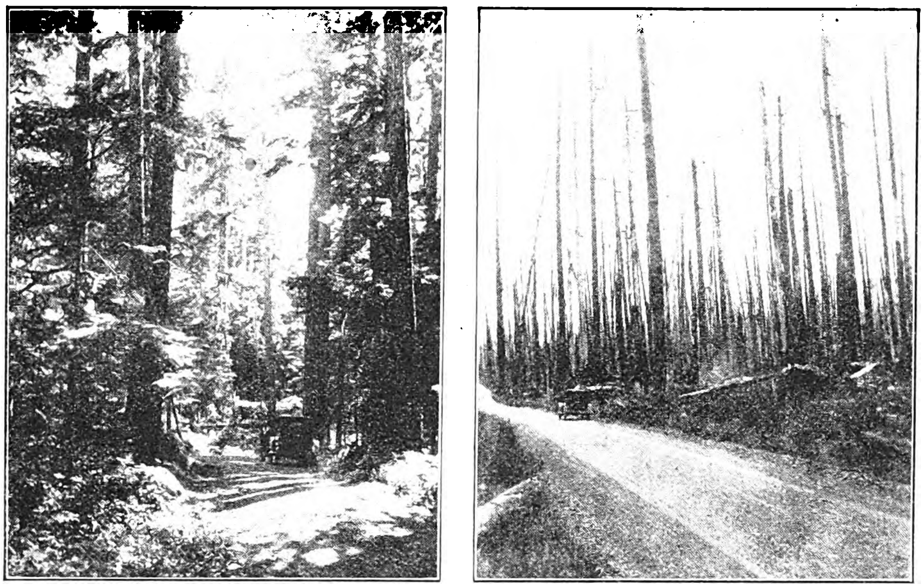
The fire-weather forecasting unit which travels throughout the state of California during the fire season and gives information to aid in fighting fires

Since fires and their complex topographical surroundings cannot be taken to the district forecast center for analysis, a mobile weather bureau office has been provided to take equipment and a meteorologist to the fires. This unit consists of a motor truck equipped with meteorological instruments including anemometers, hygrothermographs, psychrometers, maximum and minimum thermometers, rain gage, and a small aneroid barometer as well as radio receiving instruments to catch the detailed weather reports which are broadcast twice daily from the naval radio station at Mare Island. The truck has accommodations for two men who will operate it, one a meteorologist in charge and the other a combination observer and radio operator.

Traveling throughout the state during the fire season, the unit proceeds immediately to a large going fire upon receipt of telegraphic orders. Radio apparatus is set up and temporary check or key weather stations are established in the fire vicinity. These stations issue detailed forecasts of all weather conditions influencing the choice of fire tactics and the ultimate control of the fire. Such forecasts are issued twice daily together with any special advice that may be required in connection with back-firing and similar operations.

PREPARATIONS for the fire season are quite elaborate. Before the season opens, an ample supply of fire fighting equipment is distributed to points where it will most likely be needed. This equipment consists of axes, shovels, rakes, hoes, canteens, cooking utensils, and emergency food rations.

During the summer months the rangers are assisted by guards, patrolmen, and firemen, but they also make arrangements with nearby merchants,



The contrast of beauty and stark ugliness of a skeleton forest made by fire: two views of the same location. Perhaps carelessness was the cause

ranchers, and others for supplies of laborers, transportation, and food in case of emergency.

When a fire is reported, the forest ranger or one of his assistants may go to it alone if it is very small. For a larger fire, three or four men with rations for two days may be sent. If the report indicates that the fire is likely to become a big one, a large number of men, with the necessary tools, are gathered and sent to the fire. Food, supplies, and further equipment follow by slower transportation because the rangers continue fighting the fire until it is completely out and do not waste time in going back and forth for food, bedding, and tools.

Small fires in grass and forest litter can often be beaten out with branches or wet sacks, but if burning fiercely it is usually necessary to clear a wide fire line which the flames cannot cross, some distance in advance of the fire. Sometimes back-firing is necessary to control big fires. In back-firing, a fire is built in advance of the main fire, usually along a road, trail, or other suitable place where it can be properly controlled; and it is allowed to burn back toward the main fire. When these two fires meet they die out for lack of further inflammable material. Since back-firing itself is dangerous if not properly handled, only experienced fire fighters should employ it.

In all fire fighting, advantage must be taken of natural conditions. A fire may burn very rapidly up steep canyon sides, but may be stopped easily at the top of the ridge. Fires usually die down during the night and the best time for fighting them is immediately after daybreak when relative humidity is high.

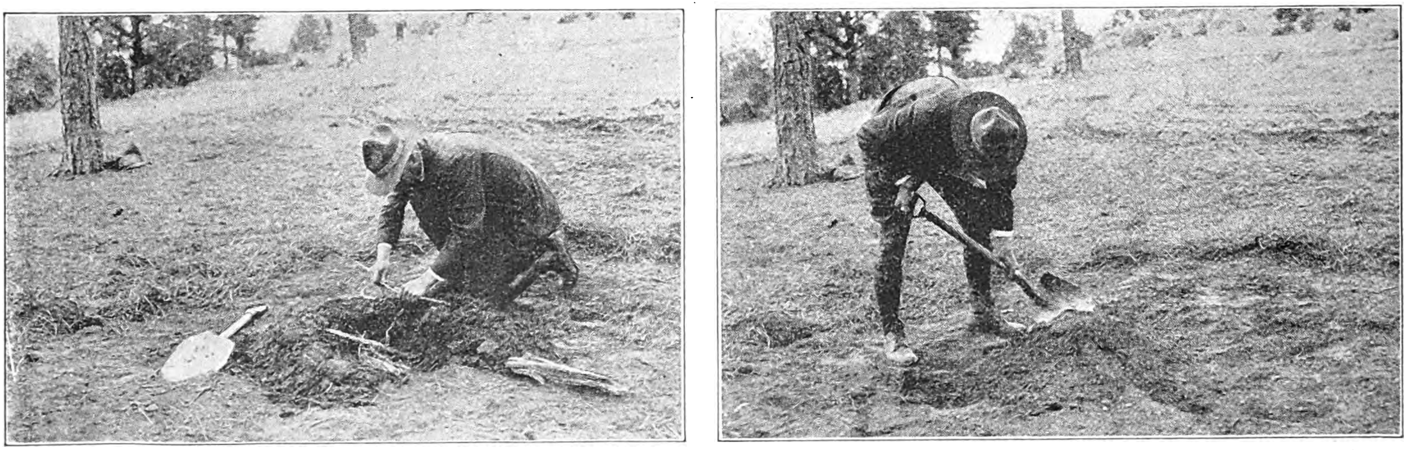
In many cases the fire-fighting equipment is supplemented by water tank pumping trucks if highways run through timber lands susceptible to fires. In many cases also, railroads have built special tank cars with necessary pumping equipment for fighting forest fires along their rights of way.

Although a large percentage of forest fires are started by lightning, a greater number are caused by the careless use of fire by tourists, campers, hunters, and fishermen. Many people know, either from actual experience or hearsay, the havoc that fires play in our orests each year; they know the necessity for precaution in using fire for any purpose in forests, but strangely, as has been noted, carelessness still seems to be the predominant characteristic of many people when they are in the woods.

Nothing betrays the tenderfoot sooner than his fire. The woodsman, before he builds a fire, clears a space of all grass, leaves, and trash, digs a small hole, and in it builds a small, quick fire. When the fire burns down he sits beside it and does his cooking. The tenderfoot, on the other hand, makes a bonfire and cooks himself while he burns his food. A woodsman never builds a fire near leafy trees, dead logs, or underbrush; nor does he build bonfires in windy weather where there is the slightest danger of the fire becoming uncontrollable.

HE never leaves camp even for a short time without first putting his fire out with plenty of water and then covering it with earth. He is always a careful smoker. He breaks his match in two pieces to make sure that it is out before he throws it away and stamps with his foot every spark in discarded pipe heels, and cigar and cigarette stubs. Many voluntarily refrain from smoking in the woods during the dry season.

Someone once said that if we could educate every American to be careful with fire, 95 percent of our national forestry problem would be solved. In closing, therefore, we shall repeat a few rules which, if followed, will aid greatly in the solution of the forest fire problem: 1, Build camp fires like those of the woodsman; 2, Be sure the camp fire is entirely out before you leave it. Be sure that matches, cigars, cigarettes, and pipe heels are out before being discarded; 3, If you discover a small fire, put it out. If it is too large for you to handle, go to the nearest telephone and notify the ranger, local dispatcher, or whomever else may be directly concerned in your particular locality and then stand by until help comes.



The woodsman is never careless with fire. He builds his campfire in a hole in the ground in the middle of a cleared space; and when he leaves, he first drenches it thoroughly with water and then covers the ashes with plenty of soil

OUR POINT OF VIEW

The Improved Patent Situation

INVENTORS who have for years been led to believe that it must take an unconscionably long time to obtain a patent, have in store for them a pleasant surprise. A keen note of optimism is now heard wherever one goes regarding the situation in the Patent Office, for things have happened there.

Admittedly, the Patent Office has had a steadily increasing file of unfinished business, patent applications that must await their turn. At the present time, it is farther behind in its work than ever, but this is partly because of the curious fact that more free-lance inventors seek patents during periods of unemployment than at any other time. But even in normal times, the majority of delays in the granting of patents are due to the fact that inventors or their attorneys exercise their statutory right to delay, for various reasons of their own, their answers to official actions of the Patent Office. The Commissioner has been diligent in his supervision and is not to be blamed when he has such conditions to face and especially when his office has been functioning under the handicaps of inadequate facilities, an inadequate examining force, and inadequate salaries for the examiners. The salary question alone has worked a great hardship on the Patent Office for years, for the examiners were never paid as much as they could command in outside practice. As a result of this, there has been a large turn-over in personnel, and new men were constantly being taken on and put through a training period that was largely unproductive.

The situation has changed. Some time ago, Congress authorized salary increases all along the line and also gave authorization to augment the force of examiners. The salary increases went into effect January 1, and the extra examiners, totaling 110 men, were on the job July 1. The examining corps now totals 708 and the total professional force 722. Members of the patent bar worked with the Patent Office for years to bring about these changes, and when final consideration was being given them, they had the unqualified support of the President, Congress, and the Budget.

An Assistant Examiner now starts at 2000 dollars yearly, a very good salary, we should say, for a man just out of college and especially in Washington where this amount is equal to 3000 dollars in most other large cities. This new man can go to 3700 dollars before he takes the next step upward to become Assistant Chief Examiner, with a fine salary increase. Then comes the Principal Examiner, head of a standard examining division of which there are 63, who now gets a larger salary than did Mr. Robertson when he became Commissioner. Still higher in the salary scale are the Assistant Commissioners and the Members of the Board of Appeals, one more of the former and three more of the latter having been included in the recent authorization to enlarge the force.

The larger force is going to improve the patent situation greatly, and the salary increase has already shown its effect in improving the *esprit de corps* of the Office to such an extent that it is felt that there will be an increasingly smaller turn-over in personnel. Besides this, further hope for the betterment of the situation is seen in the fact that within the year, the Patent Office will have moved to its larger, more modern quarters in the Department of Commerce Building, now under construction.

Sir Henry Segrave

SPEED mania has again taken its toll. This time it was Sir Henry Segrave who, piloting *Miss England II* on Lake Windermere in England, had just made a record run at over 98 miles an hour and was on a second trial run when his powerful boat swerved, somersaulted, and capsized. Sir Henry was to have entered the boat in the Harmsworth Cup races in the Detroit River August 29 to September 2.

While we still do not feel that the end justifies the means in these attempts at world speed records, we do not wish to detract from Sir Henry's reputation as a man of high and dauntless courage. Those who knew him, the entire sporting world, the automotive industry for which he performed invaluable service, and many others in high places who knew him as a gentleman as well as a sportsman of the highest type, have all been shocked and saddened by his death. His was the breed of daring that feared more to fail in what he set out to do than any physical hazards he had to face. We offer our sincere condolences to his family and to his country.

Commissioner Robertson has done much to bolster up the Patent Office and is to be commended for his part in bringing about the changes. Because of them, the Patent Office may be expected to act upon patent applications with more expedition than has heretofore been possible. In but a short time, therefore, we feel that the situation will begin to clear up; but in the meantime, we urge upon inventors a little patience, a spirit of co-operation, and promptness in replying to official communications; and upon critics of the Patent Office, more judgment in analyzing the situation.

Returning Prosperity

CURIOUSLY, last fall's stock market break did not mark the downfall of the capitalistic United States, as the small group in control of the Soviet so hopefully predicted. Of course we wouldn't think of suggesting that the prophets played too loosely with an idea—for they are very *wise*—but something happened to nullify their opinions. This capitalistic country which "bled its people dry" will soon be back at its old tricks of making and spending money and enjoying prosperity. We're sure of it!

Business has been down for an unprecedentedly long time now. An article in a bulletin of The National City Bank of New York, however, states that: "During the period of curtailed production, consumption has gone on—in somewhat reduced volume, it is true, but nevertheless at a rate in excess of production—so that it is only a question of time until shortages will begin to develop and necessitate the speeding up of the productive machine." In other periods of depression, the business of the country was far less diversified and lacked the recuperative power demonstrated in recent years. With the present easy money and "with the record of past depressions so suggestive of the country's ability to regain its stride, there seems reason for confidence that business will soon begin the climb back to normal prosperity."

Almost everywhere we hear the same opinion expressed, sense the same feeling of hopefulness. With everybody thus "tugging at the wheel," we are sure that boom days are not far in the offing. Perhaps our Soviet ill-wishers won't like to hear this but then, once *they* have a taste of prosperity—the success of some of their programs—doubtless they will feel less envious.

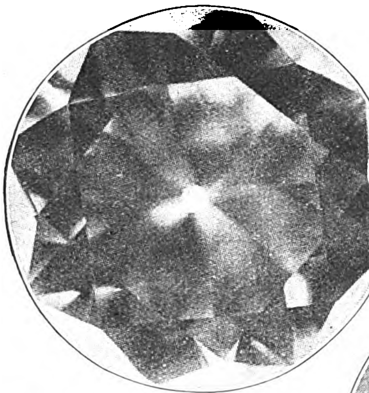
Navies and World Problems

WE still believe the treaty should be ratified, in spite of the very positive handicap it places on our Navy; and we believe there would have been less opposition to it from the press and the people if the Adminis-

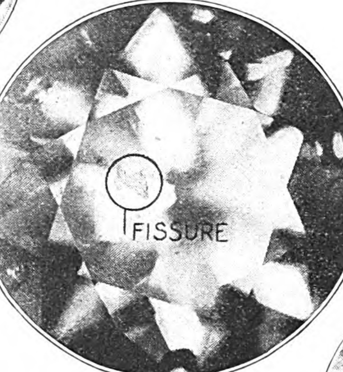
(*Please turn to page* 153)

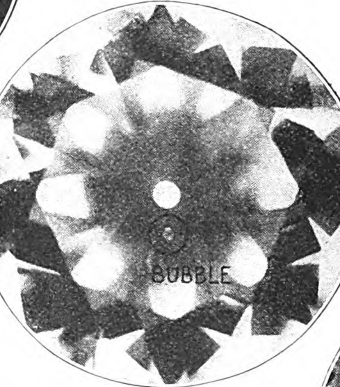
Photography Identifies Gems by Their Flaws

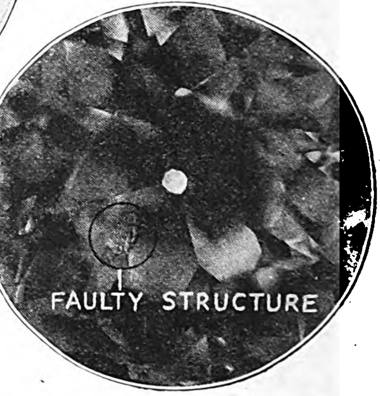
By FRANK HEITZLER



The diamond is apt to have defects such as irregularities in cutting, incipient fractures and imperfections in crystallization, included bubbles of air or gases, and specks or flakes of metallic oxides or carbon. *Above:* photograph of a perfect stone







THE diamond is always recognized as the chief among precious stones. It is the hardest and most brilliant of minerals, but it is a curious fact that the artisan is necessary to develop nature's raw product, for there is no indication of beauty until it has been faceted and polished by the hand of man. Nature does not always give us a perfect product and, even when polished, the diamond is no exception to this rule. Ninety-six percent of the stones found are more or less marked with imperfections in their creation, and as there are no two stones exactly alike, these flaws can be used for the purpose of identification by recording them, superimposed on a photographic plate. Stones without obvious imperfections can be recognized and identified by their shape, cut, color, and weight.

Imperfections or flaws in diamonds are classified in the following way:

FIRST, there are the carbon spots which may appear as a single defect or in a group. If very fine and located toward the edge of the stone, their interference with reflection is not great, but if located toward the center of the table of the gem they will prevent the colors from striking through, and consequently will depreciate the stone.

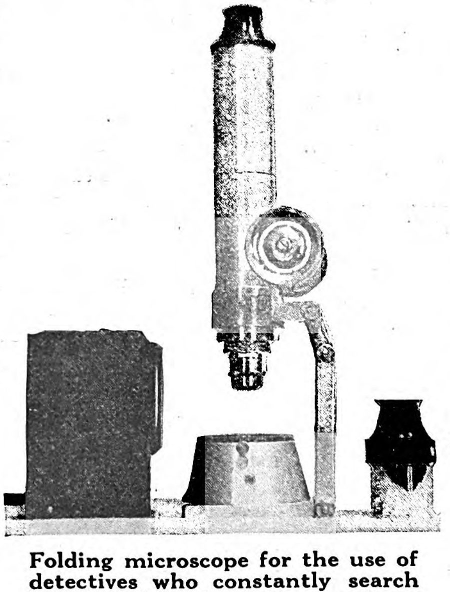
Next there are discolorations in the optical homogeneity of the stone. These may appear milky or brownish in hue, or like fine gravel. They are named "faulty structure" and are very depreciating to a stone. Another defect is the presence of bubbles; they are often filled with water or gas. As they are transparent, they do not cause any appreciable obstruction to the spectrum of colors, if not too large in size. Very fine fissures are not very detrimental, if they do not run across the table of stone, and often cannot be seen by a jeweler's glass. "Feathers" appearing on the table of a stone do not exactly improve its appearance, although they are not as detrimental as carbon spots.

Colors are ascertained through a low-powered microscope equipped with a polarizer and analyzer, intensified by a selenite plate. The operation is speedy and absolutely certain as the lens system shows the colors as they are actually present, not omitting the slightest hue. Color is the predominating factor which gives the stone its value, and it is the distinguishing favor that nature gives certain stones in their making. No cutting of facets can produce the brilliancy and wonderful display of colors imparted when rare minerals are molten in Nature's manufacture of the diamond.

It is a foregone conclusion that identification photographs of diamonds do not constitute a "beauty contest," as their purpose is to show all imperfections to the smallest detail no matter where located, as clearly as is possible with a modern scientific system of lenses. Thus it will be possible to duplicate the photographs 10 or 20 years hence, and to produce them in court as proof of ownership. In the system for identification of diamonds, the slip attached to each photograph always states size of apparatus and kind of lens used, as well as the depth of imperfections and their character.

The colors of diamonds are governing factors in obtaining a good picture. A perfectly white stone photographs an even color and the blue, greenish white, and pink tints are not so bad. However, red and yellow are two interfering colors which no filter will overcome. The reason for this is that although a filter may prevent one color from affecting the plate, the filter itself reflects back to the stone, producing another color which is usually worse than the one it prevented from coming through. In order to overcome this mixed color effect to some extent, specially prepared emulsion plates are used.

The illustrations show the equipment used; important factors are the different holders constructed so that



Folding microscope for the use of detectives who constantly search pawnshops for stolen jewels

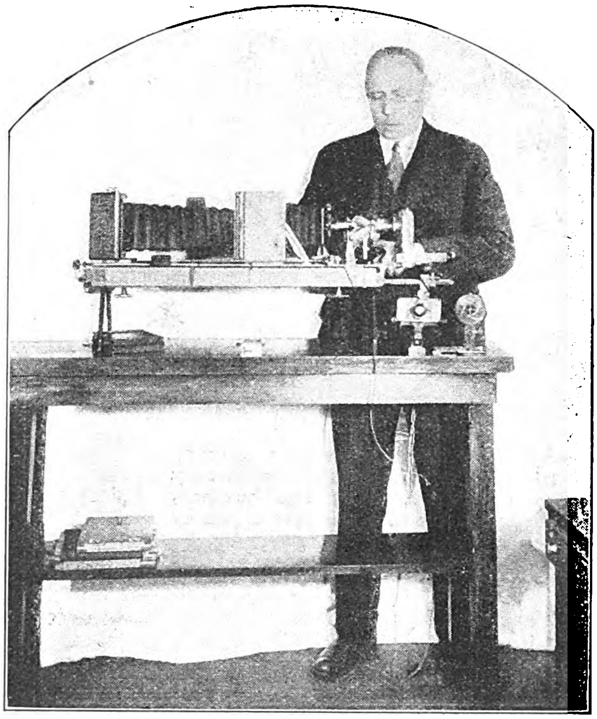
rings or stones cannot be jarred out of position while operating the apparatus. The slide which carries the lens must be a perfect fit, otherwise moving it will shift the image. The camera is of the photomicrograph type with a 42-inch bellows.

The magnification used depends entirely upon the experience of the operator. An attempt to employ too much magnification will distort the outlines of the stone, making it unsightly on account of the manifold reflections of the cut and the facets of the stone. Medium or high-power lenses are useless as the index of refraction and curve of the lens produces an interfering color. Therefore a Micro No. 1 lens is used, and the stone is inserted in the holder, after cleaning it carefully. The lens is then focused and the image appears. The back of the camera is provided with a mask having a circular opening about 3½ inches in diameter, which is placed very close to the plate. The image of the stone has to be centered by simple mechanical movements so that it fits perfectly in the mask. This is all done from the back of the camera where the operator is seated.

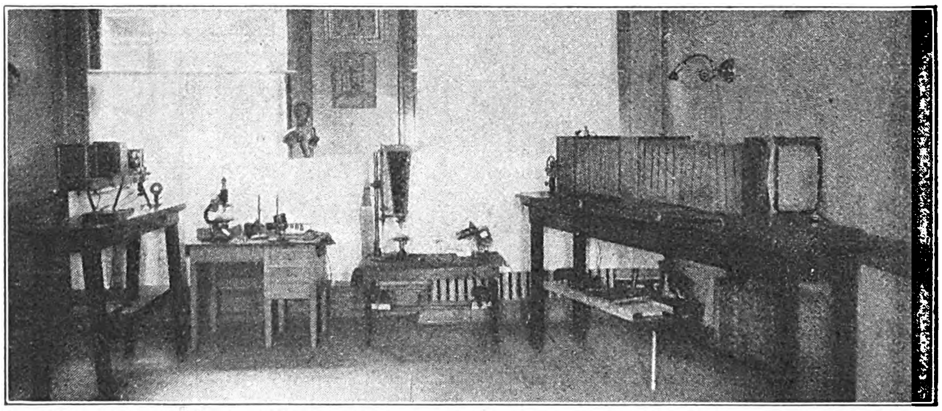
To eliminate differences in exposure due to changing daylight and to take pictures at any time, a constant-intensity electric light is used, operated by a 6- to 8-volt source. The lamp is placed in back of the stone. The condenser lens and reflector are made in such a manner as to keep the rays of light from the lens proper, confining the pencil of light to the diamond. For rubies, sapphires, and emeralds, two lamps are placed in front of the stone to give the darker stones the proper illumination. The same method is also used for settings which have no back opening or insufficient space. The time of exposure for mounted stones is from 6 to 10 seconds, and for loose stones, from 2 to 3 seconds.

After the gem is securely mounted, and the lamp turned on, the next operation is to set the micrometer to zero. This micrometer is an important feature, and is attached on the back of the camera. A rod connects the lens slide and the micrometer. The lens focuses sharply on the table of the stone, the hand of the micrometer reads zero, and the search for characteristic imperfections begins. The lens is moved toward the interior of the stone, and the depth of any flaws appearing in a certain plane is read off on the micrometer and noted. This searching is continued until the end of the stone is sharply defined. Turning backwards to the table, focusing sharp, the plate is inserted. The first exposure is of the table; second, the first imperfections as indicated by the micrometer reading. If a third exposure is necessary, all three are superimposed on the same plate.

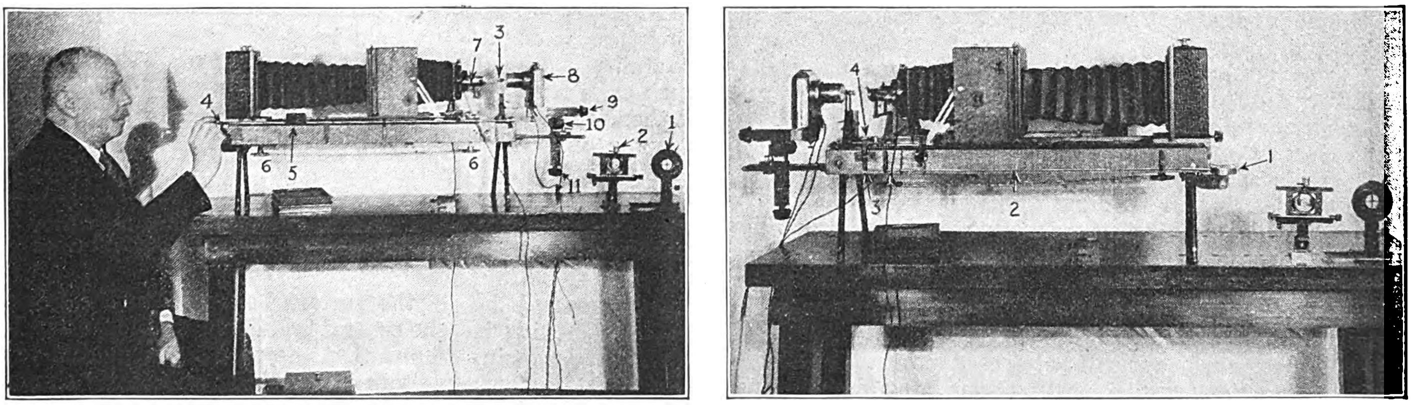
After prints have been made, a written record is attached for further reference, the negative and the record are numbered and filed, and in case of theft, prints are made and distributed to police, jewelers, and pawn shops. If a very valuable stone, the photograph can be radiographed to foreign countries thus quickly closing to the thief all possible markets for his ill-gotten treasure.



The photomicrographic apparatus in the author's laboratory used to examine gems



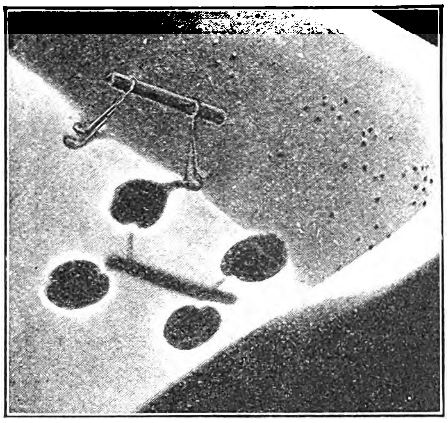
This laboratory is filled with interesting apparatus for the examination of diamonds and other precious stones by the means described in the article



Where the stones are focused and the readings taken. After the gem is securely mounted and the lamp turned on the micrometer is set at zero and the search for imperfections begins. In the left-hand illustration *1* is the holder for loose stones; *2* and *3* are holders for rings; *4* is the lateral adjustment for holder; *5* is the focusing arrangement; *6* is the device for raising and lowering lens; *7* and *8* are lamps; *9* the condenser adjustment; *10* and *11*, adjustments for light. In the right-hand illustration is the back view. *1* is the micrometer; *2* is the connecting rod; *3* the lever arrangement; and *4* the connecting pin to lens slide

Walking On Water

By HENRY J. TOMLINSON, B.Sc.



Illustrations by the author

A little artificial water skipper made of a match stick, with tiny wire legs waxed at the bottom, will float on the surface of water

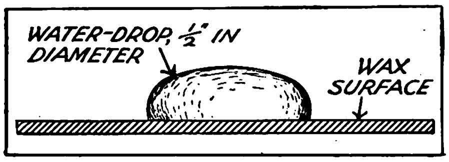
IF we stroll in the country by a pond on a summer's day, the chances are we shall see insects moving on its surface; some of them, such as whirligig beetles, are swimming, but others, for example the so-called water skippers or pond-skaters, are actually walking on the water. This is in itself a most interesting thing, but there is something else well worthy of attention.

If the sun be shining brightly, a number of little shadows will be seen on the bottom of the pond. Each of these corresponds to a foot of a water skipper, or some other insect walking on the water surface. Each is surrounded by a narrow, bright halo of light, reminding one of a tiny dark cloud with a silver lining. At the top is a photograph showing such shadows, together with their halos. How comes it that some insects can walk on water, and what is the explanation of the beautiful little shadows and their attendant halos? When a liquid is brought into contact with a solid, the liquid in certain cases is said to "wet" the solid, while in others it is said not to do so. To the non-scientific mind this would seem strange, as naturally one would expect a solid to be wetted when in contact with any liquid. It is, of course, all a matter of definition, and a simple experiment will make the point quite clear.

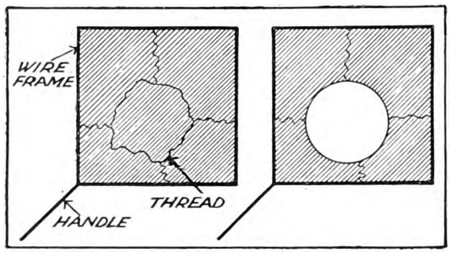
LET a drop of water be placed on a horizontal sheet of glass which has been cleaned and repeatedly scrubbed with nitric acid, and is perfectly free from grease. It will be found that the water spreads in all directions over the glass. Now let the glass be coated with a thin layer of melted candle-wax which is allowed to solidify. If a small quantity of water be placed on the solid wax surface it will not spread as in the previous case, but will gather up into a drop, the shape of which depends on the quantity of water taken; one such drop is shown at the right. The clean glass surface is wetted but the wax surface is not wetted by the water, in the scientific sense. In the same sense, the clean glass surface is not wetted by mercury since the latter, when placed on it, collects into drops.

The surface layer of every liquid behaves in many, though not all, ways as if it were a very thin *stretched* elastic skin; that is, an elastic skin under tension. Of course, the surface layer does not differ in chemical properties from the rest of the liquid, but it behaves in a different way.

A very thin, stretched, horizontal sheet of rubber will serve as a rough model indicating the behavior of the surface "skin" of any liquid. One property of the stretched rubber sheet is its tendency to shrink again, and it is evident that it will do so if the stretching force be removed. The following experiment shows that a liquid surface has the same tendency.



A drop of water on the waxed surface of glass remains heaped up



An interesting experiment made with silk threads and soapy water

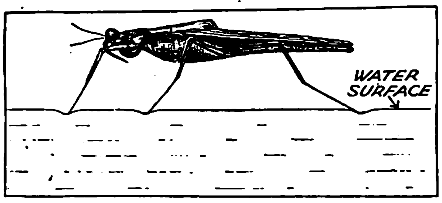
Above, at the left, is represented a wire frame to which a loop of very fine unspun silk has been attached, by means of four tethering threads of the same material. If the frame be dipped into soap-solution, such as is used for blowing bubbles, and then removed, it will be found to have a soap film stretched over it, indicated in the figure by the shading. In this film the silk loop floats. The film has two surfaces, just as a sheet of paper has, and each surface is tending to shrink. If now the portion of the film *inside the loop only* be broken by touching it with the end of a hot wire, the remaining film will pull the loop into the form of a true circle, as shown at the right. The reason is that the remaining film shrinks to its smallest possible dimensions, and in doing so it obviously pulls the loop into that shape for which the area inside it is the greatest possible—the circular one.

Returning now to the model of the stretched rubber sheet, imagine a mouse to be walking on it. The rubber will sag under the feet of the mouse, just as a tight-rope sags under the performer. In a similar way, the surface "skin" of water sags under the feet of a water skipper. In fact a tiny hollow or dimple is made in the surface under each foot, as indicated in the drawing below (not intended to be accurate in detail), and this sagging enables the weight of the insect to be supported.

IT is absolutely necessary that the nature of the insect's feet should be such that they are not wetted by water, for if they were the water would spread over them. In this case, the feet would go through the surface layer and walking on it would be impossible.

Another figure shows, on an enlarged scale, how one of the dimples mentioned can be used to explain the formation of the shadows and halos on the bottom of the pond. The black object indicates the insect's foot. For simplicity it is drawn as a vertical stump, after the manner of a wooden leg. Also for simplicity, all the rays of light falling on the water, represented by lines with arrow heads on them, are taken as being perpendicular to the undisturbed surface of the pond.

When a ray of light, for example *AB*, strikes the water surface perpendicularly, it passes into the water without any bending or deviation. But when it strikes the surface obliquely, as in the case of the ray *CD*, it is bent on entering the water and takes the path *DE*. The amount of bending depends on the magnitude of the angle which the ray makes with the surface, and if the paths of the various bent rays to the left of the central line *FG* be traced, it will be found that they are all tangential to a certain curve *HJK;* an exactly similar and symmetrical arrangement holds good for the bent rays to the right of *FG*.



The skin or surface film on water sags under the weight of the insect

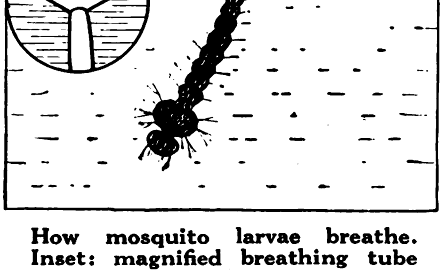
Now let the bottom of the pond be represented by the line *LM*, and consider the narrow beam of light *NP*, which is shaded in the figure. It will be seen that this beam, after entering the water, comes to a focus at the point *J*. Consequently *J* is a bright point on the bottom of the pond, and, for the same reason, *Q* is a bright point too. No light rays fall on the bottom of the pond between the points *J* and *Q*. Therefore all points between *J* and *Q* are dark; in fact *JQ* corresponds to the shadow.

As the figure shows only the rays in the plane of the paper, it is necessary, in order to obtain the explanation of what occurs in nature, to imagine the figure to revolve about the line *FG* as an axis. The bright points *J* and *Q* then travel 'round a circle so that, when we take into account all possible rays and not merely those in the plane of the paper, we see that there is a bright circle on the bottom of the pond. This is the halo to the dark circular shadow of diameter *JQ*. The rest of the bottom of the pond, illuminated by such rays as *AB*, is bright, but not so bright as the halo, owing to absence of focusing of the rays.

It is interesting to observe that the diameter *JQ* of the shadow is greater than that of the stump representing the insect's foot. Also, if we imagine the bottom of the pond to be transferred to the level of the line *RS*, so that the water is now deeper than before, the halo will be produced by such beams of light as *TW*, which comes to a focus at *K*, the diameter of the shadow being *KY*, and therefore greater than in the previous case. Thus the deeper the pond, within limits, the greater is the size of the shadow.

In nature the shadows are not circular, but of an irregular oval form, owing to the shape of an insect's foot differing from that of the stump shown in the figure.

No doubt many readers will like to know how to produce the shadows artificially by means of a little model which takes the place of the living insect. This model, which is made from a match-stick and very thin wire, is shown at the right, its total height being about three eighths of an inch. To prevent the wire feet from being wetted by water, they must be coated with little masses of wax.

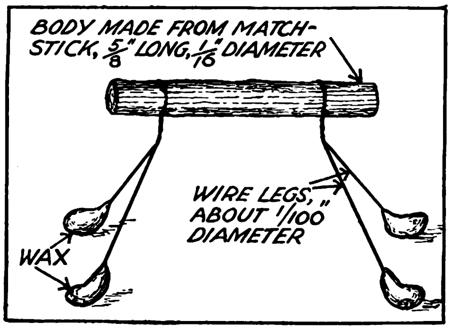


How mosquito larvae breathe. Inset: magnified breathing tube

The model will stand on water, provided it has the dimensions given, and if the bottom of the containing vessel be white, it will show very clearly the shadows and their halos when a bright source of light such as an electric lamp (in the absence of sunlight) is placed directly above it. One figure shows the corner of a white dish containing water, in which air bubbles can plainly be seen. The model, with body blackened, is standing on the water.

As wax floats on water, it may be thought that the wood and wire are buoyed up by the little masses of wax and that therefore the weight of the model is not supported by the water skin; in other words, that the model is not really standing on the water. Any doubt on this point can be removed by completely immersing the model, when it will be found to sink.

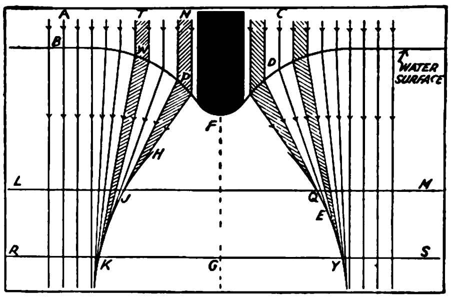
So far, we have considered insects moving on the upper side of the "surface" skin of water, but pond-snails can hang from, and crawl on, its underside, somewhat in the same way as a fly can walk on a ceiling.


BODY MADE FROM MATCH-STICK, 5/8" LONG, 1/16" DIAMETER
WIRE LEGS, ABOUT 1/100" DIAMETER
WAX

How the synthetic water skipper described in the article is made

The power of hanging from the surface layer is of great importance to mosquitoes. These insects in their larval stage, which corresponds to the caterpillar stage of a butterfly, live in water and can be found in summer in almost any place where water collects.

A drawing of the curious looking larva of one species of mosquito is shown enlarged below at left. The side tube *A* is used for breathing purposes and five little plates are hinged to the end of it at B. When the larva is wriggling through the water, these plates are brought together, so as to form a kind of conical lid to the end of the tube, thus preventing the water from entering. But when the larva needs air, it rises to the surface, pushes the end of the tube through it, and then splays the little plates outwards, so that they form a kind of miniature funnel (indicated in the figure), by means of which the larva hangs from the surface "skin." Air, but not water, now enters the tube, and in this way the larva breathes, much like a diver.



The sag on the surface film makes a negative lens, causing a shadow

Now the strength of the surface "skin" differs with different liquids and, in addition, the strength of the skin of any liquid is altered by contamination. It so happens that the skin of kerosene oil is weaker than that of water and the skin of water is therefore weakened by being contaminated with kerosene. Hence, if kerosene be poured on a pond in which mosquito larva are living, the surface is no longer able to support their weight when they attempt to hang from it, and they can not take in air through the breathing tubes. The kerosene not only cuts off the normal supply of air, but also gets into the breathing tubes and chokes them, so that the larvae die.

This method of killing the larvae has been successfully used to reduce very considerably the number of mosquitoes in those regions where, at one time, they were a pest, acting as carriers of the germs of malaria.

The surface film of water is only one example of the many existing phenomena of capillarity and surface tension in liquids. These form a fascinating chapter in the modern science of physics, from which a wealth of fact concerning the size and shape of molecules has been revealed, and there is a large though mainly technical literature on them.

Numerous examples of surface tension and other capillary phenomena exist. A familiar one is exhibited when we wash our hands with soap. Though soap is a chemical, based on stearic or some related acid, it has been learned within recent years that its main work is not done chemically but physically; the molecules crowd around and work beneath the dirt particles, actually shouldering them off by reason of the strong capillary forces they exhibit.

Soap bubbles, too, may be used in many interesting ways to display the laws regulating surface tension; some of these have been described, rather technically it is true, by A. S. C. Lawrence, former assistant to Sir James Dewar, in his recent book "Soap Films"; while the earlier researches of Dewar himself on soap films are widely known. The English physicist C. V. Boys also has written accounts of numerous related experiments. In short, the whole subject of surface tension and capillarity provides endless interest.

The normally small Des Peres River flowed behind the houses at the left. This photograph was taken during the flood of 1928. The great flood of 1915, however, reached nearly to the tops of the street lamp posts at this point

St. Louis Buries a River

By **W. W. HORNER**

Chief Engineer, Sewers and Paving

THERE is now being constructed in St. Louis a municipal drainage project on a somewhat larger scale than anything American cities have heretofore undertaken. The River Des Peres in St. Louis is, or was, a creek draining a basin of about 110 square miles. It flowed through St. Louis' best residence district, through the great Forest Park, through a heavily used industrial area, and, finally, across six miles of a developing semi-suburban district to discharge into the Mississippi River in Carondelet.

As the city has grown into this valley, sewers have been constructed discharging into the stream; as early as 1905 it had become an open sewer. Then, too, the great increase in the coverage of the permeable soil, which came about through paving and building, increased the runoff of storm waters so that the flooding of the lowlands occurred yearly with increasing severity.

The city discussed improved drainage along this stream for years but no administration was able to secure the necessary funds. Then in 1915, as an offshoot of a Gulf hurricane, a rain of over 10 inches occurred on this watershed in 20 hours. The resulting flood produced high-water marks many feet higher than any previous record; it isolated sections of the city, stopped operations on trunk-line railroads for as long as two days, and caused a serious loss of life. Thus the problem assumed alarming proportions.

Thereafter the carrying out of an improved drainage plan was a major issue in municipal affairs. Preliminary attempts to secure the funds failed but the matter was kept alive, and in 1923 a fund of 11,000,000 dollars was made available as part of the 87,000,000-dollar municipal improvement bond issue of that year.

IN the meantime sufficient funds had been available to permit surveys and detailed engineering studies to proceed, and in 1916 under the instructions of Hon. E. R. Kinsey, President of the Board of Public Service, a definite plan of improvement was worked out by the writer and adopted by the Board. This plan has been elaborated and revised, but is essentially the scheme on which the present construction is being carried out.

At the upper end of the project the river is taken into a 32-foot reinforced concrete sewer which extends for two miles to a point in Forest Park where it is enlarged to a double 29-foot concrete sewer and continues for another two miles. Below this point the drainage area is much larger and the cost of the complete "burying" or enclosing of the river would have been too great. A different plan was, therefore, adopted for the remaining nine miles to the Mississippi River, consisting of an open floodway for storm drainage and an underlying sanitary intercepting sewer.

At this time, three of the four miles of concrete sewer have been completed and the last is under contract. The central three miles of channel and sewer are complete and in service, while nearly all of the channel work for the lower six miles is under contract or has been partly completed. The whole project is scheduled for completion at the end of 1931. When finished, it will have substituted 13 miles of closed sewer and rectified channel for about 18 miles of the old natural tortuous river bed.

Two phases of this work must be of unusual interest to technically minded readers. The first of these involves the engineering studies underlying the design of the system and the more recent tests by which some of these are being checked, and the second the construction approach to the project which involved an unusual choice of tools and an organization of the work to be carried out under recurring flood hazards.

The radical difference in the character of the plan, as between the upper and the lower valley, was due to a combination of surrounding circumstances. The plan for the upper valley involves the unusually large combined sewers, 32-foot and double 29-foot in size. The adoption of this type of plan was the result in part of the restricted conditions north of Forest Park, where residential and industrial development had encroached so closely on the creek banks that there was no room to maintain a flood channel of proper size unless arranged by the acquisition of very expensive lands. Then, too, the river could be completely inclosed in combined sewers at an expense within the limits that the people were willing to consider. Finally, the city had had to live so closely in conjunction with the unsanitary stream flow and continually recurring floods, that the popular irritation with the situation had passed ordinary limits, and no improvement would have been satisfactory which would not have removed these old sores completely from the surface.

IN the lower valley, each of these considerations was reversed. There was in most instances room to construct ample floodways on land that could be acquired at moderate cost, while the expense of complete enclosures of sufficient size to carry the great floods from the larger drainage basin would have involved costs many millions more than had ever been considered. Finally, this section of the city was not densely populated and, except in parts of the upper three miles, the flood damages and the nuisance factor had not injured a great number of people.

With the adopted plan definitely fixed, the first important factor and the most significant to the whole scheme was that which would fix the amount of flood water for which the works would be designed.

In sewer design, the question of rainfall and flood frequency has been extensively studied and engineers in different cities have adopted a variety of answers to the economic question. In general, city sewers are designed for such an amount of water that they are expected to be overcharged at frequencies of once in 15 years, under conservative policies, down to an average of once in one or two years where lower property values do not justify the greater expense.

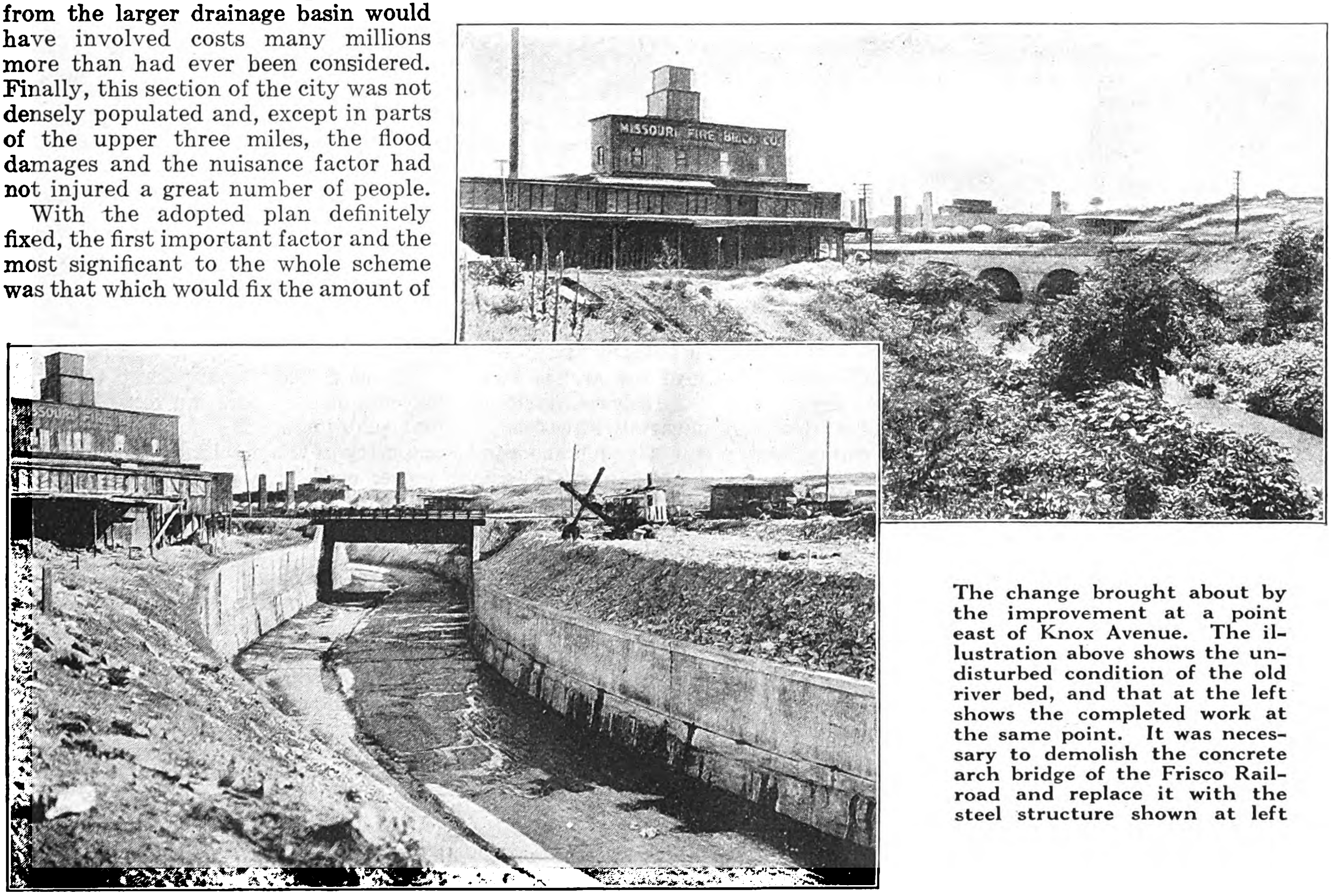
In the instance we have here, it was decided that the capacity of the River Des Peres works should be such as to care for any flood likely to occur once in 15 or 20 years, a slightly more ample basis than that used for smaller sewers. Obviously the determination of the volume of such a flood is not susceptible to exact analysis nor is there available any great amount of data of good character from which the answer can be worked out.

The figures of the amount of water per second for which provision must be made are very interesting, as showing what really terrific floods can come from small valleys with good slopes if the surface is not permeable. It is particularly surprising that the high-water flood of this little 110-square-mile valley may actually be greater than the low-water flow of the Mississippi River as it passes the city of St. Louis.

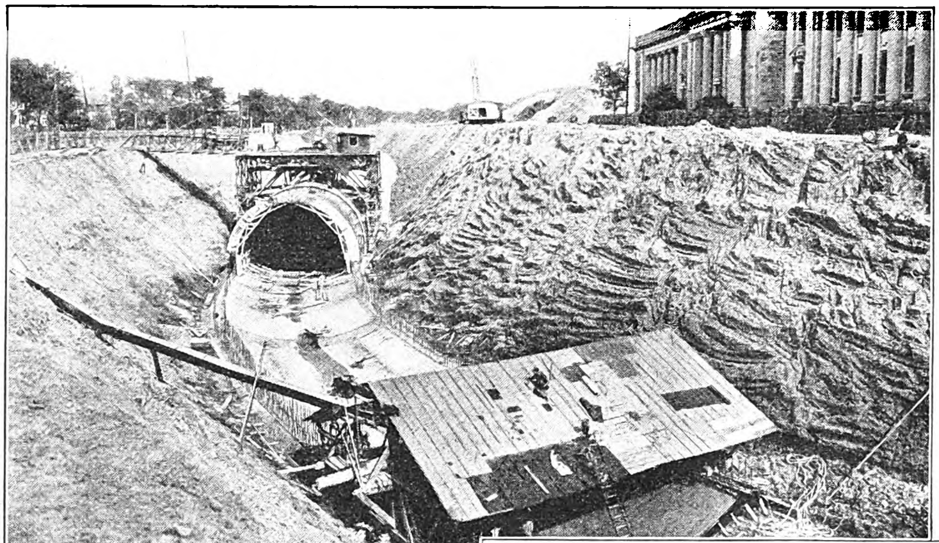
The size of sewers required on this project required us to use arches that are in a peculiar class. They are greater than the sewers originally involved in the city system and are smaller and of a different type from those ordinarily entering into concrete bridge design. Consequently there was little precedent for the engineering work to be done on them. It is not commonly known, outside the group of specialists who deal with this problem, that one of the dark spots in engineering knowledge is concerned with the pressures which earth places against such structures at the backs of retaining walls and the buried tops and sides of sewers and culverts.

ONLY in the last 20 years has any really scientific work been done in this field and most of this has been to determine the earth loads coming on small sewers either in narrow trenches or on culverts under highway fills. The result of this research work on small sewers was of some value in choosing the loads for which the Des Peres arches were to be designed, but the factors which the research had produced had to be exterpolated to such an extent as to be somewhat unsatisfying.

The arches are of reinforced concrete. The stresses were determined by an application of the elastic theory of arch design, the thicknesses were proportioned by an assumption that the compressive stress in the concrete



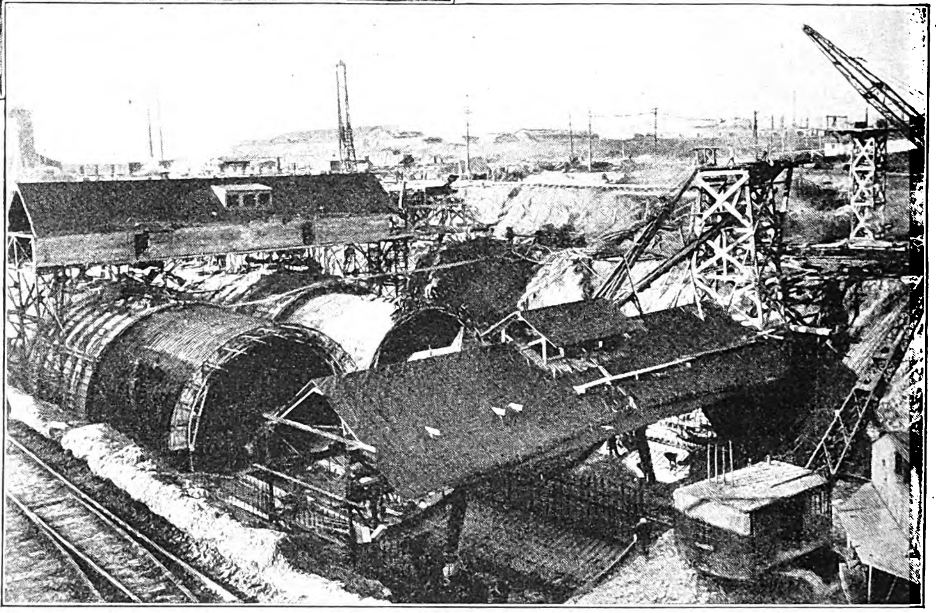
The change brought about by the improvement at a point east of Knox Avenue. The illustration above shows the undisturbed condition of the old river bed, and that at the left shows the completed work at the same point. It was necessary to demolish the concrete arch bridge of the Frisco Railroad and replace it with the steel structure shown at left



The single 32-foot sewer in process of construction in front of the Jefferson Memorial Building

would not exceed 800 pounds to the square inch and the tension from the steel bars would not exceed 22,000 pounds to the square inch.

It was critical to the progress of the work that the great steel centers on which the concrete was poured should be loosened and moved ahead for reuse as quickly as possible. It was decided that this support could be removed whenever the strength of the concrete reached 1200 pounds per square inch, and to determine this time, standard test cylinders were prepared out of the concrete as it was poured into the arch.



The double 29-foot sewer. In the right foreground is the 300-ton shovel with which the main excavation was done. Its arm has a reach of 90 feet

HAVING had to design these structures without as much satisfactory fundamental data as was desired, we felt it to be part of our duty to develop some of this data on this project for use in future structures. Accordingly a complete series of tests was developed in an effort to determine what the actual earth loads are and what the pressures under the footings are by building into the sewer a large number of Goldbeck pressure cells. These cells are interesting little machines in which the pressure of the earth against the face of a diaphragm is weighed by balancing this pressure with air pressure introduced behind the diaphragm. When the air pressure exceeds the earth pressure, a slight movement takes place, electrical contact is broken and the pressure may be read on an air gage.

Readings of earth pressures were begun as soon as the fresh backfill was placed over the sewer in September, 1928, and have been continued. It is very interesting to find that the actual measured pressures on the tops of the arches at the present time are equal to 50 percent more than the actual weight of the earth over these points would cause. One would be doubtful of the correctness of this result had not a similar condition developed on certain culvert tests made elsewhere. It appears that this is possibly because the settlement at the bottom of the deep fills on each side of the arches leaves the upper part of the fills relatively unsupported. A shearing stress is developed in the soil which transmits a part of the weight of the earth at one side of the arch on to the arch proper. This possibility was not realized at the time the arches were designed and it is fortunate that a large factor of safety has been provided.

The horizontal pressures are quite close to the assumptions used in the design, but we can see that these might not be true if the sewer had been constructed in the narrow trench instead of in a wide sloping cut.

The reactions under the footing are very peculiar. They seem to indicate that the inverted arch is supporting the center wall almost free of the ground, but we do not dare adopt this assumption, as some of the soil pressure cells occasionally fail to record when placed on shale or fireclay of hard quality as was the case here. This condition of reaction, however, is not impossible and leads to some interesting speculations.

The construction of the drainage works has been under way since 1924, when the first of the open channels was started. From the very beginning it involved unusual features not common in municipal sewerage.

As the new works lay in the valley and the site was closely restricted by both residential and industrial developments, a great part of the open channel and low level sanitary sewer had to be built in the creek bed or in such a way as to be continually crossing the creek. Construction operations were accordingly at the mercy of the weather and were subject to sudden interruptions by freshets which would sweep over the site and cover the equipment.

It soon became apparent that the success of the operation must lie in so over-equipping the job both as to capacity of the machines and as to the power used, that great progress could be made in the short periods between the rains. This led to the use of large draglines kept as far as possible out of the creek beds, assisted by small equipment in the stream to do the final trimming, this last equipment of a type that would not be seriously injured by continual immersion. In spite of the careful choice of equipment in this way, the work executed under such flood hazards was necessarily very expensive and proceeded somewhat more slowly than was expected when the project was first started.

Whatever loss of time and unusual cost entered into the first three miles of open channel was about balanced by the great savings which it was found could be introduced into the quantity production methods used on the construction of the big concrete sewers. These contracts, like the earlier ones, were equipped with extremely large and powerful excavating units. The high cost of having the work flooded was learned early in the progress and thereafter considerable expenditures to protect the site from floods yielded good returns.

Concrete for most of the work has been manufactured in central station plants of large capacity, completely equipped with machine handling devices and automatic controls of materials and of water. It was hauled to the site of the work in one case by industrial trains and in another in dump trucks. These central concrete plants not only proved to be very effective in lessening the cost of the product but were extremely valuable in producing uniformly well-proportioned mixtures. This last result was brought about not only through the efficiency of the mechanical control apparatus but also through the necessity of securing the result, as the concrete not so accurately proportioned was not subject to long haul without segregation.

The value of these quantity production methods and of protecting the work from interruption by floods is shown by the progress records actually attained. In the month of September, 1929, each of the contractors produced 30 units of sewer on 30 consecutive days. As these units were either 30 or 35 feet in length, nearly 1000 feet of sewer were built on contract that month.

Where the last contract of the big 32-foot sewer is just now being started, most of the construction must take place in a narrow gorge through which the river runs, as there is very little working room on either side. The contractor here, Stiers Brothers, has developed a totally different type of equipment consisting of duplicate electrically-driven tramways of about 1800-foot spans to haul the material in and out, and small shovels and draglines in the river bed loading skips.

ONE of the things that every worker in the ground has come to fear is the encountering of wet running soils, sometimes called muck, sometimes quicksand, depending on the amount of clay present. It has almost gotten to be a tradition among sewer contractors that when quicksand is encountered, all ordinary plans must be abandoned and enormous costs are involved in holding back the running earth with sheet piling, timber, and other effective barriers.

In recent years engineers and the more understanding operators have learned that this material is essentially the same as any other soil except for the presence of an excessive amount of water, sometimes under pressure. Systems have been devised for removing this water through pipes driven into the ground and, where the sands are sufficiently coarse, stable soils are produced.

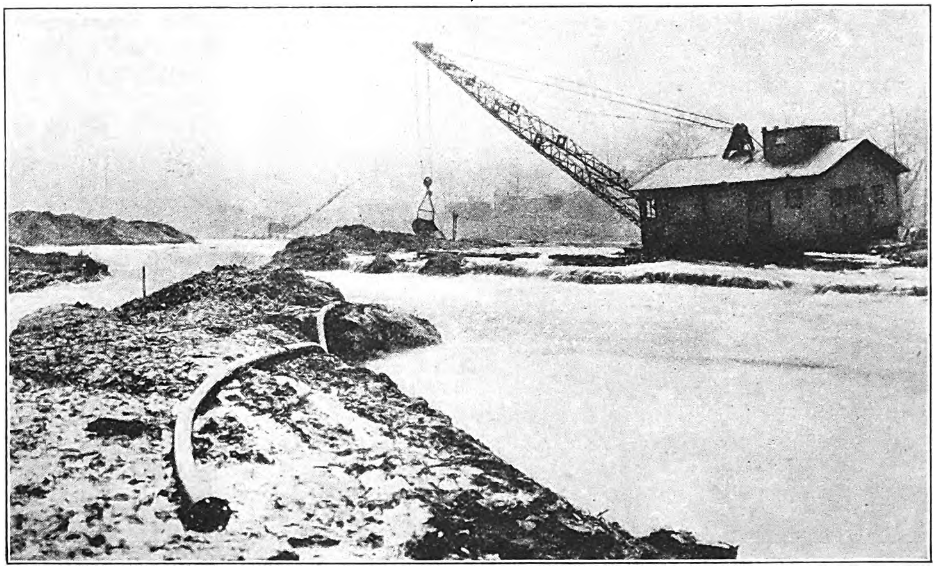
A very interesting problem of this general kind entered into the building of the Des Peres works. This problem arose because the new improvements were to give the same standards of drainage as did the city sewer system and accordingly these works must carry the floods at levels of eight feet or more below the improved ground surface. With the flood water levels so fixed, the bottoms of the channels or sewers were at a great depth below the old creek bed, sometimes as much as 25 feet.

When work on these deep excavations was started in the middle of the natural valleys, the first operation was to open a hole or excavation to the new depth. The natural result of this was that all the soil moisture in the surrounding area tended to flow to the low level outlet. In passing through the soil adjacent to the trench, the pores of the soil were filled under pressure, instability resulted and there was a continual tendency for the banks of the excavation to slide or slough in.

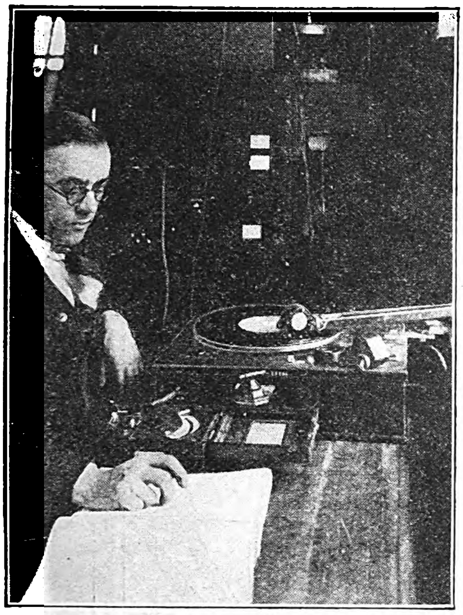
At the beginning of the work, this condition horrified the operators and they were quite sure for a time that the low level structure could never be built, or, if built, that the banks would be continually sliding and that the concrete or rip rap paving laid on the banks would be crumpled up and demolished. They advised, instead, that heavy reinforced linings be placed capable of holding back the terrific soil pressure. A small amount of such lining was actually placed as an example only, for we were convinced that the soil would become stable once the excess moisture had drained out and the pressure of the water in the pores was relieved. Accordingly, we arranged for the rough excavation to proceed and for the trimming of the banks and the placing of the lining to be deferred. A slow outseeping of moisture followed, the ground water level in the valley was gradually lowered and within six months after the original excavation the banks had become re-stabilized throughout. Of the first 30,000 feet of channel bank so treated only 300 feet gave trouble after completion and that was at a point where the bank had been supercharged with a fill of wet clay.

So effective was this means of securing stable soil by natural seepage that when one section had to be started without an outlet, it was decided to simulate this condition artificially. Six months before the beginning of the work a pumping well was sunk to the level of the proposed excavation, drain tiles were run out along the site of the work for several hundred feet and the ground water was continually pumped until the time the work began. When the big machines actually arrived and the new cut was opened the soil was found to be quite stable and no difficulty whatever arose. It was further found that once a stable condition of this sort was created, the soil moisture would drain effectively to the excavation at about the rate at which the work was able to progress up the valley so that difficulties of this kind only occurred where a new depression was opened.

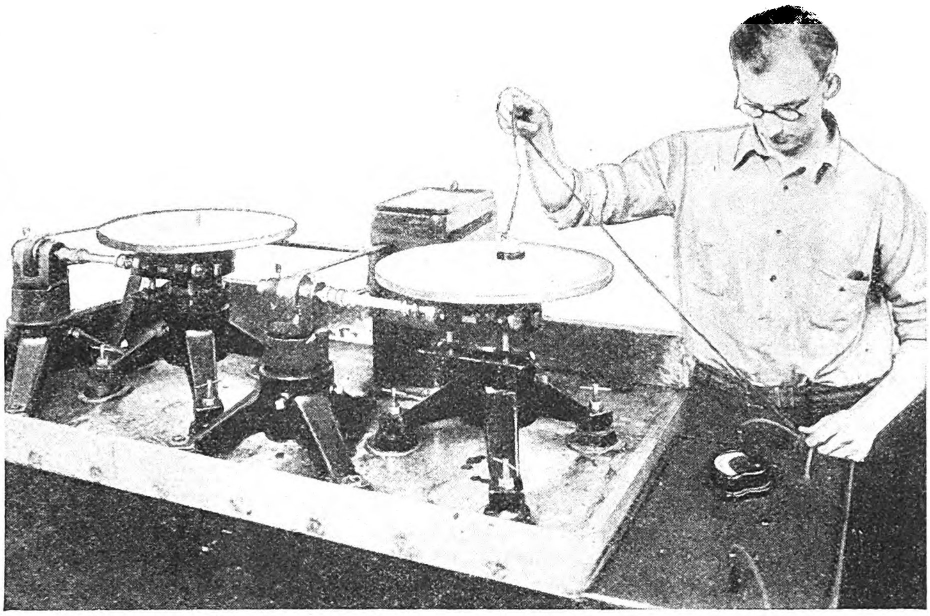
SEWER construction has for a long time been in the hands of practical men who have been accustomed to fight their way out of difficulties and it is very interesting to find how often an adaptation of some relatively simple law of science can make easy the progress of work of this kind.



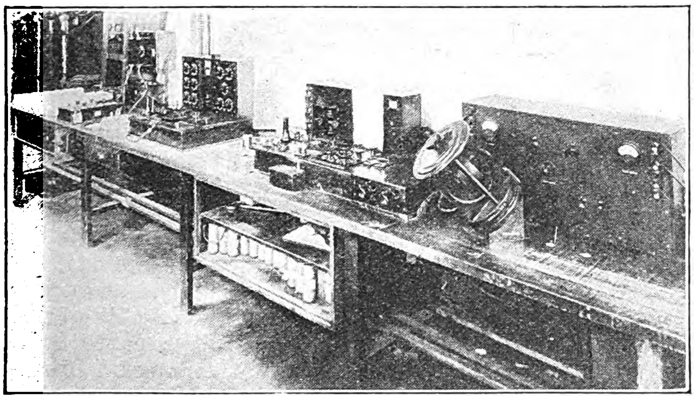
A section of the job showing one of the heavier floods passing over the construction work. The crests of these floods usually were of a few hours' duration



The electro-magnetic reproducer for disks is tested for operation

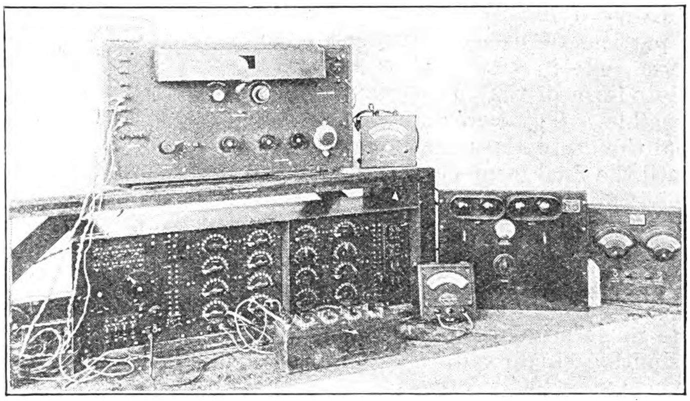


An "electric ear" is placed on the record turn-table as it whirls around on the test bench. A sensitive meter tells the operator of any noise-making faults



All photographs courtesy Western Electric Company

On this elaborate test table, the transformers of the amplifiers are tested for their electrical characteristics



The assembled amplifiers are subjected to tests more rigorous than actual operating conditions in theaters

Accuracy In 'Talkie' Equipment

ACCEPTANCE of talking motion pictures as a permanent part of the entertainment field has imposed on the manufacturers of motion-picture projectors a standard for their mechanical work that rivals that set by the makers of the finest watches. Not only must the machine project perfect motion pictures, but it must also be the source of accurately synchronized sound and voice effects.

It is doubtful if there is any other delicate machine of which more is required than a motion-picture reproducer. It must be rugged enough in construction to stand the rough usage and steady grind of every-day operation, yet parts of it must be so delicately constructed that they can handle without distortion minute voice currents so small that only the most sensitive meters will measure them. A universal type of machine can transform almost microscopic marks on the film into the most delicate shadings of sound or it can be run with disk records to reproduce from tiny scratches in the grooves on the disk. At the same time, the projection mechanism must be functioning, passing the film before the aperture where it is brought to a dead standstill 24 times a second. Yet, about 14½ inches from the point where the film is started and stopped, it must be flowing smoothly past the sound-light aperture without the slightest pause or jerk.

IT is small wonder, then, that the manufacture of sound-picture projectors requires a huge staff of inspectors. The machines must be so perfect when they leave the factory that, when they are installed in a theater, they will operate properly from the first turn of the switch. There can be no breaking-in period in the theater, such as the automobile owner gives his car, for the first performance of a projector is usually judged more critically than any other. Therefore the machines are carefully tested before they leave the shop, and the gear drives are run-in, under load, for periods varying up to 24 hours. This operation removes any burrs and irregularities from the gears, and insures that the final tests for noise and irregular operation will show whether all of the parts are meeting the exacting requirements of theater conditions.

In the photographs on this and the opposite pages we show some of the many intricate tests and inspections that are made before the projector is finally considered up to standard and is shipped to the theater. Here also it is constantly tested in preparation for each daily grind, to insure that the performance will go through without mechanical or electrical failure.

Zoogenesis

The New Theory of Evolution

By AUSTIN H. CLARK
United States National Museum

FROM the very earliest times the absorbing mystery presented by the multitudes of different forms of animal life has attracted the attention of the studious among all human races.

We know that all living things are derived from other living things—life can not arise spontaneously. So in the extremely remote past all forms of life must have had a common origin. No one with any knowledge of biology doubts this, and those with no knowledge of biology are in no position to deny it.

Every living thing is evolved from a particle of living matter—a single germ cell—in which no trace of the adult form of that living thing is discernible. This cell divides into two and the derivatives continue to divide until the final form—cow, insect, crab, jelly-fish or something else—eventually is attained.

Since every animal, no matter what it is, originates as a single cell, we are safe in saying that all types of animal life must be explained in terms of a primitive single cell.

THE course of the development of animals from a single cell to multitudes of different kinds we know today is explained by what is commonly known as the theory of evolution.

Evolution assumes the gradual development step by step of all the widely varying forms of animal life from an original form of simple structure.

But the developmental course which has been followed by animal life from its first beginnings down to the present time can not be reduced to any such simple formula. There are three separate sets of facts to be considered, and any acceptable theory of animal development must harmonize and correlate all three.

Galago, similar to the supposed common ancestor of man and the monkeys

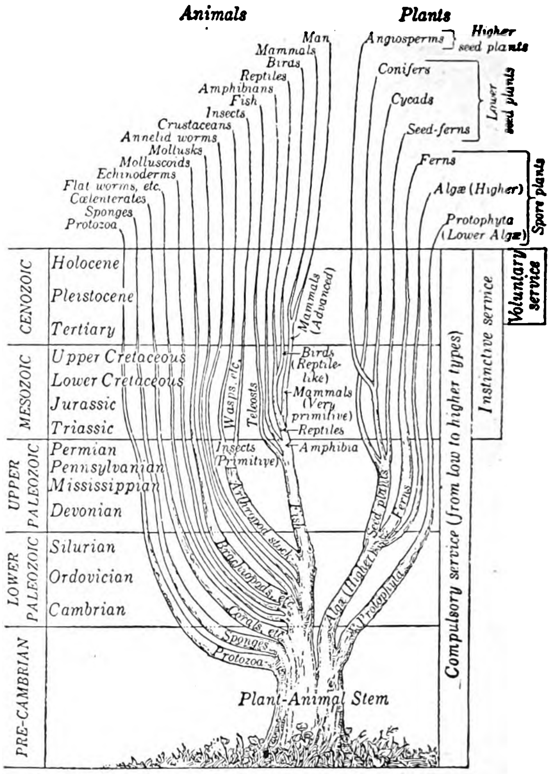
In the first place, within each of the so-called phyla or major groups of animals, as is well seen in the vertebrates, particularly in the mammals and the reptiles, there are many well marked, obvious, and undeniable evolutionary lines or "trees" which, beginning with a relatively simple form of creature, run by easy stages to a specialized and highly complex form.

In the second place, very few of these evolutionary lines are perfectly continuous. Practically all of them are more or less frequently interrupted by gaps of various widths, and these gaps are often very broad. Especially is it true that these evolutionary lines tend to be separated from each other throughout their entire course, running parallel clear through to their earliest beginnings and not converging to a common type of animal as we would expect. For instance the cat line and the dog line are always separate. No forms intermediate between cats and dogs are known, although both cats and dogs are collateral members of the great group of carnivorous mammals called the Carnivora and must have had a common ancestor.

SIMILARLY there are no intermediates between turtles and snakes, both types belonging to the reptiles, or between squid and oysters, though both types are mollusks.

In the third place, no animals are known even from the very earliest rocks which can not at once be assigned to the proper phylum or major group on the basis of the definition of that group as drawn up from a study of living animals alone. A backboned animal is always unmistakably a backboned animal, a starfish is always a starfish, a mollusk is always a mollusk, and an insect is always an insect, no matter whether we find it as a fossil in the rocks or catch it alive at the present day.

There can be only one interpretation of this entire lack of any intermediates between the major groups of animals, as for example between the backboned animals, the starfishes, the mollusks, and the insects. If we are willing to accept the facts at their face value, which would seem to be the only thing to do, we must believe that there never were such intermediates; in other words that these major groups from the very first all bore quite the same general relationship to each other that they do at the present time.


Animals
Plants
Man
Mammals
Birds
Reptiles
Amphibians
Fish
Insects
Crustaceans
Annelid worms
Mollusks
Molluscoids
Echinoderms
Flat worms, etc.
Cœlenterates
Sponges
Protozoa
Angiosperms
Higher seed plants
Conifers
Cycads
Seed-ferns
Lower seed plants
Ferns
Algæ (Higher)
Protophyta (Lower Algæ)
Spore plants
Voluntary service
Instinctive service
Compulsory service (from low to higher types)
CENOZOIC
Holocene
Pleistocene
Tertiary
MESOZOIC
Upper Cretaceous
Lower Cretaceous
Jurassic
Triassic
UPPER PALEOZOIC
Permian
Pennsylvanian
Mississippian
Devonian
LOWER PALEOZOIC
Silurian
Ordovician
Cambrian
PRE-CAMBRIAN
Mammals (Advanced)
Birds (Reptile-like)
Mammals (Very primitive)
Reptiles
Amphibia
Wasps, etc.
Teleosts
Insects (Primitive)
Arthropod stock
Fish
Brachiopods, etc.
Corals, etc.
Sponges
Protozoa
Seed plants
Ferns
Algæ (Higher)
Protophyta
Plant-Animal Stem

From Shimer's "Evolution and Man," courtesy Ginn & Co.

Tree of the evolution of living forms. The lower (pre-Cambrian) part is an assumption, like some of the unbroken branches

Is this creationism? Not at all. It simply means that from the single cell life, at its very first beginnings, developed simultaneously and at once in every possible direction. All of the phyla or major groups seem to be of simultaneous development. From each one of them a separate evolutionary tree arose, growing upward through the ages.

The numerous developmental lines are explained by the process of evolution as that term is commonly understood. This descriptive word should be restricted to these developmental lines.

THE gaps within these lines, and between related lines which run more or less parallel, are explained by the theory of mutation.

The complete absence of any intermediate forms between the major groups of animals, which is one of the most striking and most significant phenomena brought out by the study of zoology, has hitherto been overlooked, or at least ignored. This condition may readily be explained, from an application of the facts gained from a study of embryology, by a theory which may be called the "theory of eogenesis."

Restriction or expansion of the meaning of a well-known word results always in confusion. The term evolution has been used to cover the entire developmental history of animals. But the theory of evolution is based upon, or at least was drawn up from, only a portion of the facts to be explained. It was formulated from data taken from only a partial survey of the field. A better understanding of the whole subject of the development of animals will result if we call it "zoogenesis" and consider zoogenesis to embrace three interrelated phases, (1) evolution, (2) mutation, and (3) eogenesis.

WITH regard to evolution, the first of these three phases: To illustrate evolution as here restricted let us briefly review the history of the mammals and the reptiles, bearing in mind that similar histories are found in many other less familiar forms of life.

The reptiles first appeared in that very ancient time which is known to geologists as the Carboniferous, and gradually increased in diversity and in maximum size. The largest land animals of which we have any knowledge are the largest of the dinosaurs, which flourished in those periods known as the Jurassic and Cretaceous.

At the end of the Cretaceous period most of the larger and more spectacular of the reptiles suddenly disappeared, but many reptilian types, as turtles, lizards, snakes and crocodilians, continued right through to the present day.

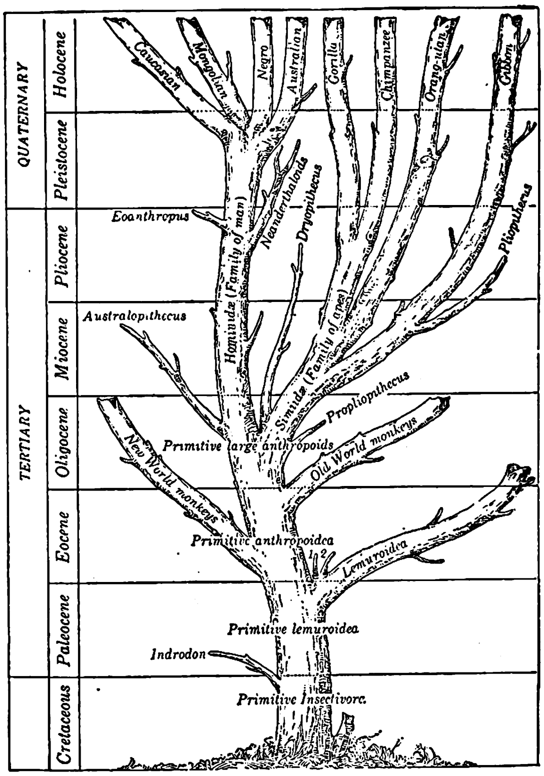
The mammals first appeared in the form of very small and insignificant creatures at the time when the great reptiles were the dominating giants of the land and sea. After the sudden disappearance of the giant reptiles the mammals increased greatly in diversity and somewhat in size, though in the earlier portion of the following epoch the largest mammal was not so large even as a sheep.

These mammals of the earlier portion of the "dawn period" (Eocene) soon disappeared; but as they disappeared their place was taken by other types which were more or less comparable to the sorts we know today. Gradually as time went on these mammals became more and more diversified. Various extraordinary types, some of huge size, appeared and not long afterwards disappeared, while together with these came others which we have no difficulty in recognizing as the direct predecessors of the types we know at the present day.

In order to make the picture clearer, let us narrow our perspective and focus our attention on the horses. In the "dawn age" we find a curious little creature no bigger than a fox called the "dawn horse"—*Eohippus*. This had four toes on the front and three on the hind feet, and a relatively short head with the eyes about half way between the ears and the tip of the nose, instead of nearer the ears as in the later horses.

Following the "dawn horse" we find a number of different kinds of horses, mostly about the size of a shepherd dog or a little larger, all of which had three toes. Like the "dawn horse" and its relatives they had low-crowned teeth which were affixed to the jaw by means of roots.

Still later there were horses which as colts had low-crowned teeth but when fully grown had teeth with fairly high crowns. With these lived others in which the teeth had high crowns at all ages. These horses had shorter muzzles and rather less deep jaws than the modern horse and, while they had a single rounded hoof, there was a toe on either side of it. These lateral toes varied from small ones which did not reach the ground to larger ones which reached the ground. Though these were larger than their predecessors, they were not so large as the later horses of the modern type.



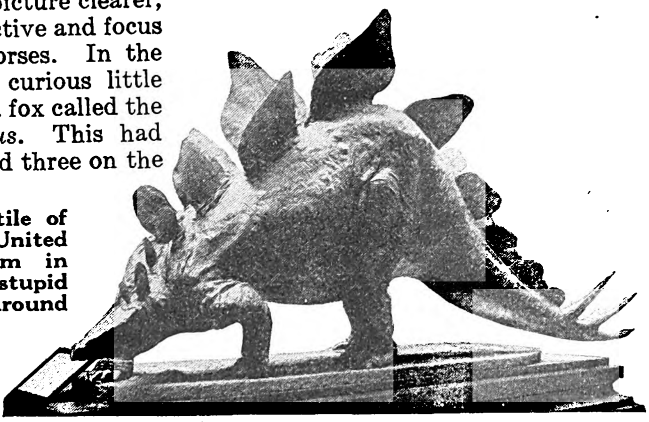
From Shimer's "Evolution and Man." Courtesy Ginn & Co.

Evolution of the primates. The author accepts man's ultimate relationship with the apes but points out that there is no intermediate type, either living or extinct

In the Ice Age we had in North America many different kinds of horses which were all of the modern type with long high-crowned teeth and deep jaws. They ranged in size from little ones no bigger than the smallest Shetland pony to some which were larger than the largest draft horse.

Before the discovery of America by the Europeans all of these disappeared, for what reason we do not know at the present time.

THIS brings us to mutation, the second of the three interrelated phases of zoogenesis mentioned above. In many other animal types we are able to trace, as in the horses, a gradual evolution from a form simple and generalized in structure to one or many forms which are highly specialized. But this is by no means always so. Indeed, it is the exception rather than the rule.



Stegosaurus, extinct reptile of the Cretaceous period, United States National Museum in Washington. When this stupid big brute was lumbering around in Wyoming in the Cretaceous period the ancestor of all the modern mammals was no larger than a rat

Most lines are broken by curious gaps which may be small and insignificant, or broad and striking. It is commonly assumed that these various gaps are due to our lack of knowledge of the animals concerned, and especially of their fossil record. No doubt in very many cases this is true, but in most cases these gaps probably are real and were never bridged by "missing links."

In the light of our present knowledge we can not doubt that all living things are the children of other living things, and that life has been continuous from parent to child from its earliest beginnings. How is it possible to harmonize this fact with the occurrence of broad and unbridged gaps in the evolutionary lines?

THE answer is, that continuity of life does not necessarily imply continuity of the bodily form in which that life is manifested. In other words, children may be very different from their parents. As an illustration of continuity of life coupled with abrupt and striking discontinuity in form, and also in mental traits, let us consider the dogs.

According to the best authorities all of the nearly 200 different breeds of domesticated dogs are descended from a single type of ancestor, which is a wolf closely resembling our native wolf. The domestic dogs may be grouped, following Gibson, into wolf-dogs, greyhounds, spaniels, hounds, mastiffs and terriers.

Some of the wolf-dogs, like the dogs

of the Esquimaux and the Kamchadales, show a more or less close resemblance to wolves, while others, like the collies, Newfoundlands and St. Bernards, are much less wolf-like. But the wolf-dogs may be arranged in a fairly continuous series from the most to the least wolf-like. This series of dog forms is parallel to many of the evolutionary lines which are seen in the geological history of the mammals, as for example, in the horses. It is a series of types passing by almost imperceptible gradations from one extreme to another which is very different.

Of the other types of dogs we may select the greyhounds, hounds, bull-dogs and pugs, the last two from the mastiff stock, as representative types known to every one.

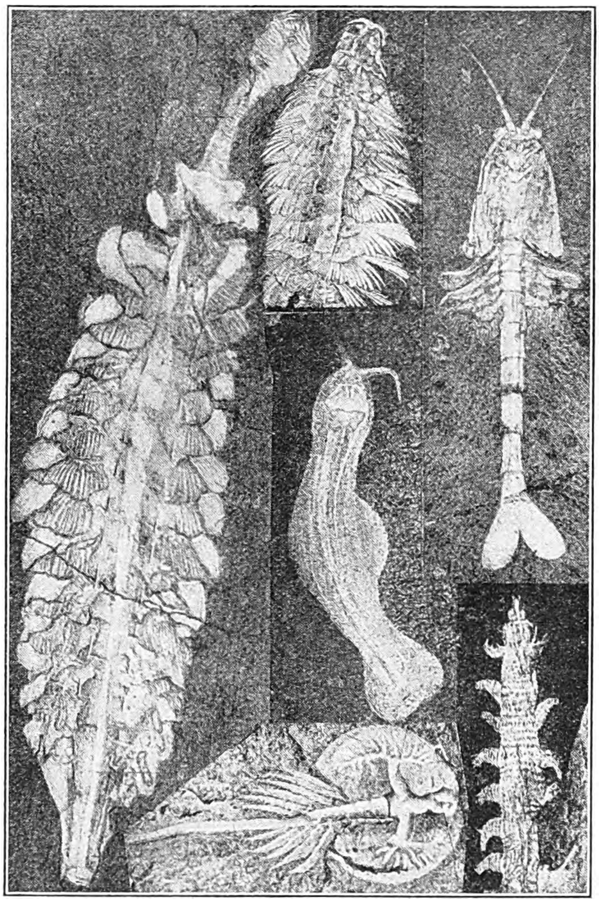
THE greyhounds or, as they are sometimes called, the "gaze-hounds" have deficient powers of scent, but unusually keen eyes. They hunt entirely by sight. There are many different forms of greyhounds. The hounds, having poor sight, hunt by scent, and are also divided into many different forms. Bull-dogs are deficient both in sight and scent, and are stupid and ferocious, displaying but little affection. Pugs, which are much like bull-dogs and are equally stupid, differ markedly from them in being timid and affectionate.

There are no intergrading types between the greyhounds, the hounds, the bull-dogs and the pugs, and there are no intergrades between any of these and wolves. If we did not know their ancestry we would never suspect that these types of dogs had anything to do with each other, or with wolves. They illustrate unbroken continuity of descent coupled with wide and abrupt changes in form and in mental attributes.

An understanding and appreciation of the conditions found among the dogs enables us to approach the problem of the relation of man to the animal world.

Structurally and anatomically man is very close to the man-like or anthropoid apes. This is a readily demonstrable fact which is quite beyond dispute. But it is also beyond dispute that there is a sharp, clean cut, and very marked difference between man and the apes. Every bone in the body of a man is at once distinguishable from the corresponding bone in the body of any of the apes.

Furthermore, man differs very widely from the apes in the possession of articulate speech which enables him to accumulate knowledge in successive generations. He also differs in his use of fire and in his use of tools which, as is shown by the fossil record, have been human attributes from the very first. Besides this, so far as history and the study of modern races enables us to judge, he differs in his use of clothing and of ornaments.



Some remarkably well preserved fossils from the Cambrian period of British Columbia, nearly a billion years ago, almost our oldest fossils, yet doubtless not half as old as life. Even in the Cambrian, the author states, the major phyla were as distinct as today, with no intermediate forms

The most important difference, however, is correlated with the fact that in man the ministrations of both parents are necessary in raising a family. A woman can not raise a family unaided. Interdependent with this we find in man a socially effective sentiment of love which creates and makes a unit of the family. The existence in all human races of taboos and laws directed toward the maintenance of the family would seem conclusively to show that family life was from the first a fundamental human institution. For laws and taboos are not, so far as we know, invented to mold society into a new and preconceived form, but on the contrary to correct the evils recognized as possessing disruptive or destructive tendencies which from time to time appear.

All monkeys, so far as we know, live together in promiscuous hordes or troupes in which each female raises her own young unaided. Family attachments are not necessary and do not occur.

While man obviously belongs to the same division of the mammals as the apes, yet the differences between man and the apes seem to be too great ever to have been bridged by intermediate types, and of all the fossils that have been found not a single one represents indubitably a "missing link."

Man appeared suddenly as a collateral line from the same general complex as the apes, but he was never one of them. Between man and the apes there is a gap, structural and psychological, of the same general nature as that between the greyhounds, hounds, bull-dogs and pugs. But while we know that the domesticated dogs are all descended from a wolf, a creature differing from all of them, and very widely from most types, we have no definite clue to the immediate ancestor of man.

The general features of human structure and anatomy were inherited, in accordance with the unbroken continuity of descent from parent to child, from some unknown ancestor common to all the primates but so far as we have been able to discover, not through an ape. The details of his structure and his mentality are his alone.

Continuity of descent coupled with abrupt discontinuities or changes in form is a common, striking, and well known phenomenon in most types of animal life. We must accord it a proper place in any theory dealing with zoogenesis.

FINALLY, with regard to eogenesis, the third phase: As we look over a series of fossils from the very earliest rocks, those of the Cambrian, we notice sponges, mollusks, crustaceans, echinoderms, and various other types of invertebrate life. Among the divisions of these groups we recognize pteropods and gastropods, crinoids, sea-cucumbers or holothurians, gephyreans, polynoids, and many other sorts.

How is it that we are able to recognize these so promptly? The reason is that these earliest animals all fall within the several phyla or major groups as these phyla are defined on the basis of the living types alone. We do not have to expand our definitions of the phyla to include all the fossil forms of whatever age.

The very earliest vertebrates, crustaceans, insects, or mollusks were just as unmistakably vertebrates, crustaceans, insects, or mollusks as are the representatives of those groups which we find living at the present day.

What is the significance of this? It

can have only one meaning, and that is, that so far back as Cambrian times, at least, the major groups of animals bore the same relationships to each other that they do today.

This is an established fact concerning which there can be no doubt whatever. In spite of the numerous and profound changes that have taken place in the various sorts of animals included *within* each phylum, the interrelationships *between* the phyla themselves have undergone no change at all. No intergrading forms occur between any two of the major groups, and so far as we know no intergrading forms ever have occurred.

WHILE the fossils in the Cambrian rocks are the very earliest fossils that are adequately known, yet it is undoubtedly true that the Cambrian is much nearer to the present epoch than it was to the far distant time when life on earth began, so that conditions in the Cambrian are not necessarily those which obtained at the time of the origin of life.

The answer to this objection is that since we know that the interrelationships between the phyla or major groups run back without the slightest change to the Cambrian, it is more logical to assume a continuation of these interrelationships into the indefinite past than it is to assume, somewhere in the unknown pre-Cambrian ages, a change in the interrelationships, for which last assumption there is not the slightest evidence.

Since there is nothing to be learned bearing on the interrelationships of the phyla from a study of the fossils, in order to solve the problem we must rely on the data supplied by the study of the special science of embryology.

The details of the process by which all of the phyla or major groups presumably arose simultaneously, or practically so, from a primitive single cell are very complicated and too technical for repetition here. They are given at length in a paper entitled "The Origin of the Vertebrates" (*Journal of the Washington Academy of Science*, Volume 13, No. 7, April 4, 1923, pages 129–138) to which the interested reader is referred for these details.

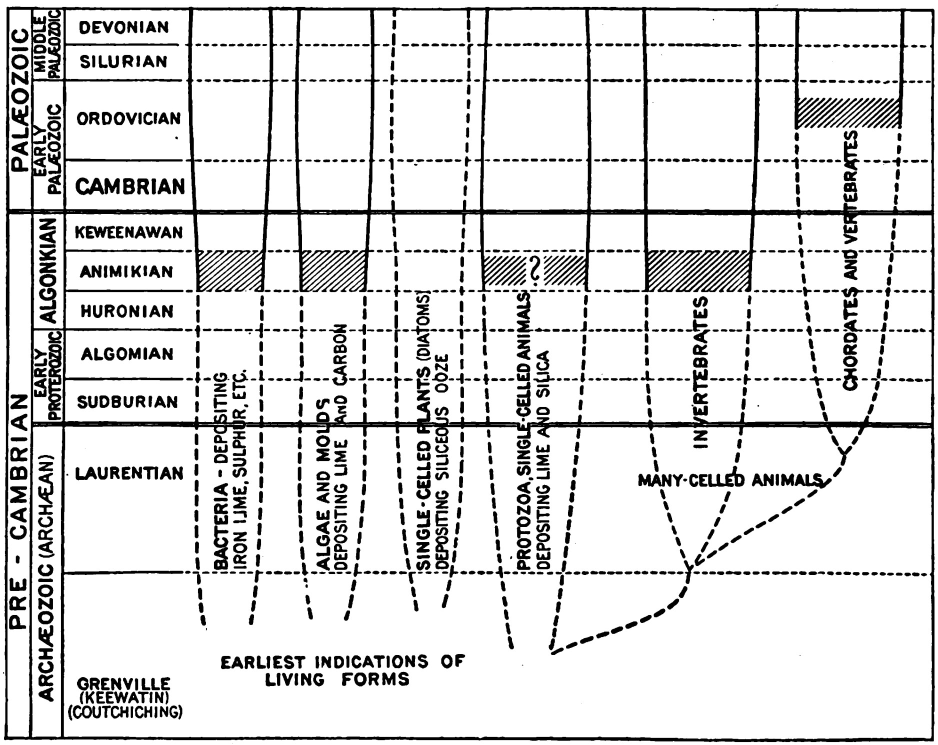
Thus, by a process which has been designated as eogenesis, all of the phyla or major groups of animals appeared simultaneously or nearly so. Although this sudden and simultaneous origin gives them the appearance of having arisen through special creation, *the origin of each may be traced back to the primitive single cell.* However, there is no evidence that single celled animals—the protozoans—are more primitive than other types, or preceded them.

By this process of eogenesis the phyla or major groups came into being, and each of these stands at the base of a separate and distinct evolutionary tree which rises upward through the ages.

THE branches, branchlets and twigs of these evolutionary trees are indicated by interrupted lines, the interruptions or gaps representing mutations whereby discontinuities in form and structure occurred between parent and child.

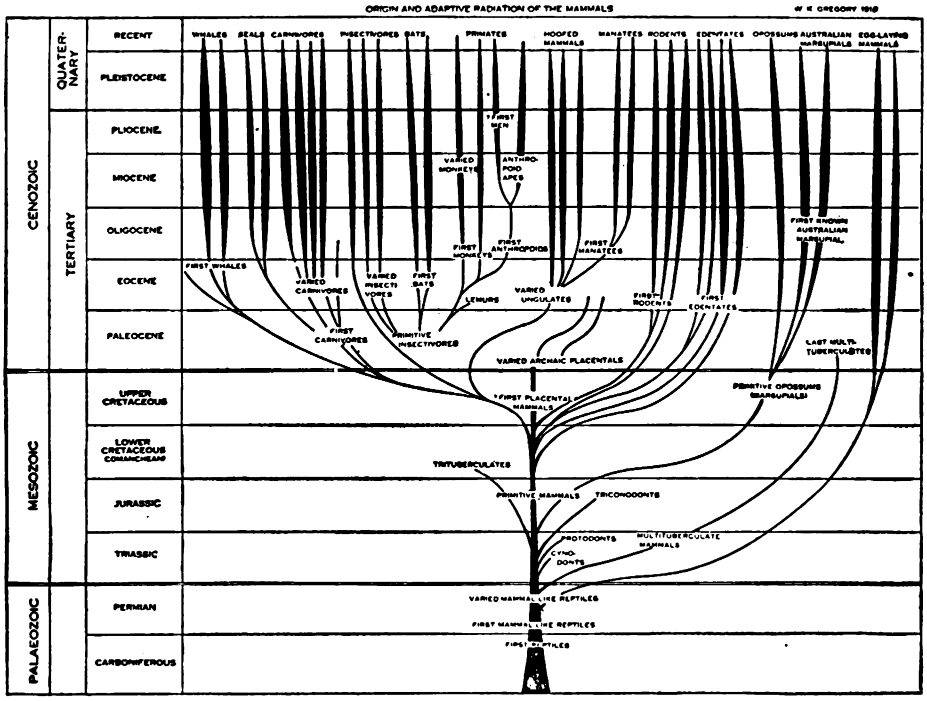
This is the picture of the development of animal life—of zoogenesis—which is to be drawn from the facts as we know them, and it is the only possible picture which is in accordance with those facts.

This new concept of evolution differs from the old chiefly in the assumption that the basic type in each of the major groups (phyla) arose through following a special developmental path from the primitive cell, the divergence for the most part beginning in the so-called gastrula, a developmental stage common to all animals except the sponges and the protozoans.


PALÆOZOIC
MIDDLE PALÆOZOIC
EARLY PALÆOZOIC
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
PRE - CAMBRIAN
ALGONKIAN
EARLY PROTEROZOIC
ARCHÆOZOIC (ARCHÆAN)
KEWEENAWAN
ANIMIKIAN
HURONIAN
ALGOMIAN
SUDBURIAN
LAURENTIAN
GRENVILLE (KEEWATIN) (COUTCHICHING)
BACTERIA - DEPOSITING IRON LIME, SULPHUR, ETC.
ALGAE AND MOLDS DEPOSITING LIME AND CARBON
SINGLE-CELLED PLANTS (DIATOMS) DEPOSITING SILICEOUS OOZE
PROTOZOA, SINGLE-CELLED ANIMALS DEPOSITING LIME AND SILICA
?
INVERTEBRATES
CHORDATES AND VERTEBRATES
MANY-CELLED ANIMALS
EARLIEST INDICATIONS OF LIVING FORMS

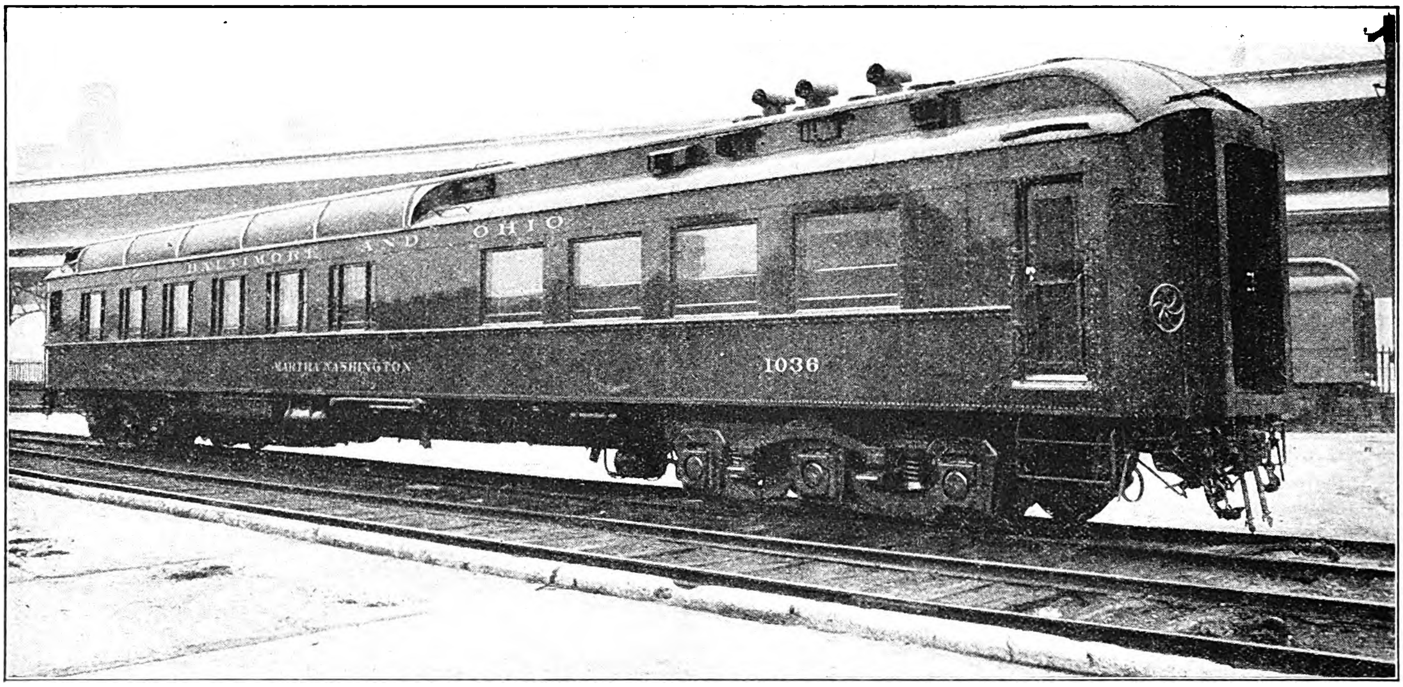
After Osborn "Origin and Evolution of Life." Courtesy Charles Scribners Sons

Earliest phyla of plant and animal life. Note the five shaded areas; these represent the geologic date of the earliest known fossil forms. The duration represented by the part of the chart below (earlier than) this date is about one billion years and the dotted line relationships are filled in wholly by inference


ORIGIN AND ADAPTIVE RADIATION OF THE MAMMALS
W K GREGORY 1919
CENOZOIC
MESOZOIC
PALAEOZOIC
QUATERNARY
TERTIARY
RECENT
PLEISTOCENE
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
UPPER CRETACEOUS
LOWER CRETACEOUS COMANCHEAN
JURASSIC
TRIASSIC
PERMIAN
CARBONIFEROUS
WHALES
SEALS
CARNIVORES
INSECTIVORES
BATS
PRIMATES
HOOFED MAMMALS
MANATEES
RODENTS
EDENTATES
OPOSSUMS
AUSTRALIAN MARSUPIALS
EGG-LAYING MAMMALS
? FIRST MEN
VARIED MONKEYS
ANTHROPOID APES
FIRST MONKEYS
FIRST ANTHROPOIDS
FIRST MANATEES
FIRST KNOWN AUSTRALIAN MARSUPIAL
FIRST WHALES
VARIED CARNIVORES
VARIED INSECTIVORES
FIRST BATS
LEMURS
VARIED UNGULATES
FIRST RODENTS
FIRST EDENTATES
FIRST CARNIVORES
PRIMITIVE INSECTIVORES
VARIED ARCHAIC PLACENTALS
LAST MULTITUBERCULATES
? FIRST PLACENTAL MAMMALS
PRIMITIVE OPOSSUMS (MARSUPIALS)
TRITUBERCULATES
PRIMITIVE MAMMALS
TRICONODONTS
PROTODONTS
MULTITUBERCULATE MAMMALS
CYNODONTS
VARIED MAMMAL LIKE REPTILES
FIRST MAMMAL LIKE REPTILES
FIRST REPTILES

After Osborn "Origin and Evolution of Life." Courtesy Charles Scribners Sons

Ancestral tree of the mammals. The base of this tree corresponds to the branch labeled Reptiles, at the center of the complete tree on page 104



Exterior of dining car. Much of the air-cooling and air-conditioning apparatus is concealed underneath the car. The curved hood along the top of the car at the farther end contains the air passages connecting with the louvres

Dining in a Refrigerator!

SUMMER rail travel is rendered uncomfortable by heat, dust, cinders, smoke, and noise. Engineers have been working for many years to mitigate these evils but the problem has been a most difficult one, for the air must be freed from all foreign matter before it can be dehumidified and cooled. A refrigerated car would be a great boon in traversing the great deserts of the southwest. Natural ice has been tried, but the expense was too great.

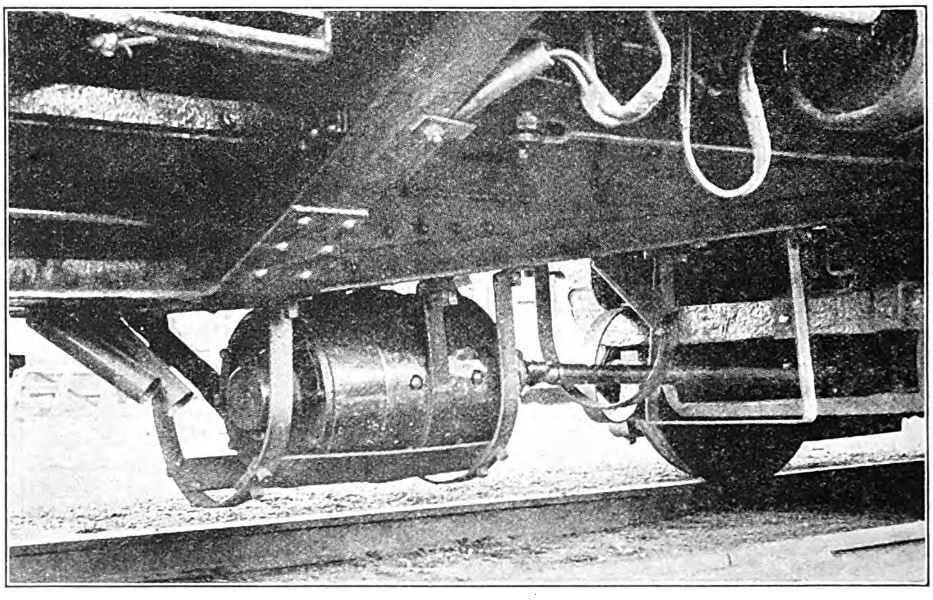
Now, however, the riddle apparently has been solved. The design and installation of the special equipment required was co-operatively worked up by the Baltimore and Ohio and the Carrier Engineering Corporation and the complete installation was made at the Mount Clare shops at Baltimore.

A run was made, with the full winter heating capacity of the car turned on. This was intensified by the heat of the kitchen and the warm weather outside. When the temperature reached 93 degrees, Fahrenheit, the new system was put in operation and in 20 minutes the temperature had dropped to 70 degrees, or more than a degree a minute. It was also shown that the temperature could be lowered considerably further but this would not often be necessary or desirable.

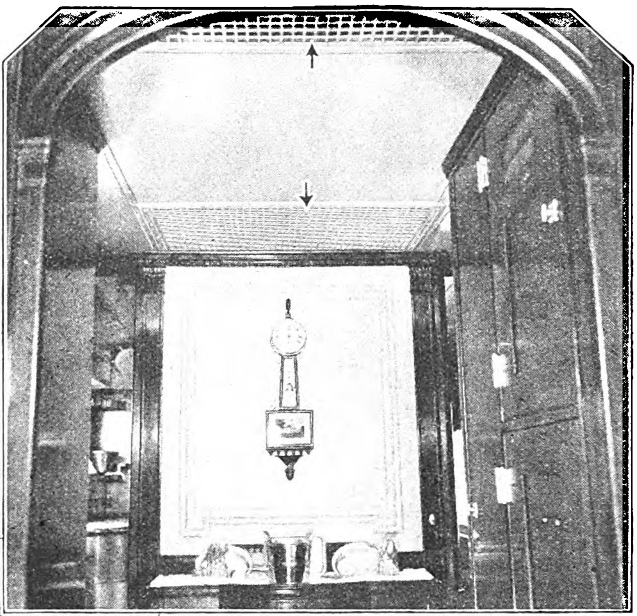
THE automatic control of the air-conditioning and cooling apparatus can be set by the steward or whoever is in charge of the car. The cooling equipment as well as the running gear of the car is so insulated with rubber cushions that vibration and noise are very largely eliminated. The car is also equipped with roller bearings.

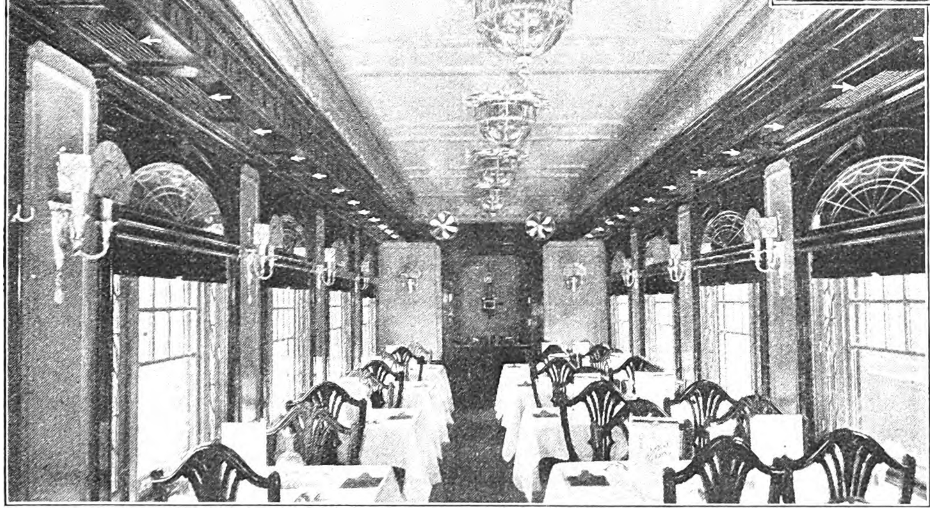
The cycle of operations will be understood by reference to the schematic diagram. The car is equipped with double sash windows which are kept closed at all times and the doors are opened and closed only to allow for the entrance and exit of the passengers and the train crew. The outside air is admitted through air filters located at the roof line. All the dust and cinders are removed from the air by mechanical filtration. The air is then cooled to the proper temperatures by passing over cooling coils. It is then carried throughout the car by overhead insulated ducts. There are no drafts created and the cool dehumidified air is distributed through louvres.

The equipment is electrically operated and as the requirements are in excess of the ordinary axle generator for lighting purposes, a special 10-kilowatt generator has been provided to supply direct current of 110 volts. The water used in the condenser is delivered by a motor-driven pump to a "cooling tower" or "spray unit" at the end opposite the kitchen where fresh air drawn from the outside is passed



The 10-K.W., 110-volt direct current gear-driven generator supplies the electrical energy for the operation of the air conditioning and cooling plant





Interior of the *Martha Washington*. Most of the apparatus is underneath the car and that part of it which is inside is concealed or worked into the decorations. Arrows indicate the louvres for air delivery. *At top:* Re-circulation vents at kitchen end. The air passes over cooling coils and is re-delivered

through the water spray, and thus the temperature of the condensing cooling water is brought back to approximately that of the outside air after which the water is available for re-circulation. The water which is lost by evaporation is taken from an overhead supply tank.

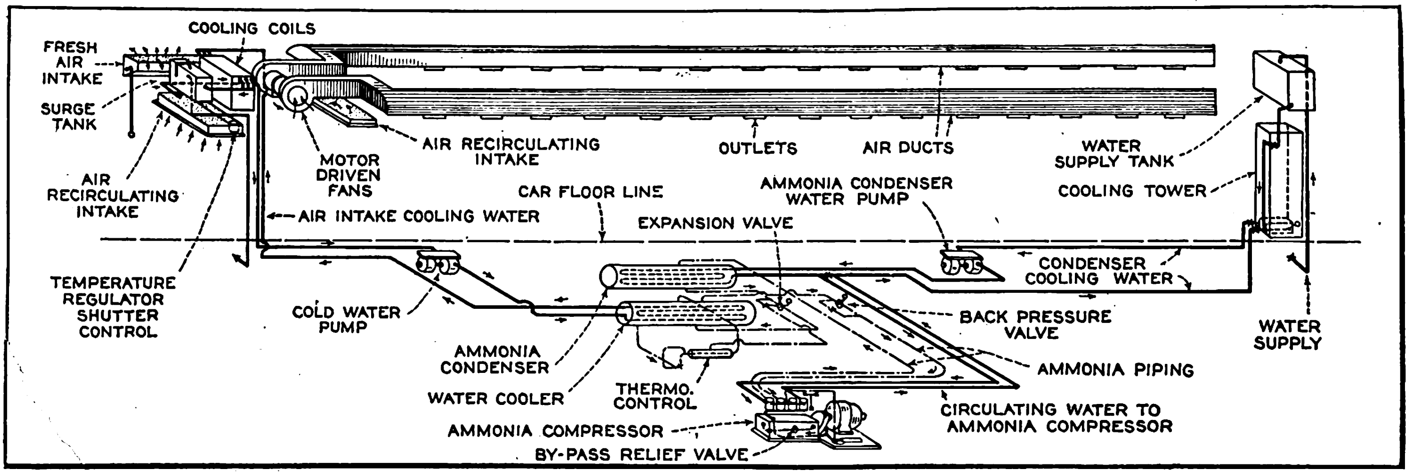
The temperature of the conditioned air which is delivered through the overhead louvres is dependent upon the chilled water in the cooling coils located overhead at the pantry end. This in turn is automatically regulated to suit the conditions by a temperature control device which through an arrangement of movable louvres so directs the re-circulated air as to prevent too low a temperature in the car. This is under the control of the steward of the car so that a comfortable temperature will be maintained at all times. If the temperature of the cooling water becomes too low, freezing of water in the evaporator may occur. To prevent this the back-pressure valve in the ammonia system will automatically cut off the supply of ammonia, thus preventing a further lowering of the temperature. The relative humidity can be controlled within certain limits depending on outside atmospheric conditions and the temperature maintained within the car.

At terminals and layover points, the equipment will be in operation sufficiently long in advance so that the car will have a comfortable temperature before being attached to a train. The system automatically begins operation when the train attains a normal speed under ordinary conditions. The time when the equipment is not functioning because of low speed, or while standing at stations, is so small that the loss would be negligible, and comfortable conditions can be maintained at all times.

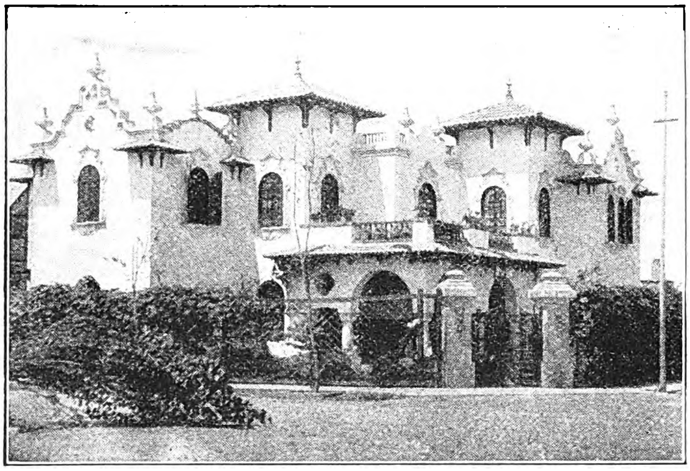
Early in July, 1929, tests were carried out by the Baltimore and Ohio Railroad and the Carrier Engineering Corporation with a coach. It is believed that this was the first railway passenger car ever so equipped for air conditioning and cooling. The equipment was applied about the first of July and the tests made during the hot summer months indicated that comfortable conditions can be maintained within cars whether fully or partially occupied by passengers under the worst conditions of temperature and humidity which are likely to prevail. The *Martha Washington* was the next step forward.

The tests of the *Martha Washington* were made by Col. Geo. H. Emerson, chief of motive power and equipment, J. H. Davis, chief of electric traction of the Baltimore and Ohio Railroad, and officials of the engineering company. This was the first car in service on any railroad to be so equipped.

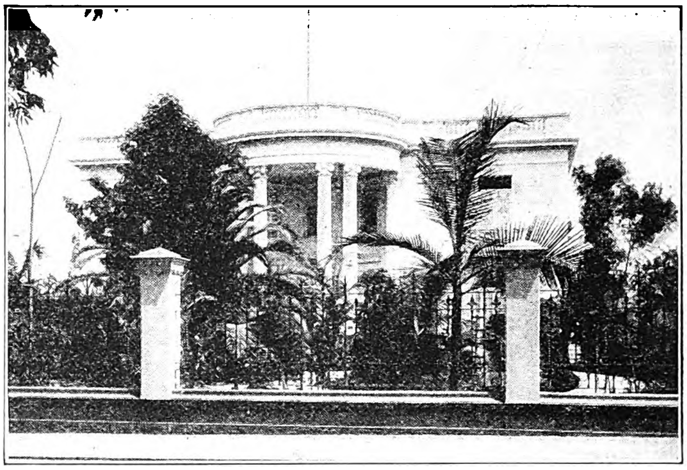
The next problem which should be attacked is the air conditioned and refrigerated sleeping car. This is a much greater engineering problem than the dining car for the reason that the cubical space to be treated is much larger, as quite a bit of the diner is taken up with kitchen, pantry, and passageways. There is an abundant field for the ingenuity of the engineer along this line of endeavor.


COOLING COILS
FRESH AIR INTAKE
SURGE TANK
AIR RECIRCULATING INTAKE
MOTOR DRIVEN FANS
AIR RECIRCULATING INTAKE
OUTLETS
AIR DUCTS
WATER SUPPLY TANK
COOLING TOWER
AMMONIA CONDENSER WATER PUMP
CAR FLOOR LINE
AIR INTAKE COOLING WATER
EXPANSION VALVE
TEMPERATURE REGULATOR SHUTTER CONTROL
CONDENSER COOLING WATER
COLD WATER PUMP
BACK PRESSURE VALVE
WATER SUPPLY
AMMONIA CONDENSER
AMMONIA PIPING
WATER COOLER
THERMO. CONTROL
CIRCULATING WATER TO AMMONIA COMPRESSOR
AMMONIA COMPRESSOR
BY-PASS RELIEF VALVE

Schematic diagram of air conditioning equipment, including piping



First glance at this Moorish type adobe house in Lima, Peru, would give the impression that it is of plaster



A home in Miraflores in the American colonial style. It is of adobe and might melt away in a heavy rain

Built of Mud

By A. HYATT VERRILL

WHEN we think of a mud house we usually visualize a mere hut or shanty, but in many portions of the world, mud, or adobe, is the principal building material. In the Orient, in sections of Europe, and particularly in Spanish America, buildings of adobe construction are the rule rather than the exception. Quite pretentious houses and other edifices are built of mud and, when stuccoed, whitewashed, or gaily painted, give no hint of the material of which they are composed.

In no other part of the world, however, has adobe construction reached such a state of development and attained to such heights as in Peru. Long ages before the Spaniards first set foot on Peruvian soil, the Incans and the pre-Incan tribes had learned the use of mud as a building material. Enormous walls, great mounds, countless dwellings, vast temples, and massive forts were built of the sun-dried mud bricks and blocks, and many of these still remain, little altered by time and the elements.

THE Dons followed their example and used the cheap and easily obtainable adobe in erecting their buildings. Their palaces, forts, homes, and churches were made entirely of adobe mud, and through the centuries these have endured and remain today as imposing and as beautiful as in the days of Pizarro.

It was left to the modern inhabitants of Peru, however, to carry mud adobe construction to the *n*th degree and literally to glorify mud. In and about the capital, Lima, is this particularly true. Of course, today, many of the business buildings, as well as residences, are of concrete or brick, but adobe still holds its own, and by far the greater number of Lima's homes, as well as a large proportion of its larger edifices, are entirely of mud.

In the days of the Conquistadors, the adobe bricks were merely piled one upon another to form the building walls, but today the usual method is to erect a light wooden framework and build the adobe upon this. In some cases metal frameworks have been used in connection with adobe. This method was employed in erecting the beautiful Rimac Building, perhaps the most elaborate mud building in the world. On the other hand, the world's largest mud building, the old Lima Cathedral, is built of adobe blocks without reinforcement of any kind.

Apparently there are no limits to what may be accomplished with mud in Peru. There are charming, one-storied bungalows with wide verandas, Moorish palaces, imposing colonial mansions, Elizabethan cottages, Spanish mission homes, and even turreted castles, all built of the same sun-dried mud dug from the land on which the edifice is built. So great is the demand for adobe that everywhere, 'round and about Lima, one sees endless piles and high walls of the mud bricks. At first one thinks these merely boundary walls between properties, but it will be noticed that in nearly every case these walls are marked: *"Este pared no es medianera"*—"This wall is not a boundary."

A mud building that has stood for over three centuries. The Torre Tagle Palace

ALSO, wherever there is available mud, one will see the natives industriously engaged in making adobe bricks.

The mud, dug from any convenient spot, is mixed with sand and usually with some chopped straw or dried manure. The resultant pasty mass is then pressed into wooden forms or frames. The shaped blocks are then removed and placed in the sun to dry and in a day or two are ready to use.

Brick making is a most

economical and inexpensive business for a man of limited means, or of no means at all. Provided he can secure permission to make use of the land, or a portion of its surface, for brick making—usually an easy matter, for the rental is taken out in completed bricks—the penniless brick-maker needs little more than his bare hands. With his wife and children, and all his worldly goods—which usually amount to nothing more than a few battered tins, and some hand-made stools—he camps upon the selected site. An ancient kerosene tin of water and a dilapidated shovel are produced. The dry earth is trod, dug, stirred, and worked into a thick paste; then some dry manure, gathered anywhere along the road, is added, and with all members of the little family helping, the bricks begin to take form. As soon as they dry they are piled in tiers.

In a few days the brickmaker and his family are surrounded by brick walls and are living quite comfortably and snugly in a little cavity left purposely for their accommodation. Here they remain as long as bricks can be made and sold on the land. And when an adobe building is in process of erection, the laborers invariably dwell within recesses in the piles of accumulated bricks—thus saving house rent—and tramp back and forth to their work.

WHEREVER a Cholo can find a mud-brick wall and employment, is "Home Sweet Home" to him, and often one may find a dozen or more families all dwelling in perfect contentment in their burrows in the piles of bricks where building is in progress.

In a damp or rainy climate, these dried mud-bricks would, of course, be worse than useless; and, should Lima be subjected to a few days of really heavy rains, most of the city and its suburbs would be reduced to the original, elemental mud. Several times within the past few years, various portions of Peru have been visited by unprecedented rains during the winter months, and great has been the havoc wrought. Around and about Trujillo, houses and churches melted like snow exposed to sunshine, and even the prehistoric ruins of the Chimu city of Chan Chan, which has stood unaltered for countless centuries, slumped and dissolved.

The fine old Cathedral in Lima, the largest adobe building in the world, built in the Sixteenth Century

To protect buildings from the drip from the eaves, practically all modern adobe buildings have several feet of the wall covered with concrete, while others have the lower portions of the walls built of stone, or stone and concrete. Even the old cathedral, which is not only the largest but one of the finest adobe buildings in the world, has been safeguarded with a concrete coating about the base of its walls.

Originally, too, the adobe buildings were all very much alike. They were massive, thick-walled, square, and usually of moderate height, were typically Spanish with iron-grilled windows, out-jutting carved cedar miradors, immense iron-studded and elaborately carved doors, and open patios. But with the modern improvements in adobe constructive methods, architecture appears to have run wild, and there is scarcely a type or style of buildings known to any part of the world the counterpart of which cannot be seen in or about the Peruvian capital.

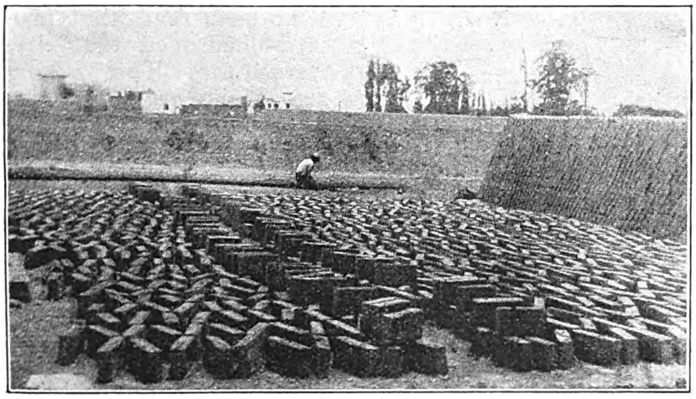
Apparently the average Peruvian never has a definite plan in view when he starts building a house. He may start with a Spanish colonial form and by the time the first story is complete, he decides that the English style is better. He then adds a second story with exposed timbers, leaded glass windows, and stucco walls. Then to the steeply-pitched roof, he adds Spanish tiles, and among the chimney-pots erects a cupola where he can loll away many a hot evening.

HIS front door may be a graceful Moorish arch, but to put a finishing touch to the whole he adds the lofty pillars and severe portico of some Virginia mansion, and builds a *porte cochere* in Japanese style.

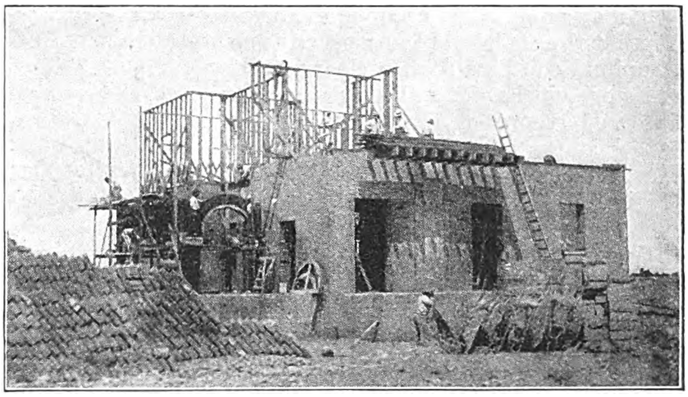
But with all his architectural failings, he loves color, and so paints his home in brilliant ultramarine, rose-pink, canary-yellow, or a combination of all. And, strange as it may seem, these architectural monstrosities do not strike a discordant note in the scheme of things. Surrounded by glorious flower gardens and magnificent pines and luxuriant palms, their bright hues are delightful, and one forgets their faults in admiration of the masses of roses and geraniums which clamber over walls and droop from the eaves.

And there are countless dwellings which are as charming and as perfect in their architectural features as one could wish.

Truly, the Peruvians have glorified mud, and by the same token, they have attained the utmost in building economy, for what could be more economical than to build one's home from the crude material dug from the land when excavating foundations or grading one's garden?



"Not a boundary wall." Piles of bricks ready for use and others drying in the sun at a native brick "factory"



Building an adobe house with a wooden frame. Construction is quite simple but the structure is substantial

Basic Patents in Evolution—I

By WILLIAM K. GREGORY

Professor of Vertebrate Paleontology, Columbia University. Curator, Departments of Anatomy and Ichthyology, American Museum of Natural History. Member, National Academy of Sciences

THE latest airship, crowded with powerful motors and directed by means of numerous instruments of precision, at first sight seems bewildering in its complexity; yet with a little assistance from the experts, one readily comprehends at least the general purpose and arrangement of its principal parts. The human body is vastly more complex than any airship, both in its locomotor machinery and in its instruments of precision; but at least the leading features of its construction and operation may be outlined with but little resort to the technical jargon of the anatomist and the physiologist.

In the case of the airship every mechanism and device doubtless has been developed from some earlier and simpler predecessor, which in turn rests eventually on one or more "basic patents," or primary inventions. An expert willing to search the records of the Patent Office could easily trace the steps in this evolution. Unfortunately, during the long ages when the "basic patents" of the engines of the human body were being tried out in Nature's testing grounds, no patent office records were being made. Nevertheless, the labors of several generations of comparative anatomists, paleontologists, and embryologists have enabled us to piece together the probable history of the human body by comparative methods, which do not differ essentially in principle from those that have been employed successfully by the archeologists or the Egyptologists in reconstructing the main sequence of historical events during long periods of time.

IT may be affirmed on good evidence that the skeleton of any given type of animal contains both a clear record of its present habits and a more or less obscured record of the habits of the earlier stages that led up to it. For example, the skeleton of a penguin (Figure 1, A) reveals many features, such as the paddle-like form of the wing bones, that are obviously connected with this bird's peculiar habit of "flying" under water. Yet many other features, such as the keeled breastbone, testify that the highly specialized and now flightless penguin traces its remote origin to birds that used their wings for flight in the air in the normal way. Again, the skeleton of a vulture (Figure 1, B) is beautifully adapted in very many ways for the habits of this bird of strong flight and predatory instincts. But it also abounds in other characters that have been inherited from the earliest reptiles that first began to skim down from the trees and flap their large skinny arms in the first feeble attempts at flight.

Examples could be multiplied of similar instances in which the "basic patents" acquired by earlier generations are transmitted, even though much disguised in external appearance, to remote descendants. In more technical language, the "habitus" (or totality of characters that adapt an animal to any given mode of life) may, under changed environments and habits, persist in part as the "heritage" of later times.

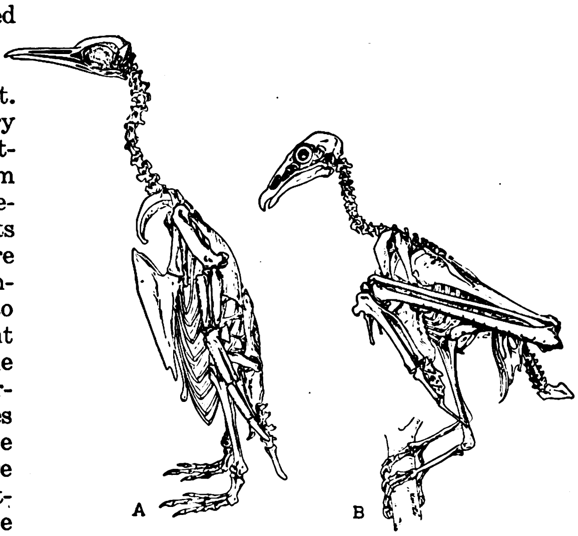


Figure 1: **Skeletons of penguin (left) and of vulture (right), showing swimming "habitus" of the penguin and strong-flying "habitus" of the vulture. Both retain many features in common, which constitute the primary "heritage" of birds**

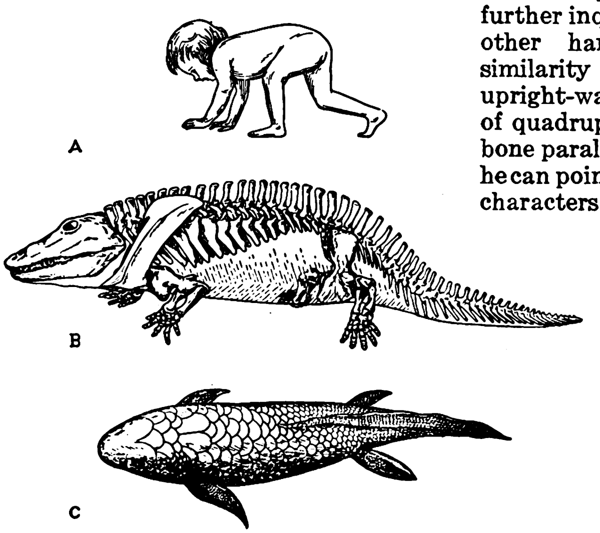


Figure 2: **Man's heritage from quadrupedal ancestors. *A* is a human infant running on all fours (after Hrdlicka). *B* is an ancient quadruped (*Eryops*) from the Permian age of Texas. *C* is an air-breathing fish (*Ceratodus*) with paired paddles corresponding to our arms and legs (oblique view from above) (after Dean)**

With this well established principle in mind, let us make a preliminary comparison (Figure 3) of the human skeleton with those of other animals for the purpose of determining its present "habitus" and of uncovering its prehuman "heritage." As to the "habitus" characters, even a cursory inspection of the human skeleton reveals the fact that it is beautifully adapted to support the body in the erect position, with the center of gravity a little above the points of support at the hip joints, immediately above the limbs. The human pelvis (the hip bones) is likewise fitted in many other ways to act as a bony anchor for the muscles that tie in the abdominal viscera, and as a base for the powerful thigh and back muscles that hold the body erect.

THOSE who believe in the sudden creation of Adam from the dust of the ground usually go no further than to say that such adaptations are part of the Divine Plan, and that the origin of this plan is one of the inscrutable mysteries of creation. But in practice such a philosophy usually blocks further inquiry. The naturalist, on the other hand, points to the basic similarity of the entire skeleton of upright-walking man to the skeletons of quadrupeds that run with the backbone parallel to the ground. Moreover, he can point to a long series of "heritage" characters in the human skeleton which appear to be inexplicable on any other scientific hypothesis than that man is a quadruped that has learned to walk on his hind legs (Figure 2). In the anatomical sense man is still a quadruped, since his fore limbs clearly correspond, bone for bone and muscle for muscle, with those of his nearest quadrupedal and semiquadrupedal relatives, the apes and monkeys.

To review even the main steps in the long ascent from fish to man would be too extensive an undertaking for our available space, as the technical papers bearing on the subject run into many hundreds; but nevertheless let us attempt to notice a few of the many "basic patents" along the way.

There is not much use in inquiring here where the fish itself came from, for professional opinion hesitates between the "jellyfish" and the earliest sea-scorpions or eurypterids. But wherever he came from, the shark is already far nearer to man in his anatomical ground-plan than he is to any known animal that completely lacks a backbone. For this reason the humble dogfish, or small shark, is recognized everywhere as a veritable epitome of human anatomy, and all properly qualified pre-medical students find that dissection of the dogfish gives them a welcome clue to the anatomical intricacies of their future patients.

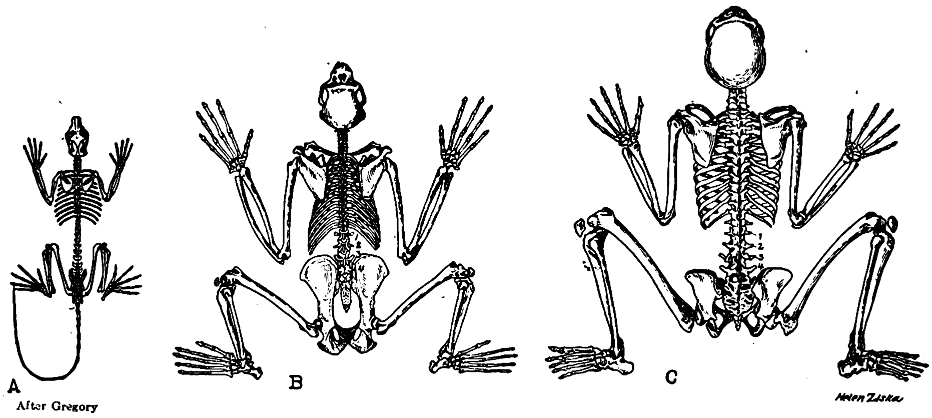
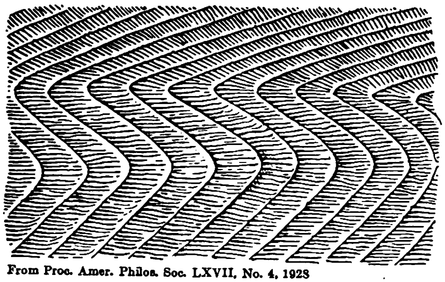


Figure 3: **Man's heritage from his anthropoid ancestors. *A* is a skeleton of an ancient fossil primate from the Eocene age. *B* is a skeleton of a chimpanzee. *C* is a skeleton of man, placed in the same position as *A* and *B***

LET us consider first the shark's locomotor machinery and then inquire what parts of it are still recognizable in human anatomy. The "basic patent" of the entire locomotor machinery of the shark is the striped, or voluntary, muscle fiber (Figure 4). The mechanism of this simple-looking little thread is slowly yielding its secrets to the siege of the physiologists. The muscle fiber has been broadly characterized as a "tiny gas engine," but it differs from an ordinary gas engine in using its oxygen in the recovery stage rather than in the work-producing stage. Vast numbers of the red muscle fibers of the shark are grouped in broad zigzag zones called myomeres, or muscle segments, arranged in tightly packed rows along the sides of the body. The ends of the muscle fibers are fastened to the connective tissue partitions that both separate and connect adjacent myomeres. By means of the delicate nerve fibrils that run to each red muscle cell the contraction of the myomeres is timed so that a wave of contraction runs along the side of the body from front to rear. But soon after the first wave starts along the body, a second begins on the opposite side, then a third on the same side, and so forth. By this very simple device the body of a long-bodied fish is itself thrown into a series of backwardly-passing waves, which by their reaction against the water, drive the fish forward.



From Proc. Amer. Philos. Soc. LXVII, No. 4, 1928

Figure 4: **Diagram of arrangement of muscle fibers as shown on the inside of a piece of dried shark's skin. In this "basic patent" of the locomotor machinery of all vertebrates from shark to man, the horizontal red muscle fibers are attached to zigzag connective tissue partitions, or "myosepta," the whole W-shaped muscle segment forming a "myomere"**

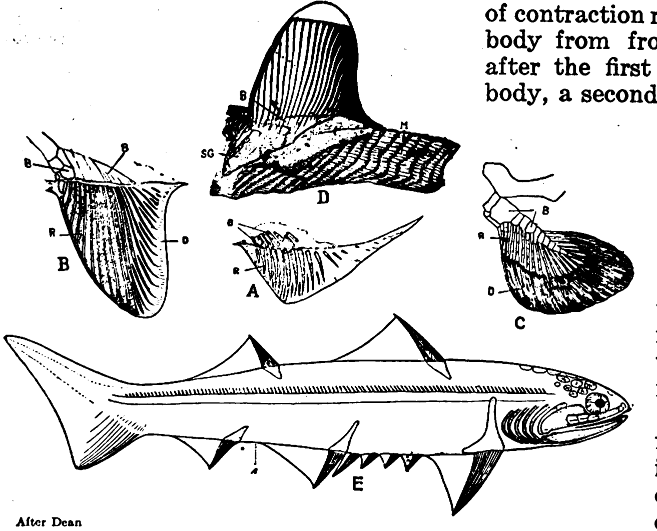


Figure 5: **Origin of fins from fin folds. *A:* Ventral fin of Devonian shark (*Cladoselache*), showing separate rod-like supports of "fin-fold" fin. *B:* Pectoral fin of the same, showing pectoral girdle and basal pieces presumably derived from fusion of separate rods. *C:* Pectoral fin of Permian shark (*Pleuracanthus*), showing fully developed paddle-like fin with jointed axis. *D:* Pectoral fin of Devonian shark (*Cladoselache*), partly covered by preserved myomeres. *E:* Restoration of generalized shark**

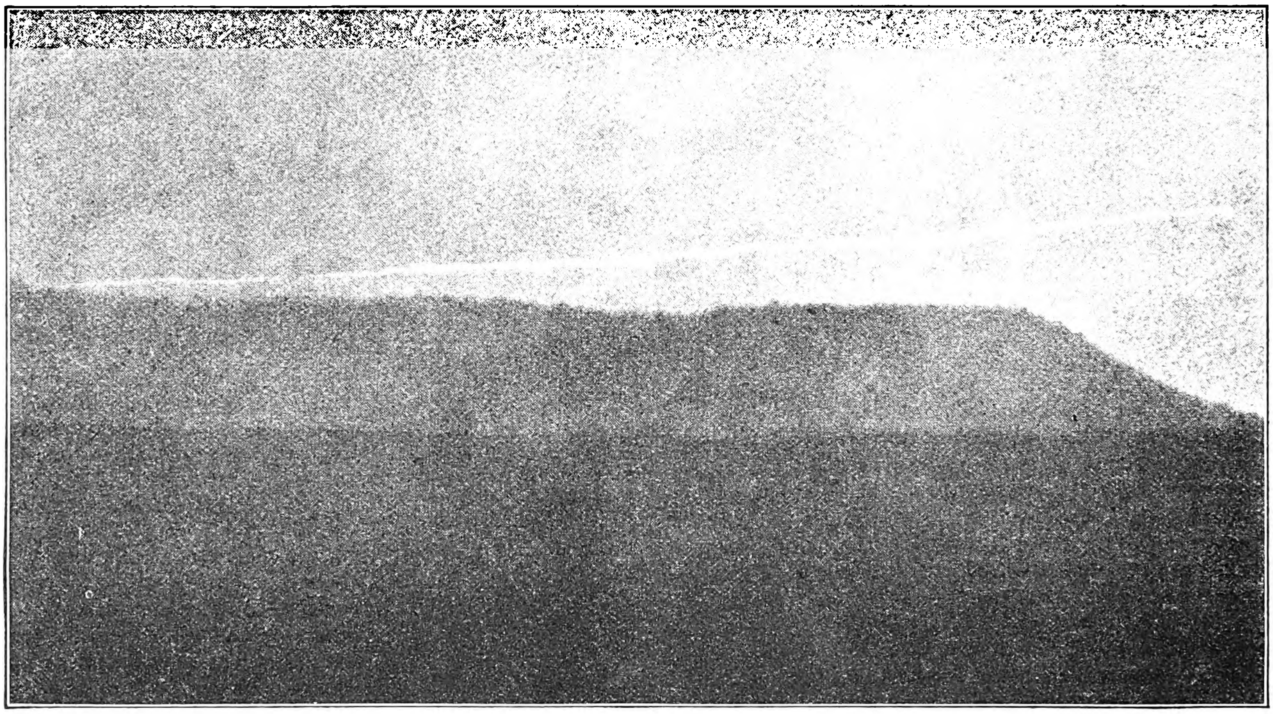
This simple arrangement was also the starting-point for the most complex locomotor machinery of the higher vertebrates. The zigzags of the myomeres soon lose their primitive simplicity. In some sharks, as we pass along the side of the body toward the tail, the tips of the zigzags become greatly prolonged and the connective tissue sheaths of corresponding tips of successive zigzags tend to adhere and unite so as to produce tendons that transmit to the tail the pull of the less modified muscle segments farther forward. And in higher fishes those parts of the muscle zigzags that control the movements of the pectoral fins often fuse into compound muscles that clearly suggest the muscles that move the limbs in the higher vertebrates.

The fins in the most ancient and primitive known fishes, the sharks of the Devonian period (Figure 5), were merely stiff folds of skin which were slightly warped by the zigzag muscles of the flanks, and mainly served as keels and rudders to steady and direct the forward progress of the fish. In some of the higher fishes, on the other hand, the bony rods that supported the paired fins fused into a skeleton that appears to have been the starting-point of the complex shoulder-girdle and fore limbs of land-living vertebrates. The pelvic fins of fishes bear even clearer traces of their derivation from keel-like fin-folds, the bases of which became invaded by outgrowths from the segmental muscles of the body (Figure 5, A).

DURING the embryonic development of all higher vertebrates, including man, the fore and hind limbs develop from bud-like outgrowths involving folds of skin from the body wall and an extension of the segmental muscles of the flanks.

In short, the detailed evidence of comparative anatomy leaves no substantial doubt that upright-walking man has derived all four of his limbs from the corresponding organs of some early four-footed animals, that these quadrupeds derived their limbs from the paired paddles of certain types of air-breathing, lobe-finned fishes, and that they in turn derived their paddles from the simple fin-folds of still earlier shark-like fishes. Such were the "basic patents" of our motor system.

(*To be continued*)



It is a commonplace that we "see the sun after it actually has set," due to the bending of its rays (atmospheric refraction) by the earth's atmosphere. Above is a photograph of the trail of the star *Alpha Centauri*, made by time exposure in a 24-inch fixed telescopic camera by Professor W. J. Luyten of Harvard's South African observatory. The star dips behind the theoretical horizon by as much as the diameter of the moon, yet is visible above it due to refraction. The telescope, of course, is not moved

The "Green Flash" and Other Odd Phenomena

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

As one watches the setting sun, it sometimes takes strange forms. Always when it is low on the horizon it appears flattened, with its vertical diameter considerably shorter than the horizontal, and just before the lowest point of the rim disappears it may be noticed that the lower half of the disk appears more flattened than the upper. These are normal phenomena which can be seen whenever clear weather and the free horizon permit, but not infrequently—especially when the sun goes down into the sea—its shape may seem strangely distorted. At times the lower half may look larger vertically than the upper, so that the partly set sun looks like a Chinese lantern. The likeness often is emphasized by the appearance of little corrugations in the outline of the upper dome-like half. On other occasions the top of the sinking sun, instead of disappearing quickly, seems to hang on the horizon as a fine horizontal line of light.

It is not the sun alone which shows these strange vagaries. A distant coastline may look distorted. Low sand banks sometimes seem expanded into high cliffs or a long line of distant coast which normally runs out at the horizon, may seem to end in the air with a narrow line looking like sky, separating it from the sea surface below. Ships on the horizon or beyond it, too, are often absurdly distorted, so that only the experienced sailor long familiar with the effects of what he calls "looming" has any real idea of what sort of craft it may be at which he is looking.

Most remarkable of all are the things that are seen upon the desert.* A level stretch of hot sand may appear to be covered with water, reflecting not only the sky but the barren hills beyond and producing a perfect illusion—as the writer has seen it within a few days on the sandy wastes of Nubia.

These more conspicuous phenomena, whether on land or sea, are grouped under the general name of mirage. Though visible and sometimes conspicuous to the unaided eye, they usually show up better with a field glass of low power. But when a high-powered glass is used—much more a telescope—the image is found to be so blurred and trembling that very little can be made out. Just at the edge of the mirage, indeed, the bad definition is often perceptible even by the naked eye.

All this is interesting, surely, to the traveler but what has it to do with astronomy? "Much every way," as Saint Paul once said—it is the most spectacular exhibition of something with which the astronomer has to reckon in all his observations—namely, the refraction of light in the atmosphere.

In empty space all the waves of light travel with the same standard speed but in air they are retarded, and the more so the denser the air. As a result the "rays" of light—that is to say lines drawn at right angles to the waves and indicating in what direction the

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*Dr. Russell s article was written in Egypt, where he had just seen some of the phenomena described in it.—*The Editor.*

latter are moving—are usually curved when passing through the air, instead of straight as they are outside in space. One simple rule suffices for an understanding of most of the numerous effects of such refraction. The rays of light always curve toward the side on which the air is denser. Why this happens can be seen at once from Figure 1, which represents a number of successive positions aa', bb', and so on, of the crest of a light wave. The air is supposed to be denser toward the bottom of the picture than toward the top, hence the distances ab, bc, and so on, through which the light wave moves, will be greater than a'b', b'c', and so on (the effect is of course vastly exaggerated in the figure). The rays of light XY and X'Y', which are drawn so as to be always at right angles to the waves, will therefore curve downward; that is, toward the denser air.

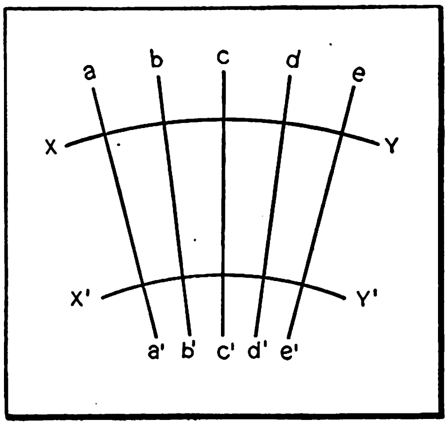


Figure 1: **Explaining the cause of refraction or bending of light. See the explanation in the text**

UNDER normal circumstances the air grows steadily denser downward from great heights to the earth's surface. Hence the rays of light curve downward and the direction in which they enter our telescope or our eyes is altered so that we see the sun, moon and stars higher in the sky than they would appear were there no atmosphere.

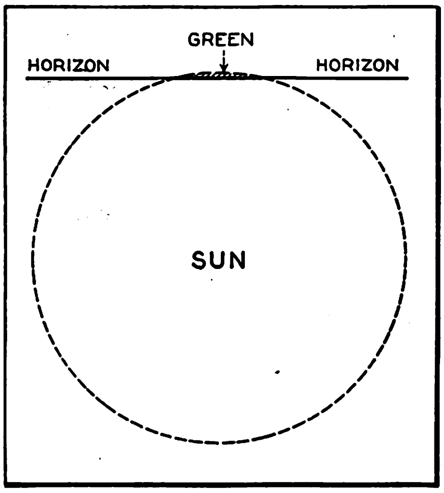
The more obliquely the rays traverse the air the greater is this effect. At considerable altitudes the shift of apparent position by this "astronomical refractor" is not very large—about a minute of arc at 45 degrees altitude. In all accurate observations, of course, it must be carefully allowed for—which is laborious since its amount varies with the pressure and temperature of the air. Near the horizon the refraction becomes large, amounting at rising and setting to more than half a degree. For bodies only a little higher, its amount is considerably reduced. When the sun is setting, therefore, the rays from its lower side are more curved than the less oblique rays from its upper side, the lower limb appears to be raised more than the upper, and the disk seems flattened. It may be noted in passing that refraction makes the sun set later than it would otherwise do, and rise earlier, since it raises the sun in both cases, so that the day gains about 5 minutes in length in temperate latitudes at the expense of the night.

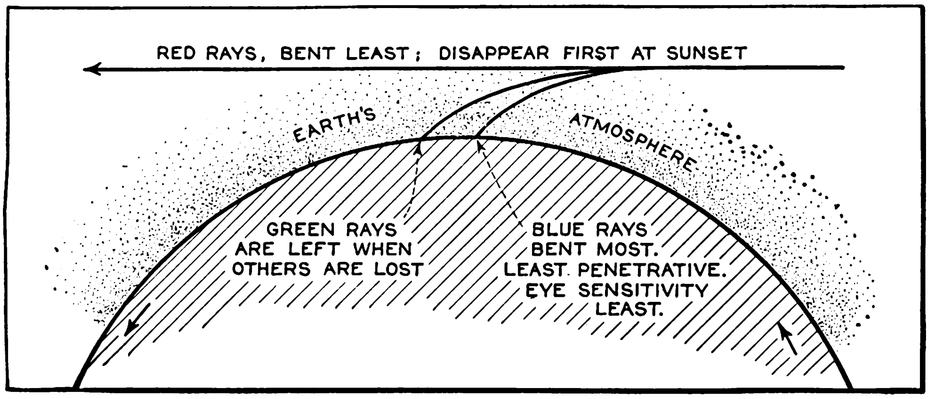
Before leaving this normal refraction we may mention an interesting effect which, though of the "second order" depending on small changes in a quantity which itself is usually small, can be easily observed without instruments.

Shorter waves are more slowed by air than longer ones, and hence the rays of red light are curved least and the violet most. When the sun is low, therefore, it appears to be raised a little higher if seen by green light than by red, and if viewed through a telescope its disk shows a greenish border at the top and a reddish one at the bottom (the violet is always lost in coming through so great a thickness of air). This border is far too narrow to be seen by the unaided eye, but just as the sun sets the green image remains in sight for an instant after the red and yellow have disappeared, so that under favorable conditions the last speck of sunlight can be seen to turn from yellowish red to green.

This "green flash" (Figure 2) is a normal phenomenon and can be seen unless something interferes. Unfortunately a good many things may interfere. The air, of course, must be clear and free from haze. There is little hope of seeing it unless the setting sun looks yellow rather than red, and is too bright to look at without dazzling the eyes. The horizon must be fairly distant, sharp, and at a low altitude. A sea horizon or a low distant range is the best. Finally the eye must not be fatigued by gazing at the brilliant disk before it sets. A mere glance now and then to see how things are going is all that the observer should allow himself until hardly more than a speck of the sun remains. Granting these conditions the green flash is visible under a great variety of conditions. It is better seen with a field glass than without. At sunrise, of course, it is equally well visible, with the advantage that the eye is not tired, and the disadvantage that one must keep a sharp watch not to miss it.

Figure 2: **The phenomenon of the green flash is not especially spectacular; it occurs when less than 1/100 of the disk remains in view (right). Below is the explanation of the effect (diagrammatic)**




RED RAYS, BENT LEAST; DISAPPEAR FIRST AT SUNSET
EARTH'S
ATMOSPHERE
GREEN RAYS ARE LEFT WHEN OTHERS ARE LOST
BLUE RAYS BENT MOST. LEAST PENETRATIVE. EYE SENSITIVITY LEAST.

MIRAGE, including in this term all the protean forms of distorted images of celestial and terrestrial objects, arises from abnormalities of refraction mainly if not entirely due to irregular distribution of temperature within the air. The normal and gradual increase of density downward is due mainly to the increase of atmospheric pressure. To be sure, the air is warmer low down than higher up; and this works the other way, though under ordinary conditions to a much smaller degree than the change in pressure.

When, however, the earth's surface, whether land or water, is considerably hotter than the air at large and the weather is cooler, a thin layer of air just above the surface may be heated so much that it becomes considerably less dense than the overlying cool air, even though it is at a slightly higher pressure. Rays of light passing through this stratum will be curved upward, as illustrated in Figure 3, which shows how the illusion of a sheet of water filling a desert plane will be created. The distant object A is seen by the observer at O, through the upper layer of normal air, by light which follows the path AaO, which is curved very slightly downward. Light rays traversing the layers of hot air near the surface indicated by the lower lines will

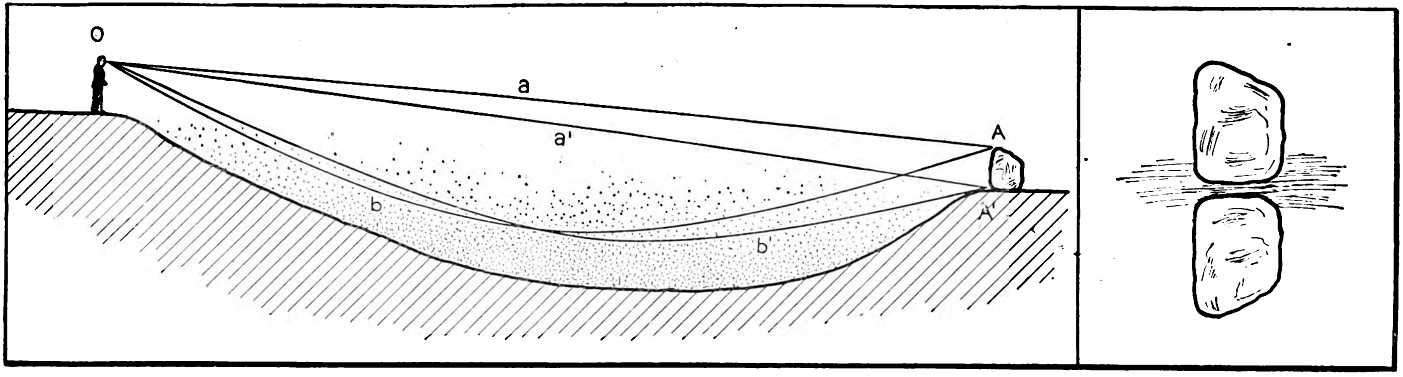


Figure 3: **Explaining the familiar illusion of a lake on a desert, also at right the rock at A is seen doubled, a "superior mirage"; see Humphrey's "Physics of the Air," standard work in which peculiar phenomena are treated**

be curved strongly upward so that the observer may see a second image of A, caused by light which has followed the path AbO. The base A′ of the object will be seen both along the rays A′a′O and A′b′O, so that the observer will see two images, one erect and in its normal position and another inverted and lying below it as if reflected in a sheet of water filling the valley.

Mirages appear most typically under two very different conditions: first, on land where the bare surface of the ground is highly heated by the sun, and secondly at sea where the vicissitudes of the weather bring cooler air over warmer water. The first situation is characteristic of desert regions, but one need not go to the borders of the Sahara nor to Death Valley to find it. Almost any bed of level railroad track on a calm sunny day will suffice, and a stretch of level oiled highway still retaining the heat of the sun though the air above has cooled after nightfall, does even better. Most of us have seen a distant locomotive looking twice as high as it should, and it is a common thing looking from an observation tower to see the space between the rails apparently filled with water. Almost all of us, too, have seen the lights of an approaching car half a mile or so away apparently refracted from the pavement of the road; and all these are as truly examples of mirage as the proverbial "lakes" in the desert.

ALONG our coasts, too, when the autumn days and evenings are cool and the water still retains its summer heat, distant shores seem lifted into the air, ships are strangely distorted, and far-away light-houses show double lights one above the other. No one can live long by the water without seeing these things, but not so many understand them.

Another effect of these anomalies of refraction is that the distance of the horizon at sea, or of the farthest objects that are visible on land, may be very different on different days, or even at different hours of the same day How this happens is again best understood from the diagram. Figure 4 almost explains itself. In the absence of refraction the rays of light are straight and the horizon at A. When there is a stratum of hot air close to the surface the rays curve upward and the horizon is nearer at B, but when the air near the surface is abnormally cold the rays curve downward and the horizon is shifted to C.

It is clear from the figure that not only the distance but the apparent direction of the horizon is altered. As a result the dip of the horizon, for which allowance has been made in all observations, may differ perceptibly from the standard value given on the tables employed by mariners. The error arising from this cause is often a good deal larger than any other which occurs in careful observations with a good sextant, and it sets a limit to the accuracy of determination of longitude and latitude at sea; but fortunately the uncertainty arising from the cause is usually less than the distance which the ship would run while the captain is "working his sights," and so it is not of practical importance.

THE diminished distance of the horizon under mirage conditions is not very noticeable, but the increase when the air is cold close to the ground may be very remarkable. On the Texas prairies, where the ground is as level as the sea, and distant buildings look like ships "hull down," the writer has seen just before sunrise houses and farms which were ordinarily quite invisible. Within a few minutes after the sun's rays warmed the ground these began to settle down into the horizon and before long they had quite disappeared. Under these conditions in clear weather the mariner may see light houses which normally would be far beyond the horizon.

The most remarkable instance of refraction which the writer has seen happened one afternoon in a New England harbor when the sea horizon was clearly visible above the top of a house on an outer beach, although the observer in a small motor boat had his eyes less than six feet above the water. In this case the downward curvature of the rays must have been so great that, although passing above the house (fully 30 feet above sea level), they bent down to the water within a few miles on each side.

IF the layers of warmer air were horizontal and absolutely calm the reflected or distorted images of a mirage would be sharp and clear, but even in the stillest weather there is always more or less stirring of the air, if only by currents arising from the hot ground, and this turbulence confuses and disturbs the images so that they bear at best only a low magnifying power. This is but an extreme instance of the "bad seeing" which is always more or less present and is so troublesome to the telescopic observer. If the atmosphere were visible like water, its turbulence then would be far more impressive than it is. In comparison the wild turbulence of Niagara Rapids would seem quite tame.

All the phenomena of atmospheric refraction, whether normal or abnormal, are an unmitigated nuisance to the astronomer but they are so varied, so curious, and so easily to be seen if one is on the watch for them that some knowledge of them may add interest and pleasure to a summer vacation.—*Luxor, Egypt.*

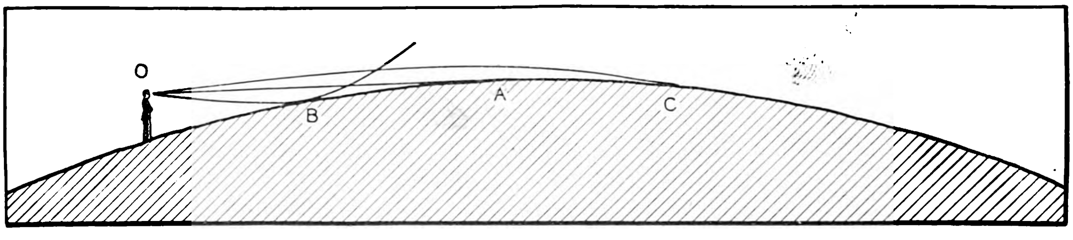
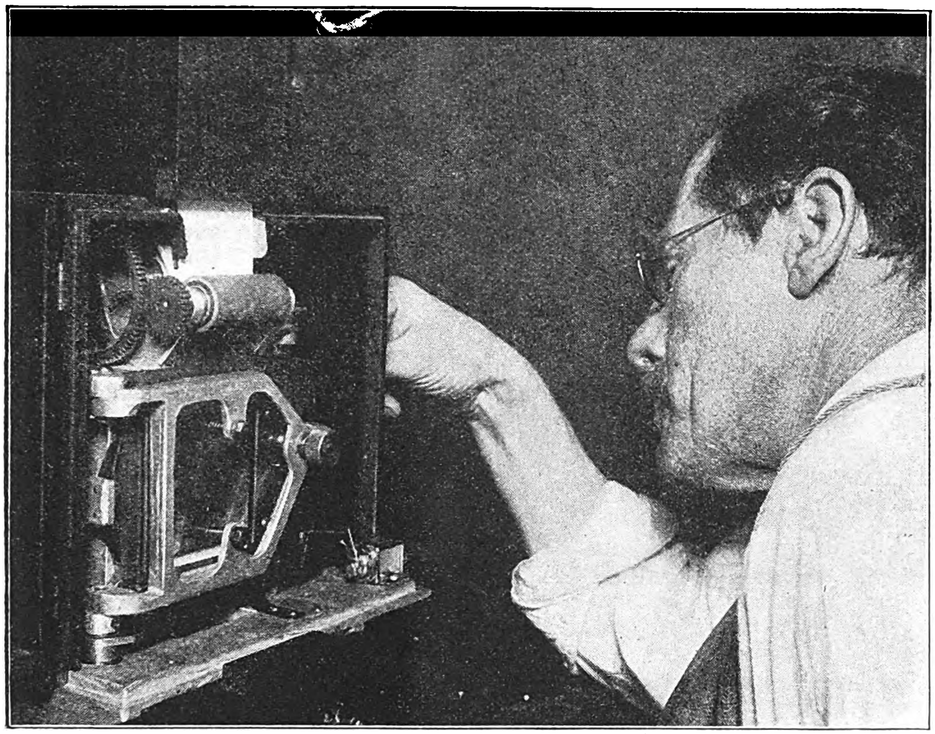


Figure 4: **Why different temperature effects cause the horizon to vary in distance**



The electrical photographing mechanism is automatic. The photograph is taken through a screen and it, in turn, is viewed through a screen

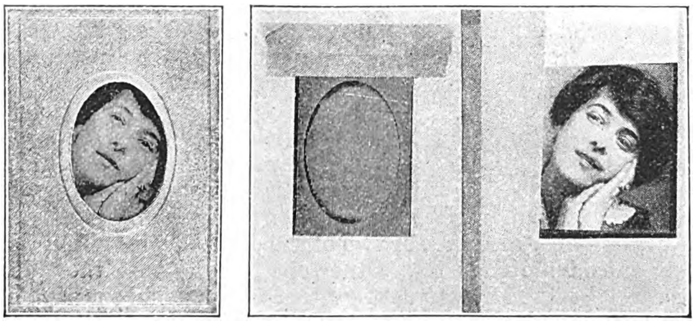
Film Yourself for a Quarter

THE theatrical business is precarious at best and "flops" are common so that there is little wonder in a producer taking a flyer on stocks or in an invention, particularly in something which has a very popular appeal. Mr. A. H. Woods is one of these producers who is backing a very clever device that makes simulated motion pictures of subjects while they wait. Mr. Woods obtained the rights in an English invention a few years ago but the time required to produce the picture was inordinately long. For the past two years Mr. Stanley J. Pask, a practical camera man, has been making the device commercially marketable. The pictures may be radically different—thus you may smoke, use a telephone, or take a group of a family of three, and each can be animated in turn.

The would-be movie star sits in the booth and the face is well lighted

The new camera is very complicated and only a brief outline of the cycle of operations will be given. Three (or more) pictures are taken on one plate film through a screen composed in part of transparent material and in other parts, of opaque material. The screen is positioned directly in front of and resting against the sensitized film and with the object to be photographed focused properly in front and illuminated by a powerful electric light, so that at least three exposures may be made. The screen is shifted at each exposure, the person being photographed changing position. The person sits on a stool in a booth fixed up like a dressing room. The idea is to take the photographs so that they will give some idea of how he or she will "screen."

ONCE in position the attendant presses a plunger and the cycle of operations begins. After the three exposures are made, the sensitized film is developed automatically in the machine in 12 seconds and we have what appears to be an ordinary photograph except that it is ruled with almost invisible vertical lines. This is mounted in a pasteboard frame 2⅜ by 4 inches and a cover of the same material is provided with a cut out window to which is attached a vertically ruled film. The two pieces of cardboard, one holding the photograph and the other the film, are loosely attached so that there can be lateral movement. If the sides of the mount are pinched slightly, the picture is "animated" giving the effect of a moving picture, which is most amusing. These booths will soon take their places where amusement devices are shown, and in theater lobbies.



At left is picture ready to be "animated." In center is the cover with the ruled screen and to right the photo

Gathering petals for perfume in the Balkans. Egypt, too, produces fine flower oils to a growing extent

Perfume

By MARTIN MEYER, Ph.D.

Assistant Professor of Chemistry, College of the City of New York

THE sense of smell is one of the human functions which not only has failed to advance with evolution but which in many respects has actually deteriorated with the increase of civilization. The dog distinguishes friend from enemy by the smell, and can track a man over a long period from the mere recollection of the odor of one of his articles of clothing. Wild animals scent danger at incredible distances where no explanation save smell or intuition is forthcoming.

The human animal no longer possesses this delicate perception. He can distinguish agreeable odors from disagreeable ones, but the very language itself expresses the atrophy that has occurred. One does not have to be exceptionally well skilled in the use of words to be able to describe a scene so accurately that another who has seen it will recognize it or, not having seen it, would later feel familiar with it. With a smell, however, this is quite impossible. Try to depict in words the most familiar fragrance, that of the rose, for example, so that a hearer will know it, without employing words such as "rose-like," which suggest the object described. Your effort will certainly be a failure.

Perfumes are solutions of essential oils and other fragrant materials in slightly diluted alcohol or spirits, while those of the ancients were merely the odoriferous materials themselves.

Essential oils are interesting substances indeed. They are all obtained from vegetable sources, occurring in the flowers, leaves, stems, and roots of plants, and are extracted by highly ingenious methods. They derive their general name from the fact that all are oily materials in the sense that they are usually lighter than water and float on its surface but do not mix with it. They also resemble other oils in that they will form a greasy spot on a piece of paper, but they differ from the so-called fixed oils, in that this spot disappears or evaporates completely on standing, whereas the others do not. Not all have pleasant or even agreeable odors.

OTHER perfumery materials, and some of the most expensive, are obtained from animals. Ambergris, a highly prized perfumery component, is found occasionally in large lumps on the seashore, washed in by the waves. It is a material emitted by sick whales. Musk is obtained from a variety of oriental deer, now nearly extinct, because of the merciless hunt for it, and civet, another valued fragrant essence, from a member of the cat family, in ways that have nearly exterminated the species.

Some of the flowers yield their essential oils simply by pressing the petals, but the yield is extremely small. A ton of flowers may give only an ounce or two of the desired perfume material. Other oils may be obtained by extracting them with alcohol or other solvents.

Steam distillation is yet another method employed in coaxing flowers to yield the secret of their gorgeous fragrance. The flowers are macerated with water, and then steam is passed through the mixture and the escaping vapors are condensed. The essential oil floats upon the surface and can be separated and used in making perfumes, while the residual water itself retains enough of the oil in solution to be highly fragrant and has commercial value. Oil of roses can be made in this way, and the remaining liquid is sold as rose-water. In France they employ an interesting process termed *enfleurage.* In that land, growing flowers is a branch of agriculture conducted on a scale comparable with the raising of the cereal grains. One of the greatest beauties of southern France is the large flower fields in bloom. Fats and oils possess the property of absorbing odors to a marked degree; every housewife knows the result of placing butter in the icebox with fish, and in *enfleurage* the petals of the flowers in full bloom are packed in a box on shelves between pans of a very pure fat which slowly absorbs this fragrance. The essential oil then may be extracted from the fat and used for perfumes, or the fat itself may be made into pomade. The yield of essence by this method is extremely small but its quality is very high.

ESSENTIAL oils and perfumery materials are high-priced articles of commerce but they rarely reach the retail trade. They are made or purchased by the manufacturer of perfumes. In price they vary from a few dollars an ounce to hundreds of dollars a pound, and many of them are literally worth more than their weight in gold. Perfumes are made by dissolving them in alcohol, and as a rule a perfume does not contain more than 10 percent by volume of essential oil.

Usually perfumes do not consist of a single essential oil dissolved in alcohol. Therein lies the secret of their manufacture, for the blending of the oils to make the commercial odors is a delicate art and a closely guarded secret of the firms which have become world-famous. Some of the formulas, such as the famous German Cologne water, have been in the sole possession of single families for generations and to obtain them is impossible. They are available neither in the interests of science nor for any price.

A chemist named Piess once devised the interesting scheme of likening the odors to the musical scale, and made up a keyboard on which the lower notes were represented by the heavy oriental odors such as patchouli, ylang-

ylang, and sandalwood, rising to the lighter and more evanescent ones like rose and heliotrope. On this fascinating scale one could play odor symphonies like a musician, for musical accords represented agreeable combinations, and discords incompatible mixtures. The device was, of course, purely of academic interest for there is no mechanical rule by which perfume formulas can be originated. Mixing of essential oils to form fragrances which will strike the popular fancy is an art requiring a delicacy of perception that doubtless can be acquired only by long experience.

The manufacture of perfumes is a field in which the chemist finds a very agreeable opportunity to display his talent and his ingenuity, and he already has done so with a marked degree of success. Usually the chemical laboratory is a place distinguished by odors that are proverbially vile beyond description. The perfume laboratory is truly a garden of roses, for practically every material which enters into their manufacture, as well as the perfumes themselves, have highly aromatic agreeable odors.

WITHOUT the chemist, perfumes would still be far too expensive to be used as generally as they are, even though they are still relatively costly. The cheapest of them which contain any considerable quantity of natural essences sell for three to five dollars an ounce, and 25 dollars is not unusual.

In the case of the most expensive of all, the rôle of the chemist is best illustrated. Natural violet perfume is the rarest and most costly of all the fragrances in the perfumer's bouquet. An acre of violets yields only a few drops of the essential oil which is this essence, and it is exceedingly difficult to obtain and keep. By careful analysis it has been determined that the chief component of violet oil is a chemical substance called ionone. When pure, this material is so powerfully fragrant that it paralyzes the sense of smell completely and seems odorless, a phenomenon which is not unusual with strong solutions of highly odoriferous substances. Synthetic organic chemistry has shown how to make ionone very cheaply and violet perfume so made is now among the cheapest of all. This is so true that natural violet perfume scarcely can be obtained, for it can not compete with the five-and-ten-cent-store variety with which the untrained taste, or rather, smell, so easily confuses it.

Among the other triumphs of the chemist of a similar nature have been methyl salicylate, identical with the chief component of natural oil of wintergreen; coumarin; geraniol, characteristic of roses; citral; musk; and many others. The products of the chemists' laboratory can not, however, be used alone in any but the cheapest perfumes. While they have very powerful odors identical in many cases with the principal substances in the natural essential oil, the discriminating sense can easily distinguish the many other components which shade so delicately the perfume made from a natural flower.

THESE do, however, make perfumes cheaper to manufacture because they can be used to replace part of the true essential oil, which then gives the bouquet which surrounds and enriches the principal odor. Practically no perfumes as sold today are without synthetic organic products, yet on the other hand, none, save the very cheapest, is completely synthetic.

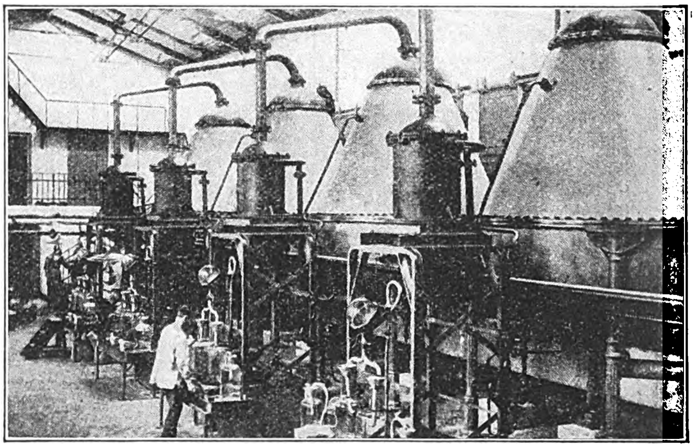
Relatively few people seem to enjoy the fragrance of a perfume with the true appreciation of a connoisseur yet, like the taste of tobacco or the fine bouquet of a wine, the appreciation of which is almost a lost art in America, it is easy with care to perceive the extremely nice shades of odor which distinguish the higher grades of perfume from each other. This is especially uncommon and enjoyable in the case of popular odors which are blends not characteristic of any one flower. Frequently I have experimented with women who have used the same and expensive odor of perfume for many years. After modifying the perfume so that the chief odor remains the same, as well as the color, though the difference was easily perceptible to one who had carefully observed, I have presented it to them in the expected package and bottle, and they often not only fail to detect the deception, but compliment me upon the fact that it appears fresher because it is stronger and more lasting. With age perfumes do change in color and in odor.

IT is interesting to note that here, too, as in the case of any rare and expensive commodity, the practice of bootlegging flourishes and is very profitable. Rare ingenuity is sometimes exhibited, running from the comparatively crude device of diluting the original perfumes with alcohol and cheaper perfumery materials, to complete and spurious imitation of the original product. In the case of two or three internationally known perfume manufacturers, especially in purported re-bottled perfumes, this has been perpetrated so extensively and unconscionably that it has damaged considerably the widely advertised and wholly deserved name.

Careful chemical study established the nature of the devices used and strenuous methods have been adopted to stop the deception, but if the public which, in general, detected it only where the perfume became so dilute as to be not at all lasting, would cultivate a more refined sense of smell, this would be much more difficult. One would think that this would be done by people who are willing to pay 25 dollars for an ounce of material, the use of which, without such artistic perception, is like casting pearls before swine.

¶ This is the third and last of Dr. Meyer's very interesting and instructive series of articles. It is hoped that at some future date other popular articles, equally interesting, may be written by this author.—*The Editor.*

Detaching petals from rose blossoms in a factory at Grasse, near the sunny Riviera, in Southern France



Distilleries in a perfume factory at Grasse. Here the detached rose petals surrender their fine fragrance

The Eight-Inch Gun Cruiser

By CAPTAIN W. D. PULESTON, U.S.N.

At the close of the Revolutionary War the Continental Navy was disbanded. Due to attacks of the Barbary pirates on our commerce in 1794, Washington recommended and Congress authorized the construction of six frigates. This was our first building program as an independent state. General Knox, Secretary of War and Navy, decided that these frigates "should combine such qualities of strength, durability, swiftness of sailing, and force as to render them equal if not superior" to any European frigates. The results of the battles between frigates during our wars with France and England indicated that American designers measurably succeeded in their object. President Roosevelt voiced the same idea in his demand that the American Navy "ship for ship" must be better than any other in the world.

The era of wooden ships culminated in two principal naval vessels—ships of the line displacing 1300 to 3100 tons, carrying 60 to 120 guns, and maximum speed of 12 to 13 knots; and frigates displacing from 650 to 1300 tons, carrying 32 to 50 guns and capable of outsailing the ships of the line, except in heavy weather. In addition to these were sloops of war and fire-ships corresponding to our light cruisers and destroyers, and bomb-ketches especially designed for use against shore defenses.

The advent of the steam engine, the paddle-wheel, and the screw propeller gradually gave a reliability to naval motive power entirely lacking in the sailing vessels. The iron and steel industry furnished the naval designer with material that permitted greater freedom in design than wood.

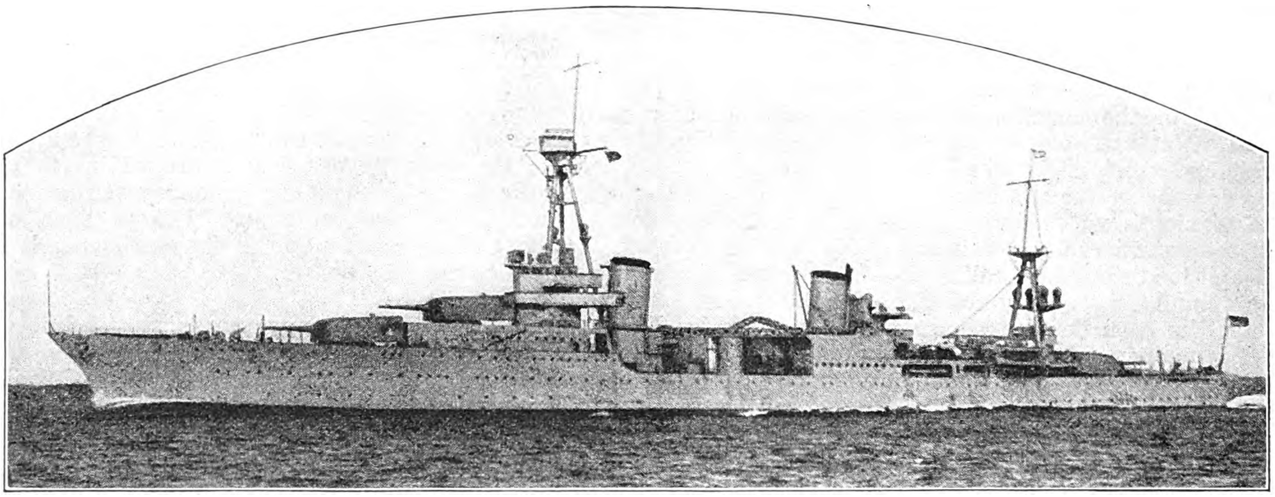
The great advantages of seapower were early known to Europeans, and modern European states, particularly from 1870 onward, demanded navies, and gave an increasing impetus to naval design that continued to the Washington Conference in 1921-22.

The weapon builders and the armor manufacturers responded to the urge, and the development of the gun, the mine, and the torpedo, and the improvement in armor and compartmentation of ships, proceeded apace. After the Spanish-American War we began to build a fleet. The submarine and the airplane made their appearance to complicate the task of the naval designers further, and the World War accelerated the natural rate of improvements of all naval weapons and vessels as nothing else has ever done.

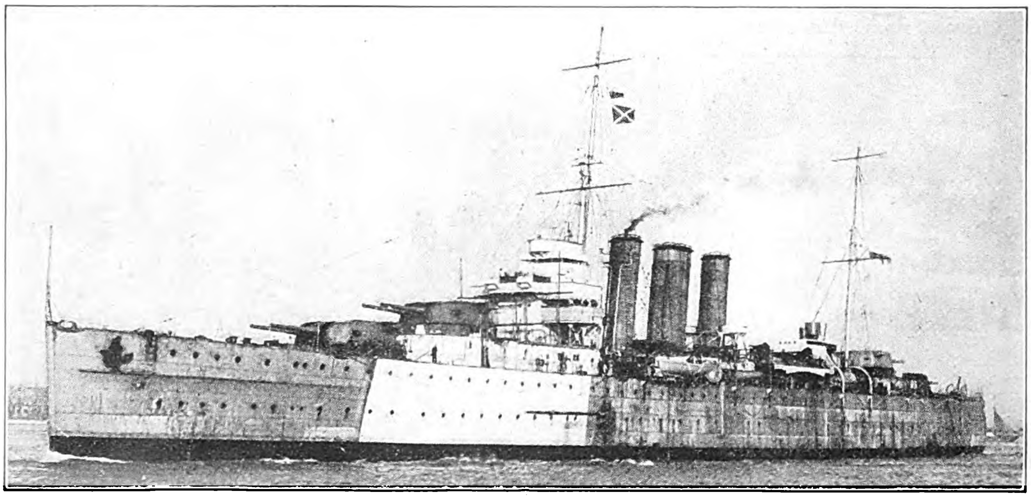
For over a century of design, naval constructors generally and American particularly, following the idea of General Knox, have struggled to obtain three almost unattainable attributes—invulnerability, omnipotency, and omnipresence. They sought an unsinkable ship, an irresistible ship, and a ubiquitous ship. Together with their ordnance and engineering designers, they strove to create a ship that could resist any other, run down any other, and sink any other ship. In the same plant, the ordnance manufacturer would seek to develop impenetrable armor and an armor-piercing projectile.

This competition led to continued increase of tonnage because designers soon discovered increased size gave them a still greater corresponding increase in offensive and defensive values. There naturally followed a constant increase in size of all types of ships.

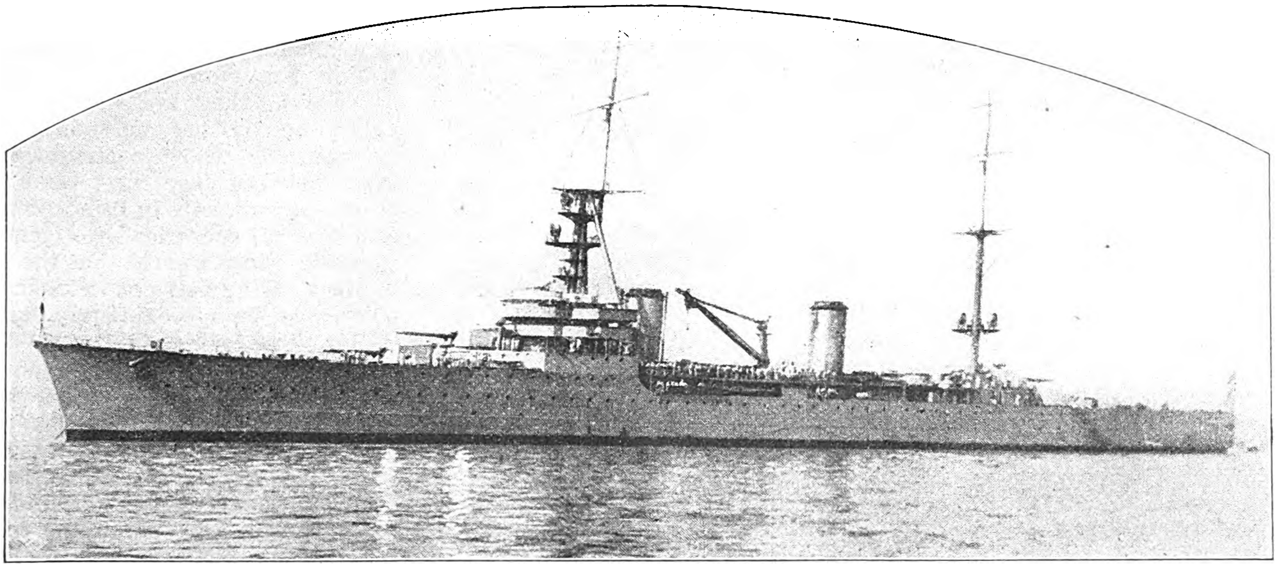
Mahan's widely read books on the advantage of command of the sea spurred the great powers, particularly Great Britain and Germany,



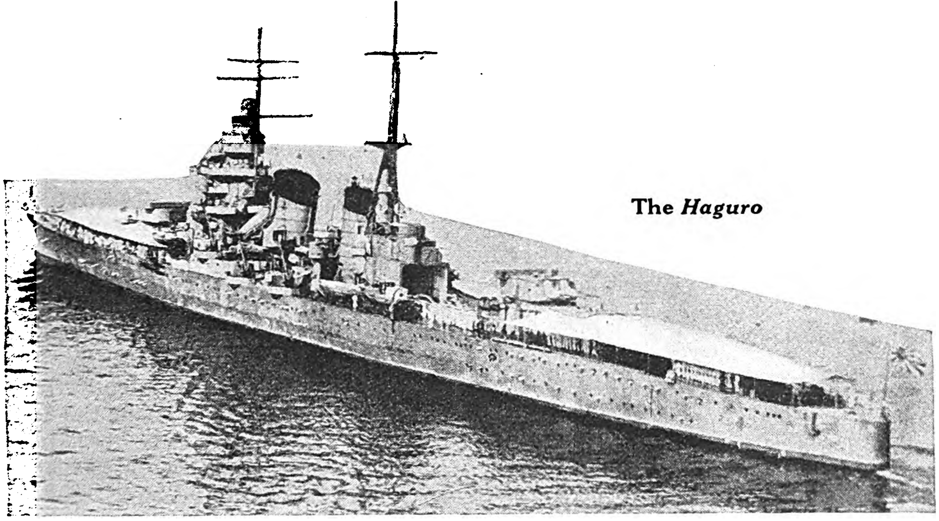
U. S. S. *Northampton*



H. M. S. *London* ➤



The *Duquesne*



The *Haguro*

to renewed efforts and the first decade of this century saw an enormous development in naval strength. Until Admiral Sir John Fisher became First Sea Lord of the British Admiralty, design proceeded generally on the tentative system, following a step-by-step development. Fisher brought in the dreadnought type of battleship and battle cruiser, and led the world in the pre-war design; other countries quickly followed his example. The British pre-war design culminated in the battleships of the Royal Sovereign class, the battle cruisers of the Tiger class, and the so-called battleships of the Queen Elizabeth class whose 25 knots made them practically battle cruisers. The progressive design of battleship and battle cruiser almost met in the Queen Elizabeth class, as shown by the following table:

	Tons	Speed	Guns	Armor	Protective Deck
Queen Elizabeth..	27,500	25	8-15"	13"	1" to 3"
Tiger..........	28,500	30	8-13.5"	9"	1" to 3"

This table also shows the great cost of the last few knots; thus for five knots extra speed, the battle cruiser *Tiger* conceded the *Queen Elizabeth* 4 inches of armor belt and 15-inch guns instead of 13.5 inches.

In the naval competition between Great Britain and Germany, neither state made much effort to conceal the fact that they were building against each other and expected to fight in the North Sea. In fact, one of the main reasons for Fisher's designing the dreadnought class was that Germany, until she deepened the Kiel Canal, was at a handicap in this deep-draft class.

American designers have to build their vessels for service in all parts of the world; and with no hereditary enemy, they have to design vessels for more than one purpose and fit them for duty in any part of the world.

OUR 1916 naval program provided for ten superdreadnought battleships and six battle cruisers. We kept our battleship types quite distinct from the battle-cruiser type, not attempting the great increase in speed in our battleships attained by Great Britain. So did Japan, although generally speaking, the designed speed of her battleships has exceeded ours.

The first modern limitation on the size of all naval vessels was the dimensions of the locks of the Panama Canal. This fixed absolutely the maximum outside limits of American ships and practically fixed it for other navies that will probably find the Canal useful, if not essential.

The Washington Conference placed the next limitation on naval design by creating a battleship holiday and by limiting cruiser displacement to 10,000 tons and armament to guns of 8-inch caliber. The battleship holiday, recently renewed at London, increased the importance of cruisers, destroyers, and submarines, and naval constructors concentrated their attention on the designs of these and aircraft carriers. The limitation placed on the tonnage and caliber of guns to be carried on cruisers left open to competition within very narrow bounds, the factors of speed, armor, and armament.

IN the previous competitions, designers had learned the great advantage of increased displacement and heavy caliber guns, so most naval constructors went at once to the 10,000-ton, 8-inch gun cruiser, with slight variations in speed and protection, depending upon the ideas of the line officers, the skill of the naval constructors, the efficiency of the establishments furnishing the materials going into the construction, and the available appropriations. It is significant that competition in design was just as sharp as before, except that it was concentrated in certain types, and confined to prescribed displacements.

The art of naval construction had practically reached a parity in the leading naval countries before the Washington Conference suggested a combat parity and ratios instead of unlimited competition in design; and there is small difference in the quality of the shipbuilding materials available in first class countries, so that it is not surprising that the 8-inch gun treaty cruisers of the five leading nations have approximately the same characteristics. This is shown by the similarity in the 8-inch gun treaty

	U. S.	Gt. Britain	Japan	France	Italy	Germany
	North-ampton	*London*	*Haguro*	*Duquesne*	*Trento*	*Ersatz Preussen*
	1930	1929	1929	1929	1929	1929
Displacement (tons) (fully equipped, without fuel or feed water)	10,000	10,000	10,000	10,000	10,000	10,000
Dimensions (feet)						
Length (over all)	600	633	630	626½	640	604
Beam	67	66	57	63	67½	66
Draft	19½	17(std) 20 normal	16½	20½	19	16
Ratio: (length: beam)	8.96	9.74	11.05	9.94	9.48	9.15
Armament:						
Guns—						
Main Battery	9 8-inch 3 triple turrets	8 8-inch 4 twin turrets	10 8-inch 2 triple, 2 twin turrets	8 8-inch 4 twin turrets	8 8-inch 4 twin turrets	6 11-inch 2 triple turrets
Secondary Battery	4 5-inch Anti-aircraft	4 4-inch Anti-aircraft	4 4.7-inch Anti-aircraft	8 3-inch Anti-aircraft	16 4-inch Anti-aircraft	
Torpedo Tubes	6 2-triple training	8 2-quadruple training	12 6-twin	6 2-triple training	8 4-twin fixed	
Airplanes	4	1	4	2	2 or 3	
Catapults	2	1	2	1	1	
Propulsion:						
Speed	32.7 stabilized	32.25 stabilized	33 stabilized	35–36	35	26
Machinery	Geared turbines	Geared turbines	Geared turbines	Geared turbines	Geared turbines	Diesel engines
Horsepower	107,000	96,000	130,000	120,000	150,000	50,000 (shaft)
Boilers	8, oil	8, oil, Yarrow	12, oil	8, oil	12, oil	
Radius of Action	10,000 at 15 knots	11,000 at 12.5 (probable)	14,000 at 14/15 knots	5000 at 15 knots	?	10,000 at 20 knots
Complement:						
Officers	45	40	?	30	43	?
Men	620	650	?	592	650	?

TABLE A

cruisers of the five nations in the accompanying Table A, in which for convenience of further comparison, is also included the German battleship *Ersatz Preussen,* which is limited by the Versailles Treaty to 10,000 tons displacement but the 11-inch guns the Germans used came as a surprise.

Table A indicates that the designers of Great Britain, the United States, and Japan have practically stabilized the speed at 32.5 knots and battery, while France and Italy are building 35-knot cruisers. They all burn oil and use geared turbines except Germany, who depends upon the Diesel internal combustion engine. This table again shows the price paid for the last few knots speed in cruisers; thus the *Ersatz Preussen* carries 11-inch guns, is comparatively heavily armored, and can make 26 knots, only 6½ knots less than the typical treaty cruiser with 8-inch guns and comparatively unarmored. There is a striking parallel in the relationship between the *Ersatz Preussen* and the Queen Elizabeth class of fast battleships, and the treaty cruisers and the Tiger class of battle cruisers.

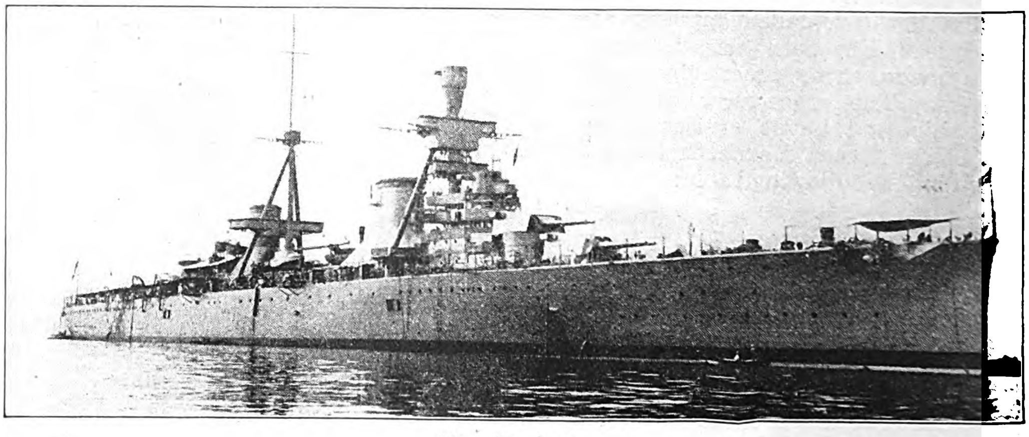
Mahan's test of a ship was: Is she well designed to accomplish her war tasks? This is a principle easier to enunciate than to apply, for its application implies the ability to determine with a fair amount of accuracy the future adversary and the nature the war will take.

At the present time, under the principle of parity, Great Britain and the United States are confronted with the problem of finding parity in cruiser strength when Great Britain believes she needs more 6-inch gun cruisers and the General Board of the Navy believes we need more 8-inch gun cruisers. Both countries trade in all parts of the world; the volume of their foreign trade over a period of five years is approximately the same; while Great Britain has more widely-spread dependencies, they are more strongly linked up by her numerous bases, whereas our water communications, even between our east and west coasts, pass directly in front of numerous foreign countries, so, generally speaking, it can be said that the naval burdens of the two countries in time of war will be approximately equal.

THE vital interests of Japan are much more closely concentrated than either American or British. She is an insular empire with adjacent continental possessions, very similar to England with French possessions under the Plantagenets. In addition to her navy she possesses the second or third largest army in the world. Accordingly, her naval ratio at Washington was made 5 to 3, and in return we agreed to cease fortifying our Far Eastern possessions. At London, substantial concessions were made to Japan, in cruisers and destroyers, and parity was given her in submarines. Members of the General Board have pointed out the additional handicaps the abandonment of the 5:3 ratio with Japan will impose upon our Navy in the event of war in the Pacific.

Naval competitions are certainly expensive and they may become provocative; limitations of naval armament will reduce somewhat the expense and if carefully done, need not jeopardize the legitimate interests of any state. But it should be recognized that *navies are symptoms of the probability of wars,* not their primary causes.

The task confronting world statesmen today should be to obtain a friendly accord between the nations of the world. Until they accomplish this preliminary essential, conferences on the limitations of armaments will continue to disappoint the fine hopes of Americans who have been led to believe that the scrapping of a few warships will banish self-interest from the peoples and ambitious policies from the rulers of the world.



The *Trento*

A Home Made Microscope for the Amateur

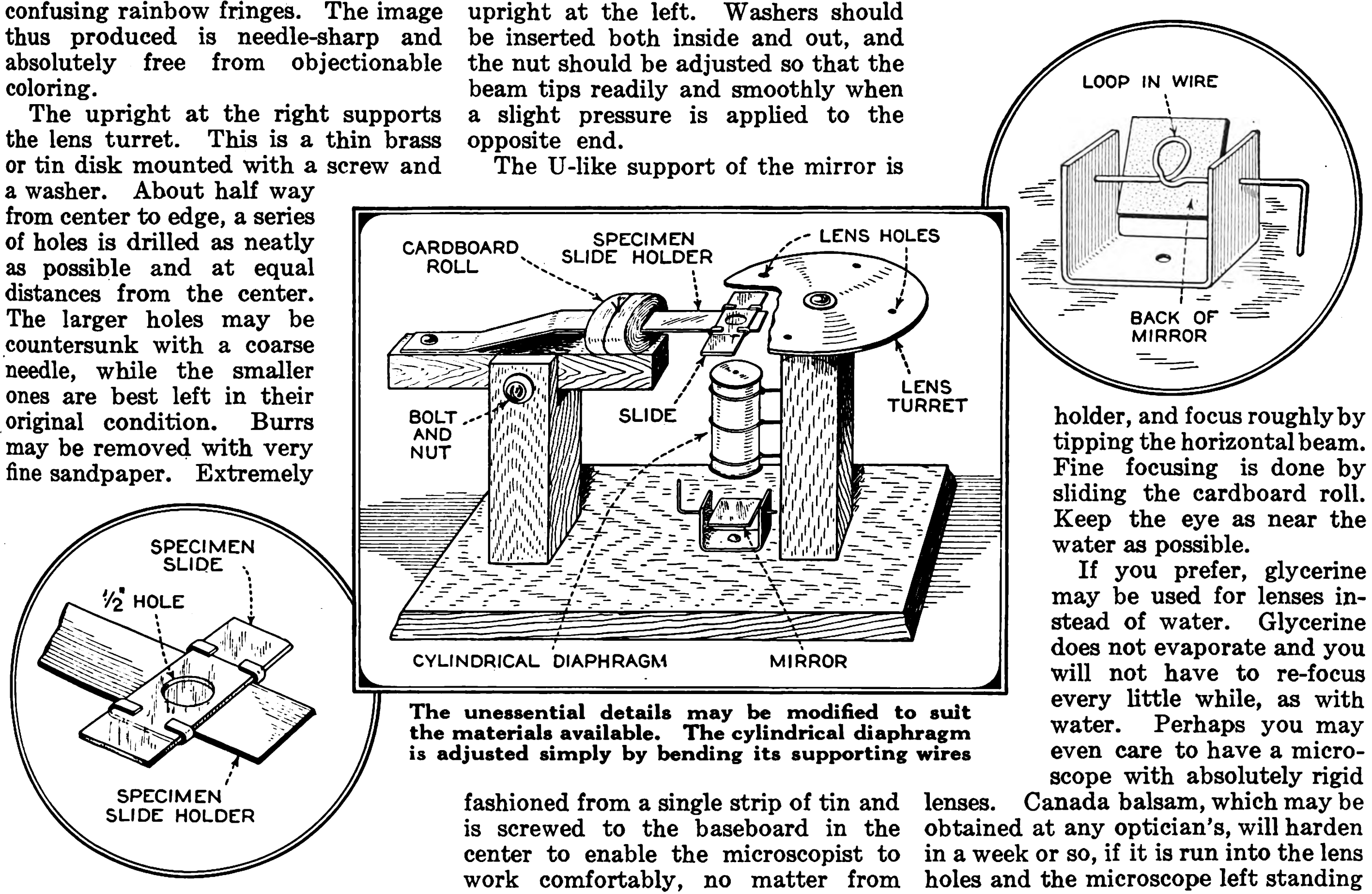
By LEON J. ISRAELOVITCH

Associate Editor Science and Engineering, *Leningrad*

A MICROSCOPE magnifying from 25 to 300 diameters may easily be constructed in the home workshop, with practically no expense. Only the simplest and most ordinary tools are required.

This may sound too good to be true, yet it is a fact. The reason is that small drops of water, which cost nothing, are used instead of expensive powerful glass lenses. A cylindrical diaphragm is also employed, doing away with blurring of the image and confusing rainbow fringes. The image thus produced is needle-sharp and absolutely free from objectionable coloring.

The upright at the right supports the lens turret. This is a thin brass or tin disk mounted with a screw and a washer. About half way from center to edge, a series of holes is drilled as neatly as possible and at equal distances from the center. The larger holes may be countersunk with a coarse needle, while the smaller ones are best left in their original condition. Burrs may be removed with very fine sandpaper. Extremely small holes are made as follows: Use the smallest drill you have and stop drilling when the tool is almost through—when a little "pimple" appears on the other side. Remove the drill, pierce the "pimple" with a fine needle and even up the edges with sandpaper.



The unessential details may be modified to suit the materials available. The cylindrical diaphragm is adjusted simply by bending its supporting wires

The wonder-working cylindrical diaphragm is held in place under the lens turret with three wire supporters. It is merely a small metal or cardboard tube closed on both ends with black cardboard disks and India-inked on the inside. A small hole is made in the bottom disk, while the top one or lid is pierced in the center with a fine needle heated to red heat in a flame, so it will not leave any burr.

A special holder for slips of glass upon which objects to be examined are mounted, is fashioned from a strip of thick tin. Its business end is shown in the left-hand drawing. The other end is securely nailed to the square beam. The holder is slightly bent in the middle, to accommodate a small roll of cardboard secured with glue or a thread and wound loosely enough to slide back and forth easily.

The square beam is drilled exactly in the middle and is held by a bolt and a nut, in a fork sawed out of the thick upright at the left. Washers should be inserted both inside and out, and the nut should be adjusted so that the beam tips readily and smoothly when a slight pressure is applied to the opposite end.

The U-like support of the mirror is fashioned from a single strip of tin and is screwed to the baseboard in the center to enable the microscopist to work comfortably, no matter from which direction the light falls. Liquid glue is used to attach the mirror to its looped-wire support.

No dimensions are given on the drawing, for the very excellent reason that they are of absolutely no importance. There is only one thing to watch for, when assembling the device. The fine pencil of light streaming up from the diaphragm should go squarely through the lens holes in the disk.

There is nothing difficult in the use of the water microscope. Decide which enlargement you need and choose a hole in the lens turret accordingly. The smaller the hole, the more powerful the lens. Rub the hole with your fingers, coating its sides with a thin film of grease, to prevent water from spreading. Dip a sharpened match into clear water and apply the point to the hole. Water retained on the match will flow down and form a nice round drop. Turn the lens turret until light from the diaphragm shows through. Work the mirror about to obtain the best lighting. When high powers are used, say 250 diameters, the source of light must be a strong one, preferably the sun or a powerful electric lamp.

Now insert the specimen slide in the holder, and focus roughly by tipping the horizontal beam. Fine focusing is done by sliding the cardboard roll. Keep the eye as near the water as possible.

If you prefer, glycerine may be used for lenses instead of water. Glycerine does not evaporate and you will not have to re-focus every little while, as with water. Perhaps you may even care to have a microscope with absolutely rigid lenses. Canada balsam, which may be obtained at any optician's, will harden in a week or so, if it is run into the lens holes and the microscope left standing in a warm dry place.

¶ Editor's note: *William Waldeyer, a San Francisco reader of this journal, has made an interesting suggestion. "Let the mechanically inclined amateur expend, say, eight dollars for a 10*x *objective, mount it in a stand of his own design, and add a 5*x *or 10*x *Huygenian eyepiece, also a small lens of short focal length for a condenser. Just as in amateur telescope making a little study will be necessary, but the first qualification for a real hobby is that something must be left to the ingenuity of the amateur." For the study, Gage, "The Microscope" is recommended. No blueprints or instructions are available.*

Work and Fatigue

Industrial Fatigue Is Passing Out of Style

By DONALD A. LAIRD, Ph.D., Sci.D.
Director, Colgate Psychological Laboratory

MEN of science visiting an exhibit arranged by the Genetics Department of the Carnegie Institution, saw a specially developed race of tireless mice which danced all day long. This was a product of careful breeding. Sir Arthur Keith and Ales Hrdlicka, well-known anthropologists of England and America, see evidence that a new type of man is emerging from the biological melting pot in America. Greater resistance to ordinary fatigue may be one of the characteristics of this new biological development in the human race, but none of us, obviously, shall live long enough to see this changed specimen. And it will not help to make us at present more resistant to fatigue.

Fatigue will doubtless be removed pretty thoroughly from the world many decades before the new biological man has emerged. In fact, one who has been keeping in close touch with the progress of fatigue elimination in industry for the last ten years knows definitely that a great deal of fatigue has already been eliminated.

IT is not the invention of labor-saving machinery that is doing most to eliminate fatigue. Such machinery may save the labor of three men, but add to the fatigue of the two men who operate it. The noise and jar and "high speed" attention the new machine demands is often more fatiguing than the brute labor that it is replacing. An invention can be labor saving but fatigue increasing.

Realizing this truism, some years ago the Society of Industrial Engineers organized a special Committee on the Elimination of Unnecessary Fatigue. This committee, to which I have the honor of belonging, serves to stimulate and co-ordinate the work on the conquest of fatigue in America. It has brought together mechanical engineers, physicists, physiologists, and psychologists on a common battle-ground for applying their sciences. In England we find a more formidable and official organization for battling fatigue, in the form of the Industrial Fatigue Research Board, which is a part of His Majesty's Governmental agencies. This board keeps a large group of investigators active in the textile, metal, wood-working, and other industries, searching out new facts about fatigue and new ways of eliminating it.

There are four general sources of fatigue which, fortunately, are being attacked by modern Saint Georges. The most treacherous and insidious source is poor emotional adjustment of the individual. One who is of necessity engaged in work which he does not like, or for which he is otherwise poorly adapted, is especially likely to experience a vague but pernicious fatigue. The rapid growth of vocational guidance in the schools, and the development of psychological tests for determining fairly accurately what work one can do best, are powerful forces for eliminating much emotionally generated fatigue. Monotony is another cause of emotional fatigue. We know that there is no such thing as intrinsically monotonous work; work which is monotonous to one person is fascinatingly interesting to another, but it is highly important that each individual work at a job which is not monotonous to him.

Fatigue of an emotional origin also arises from poor supervision of workers. The roughness of the foreman of the old school caused much fatigue. Today foremen and other supervisors are being given special training in how to handle people. This foremanship training, which is on a state-wide basis in states such as New York, is already eliminating much fatigue which has been caused by reprimanding and ill-chosen supervision of the kind not based on a good comprehension of the nature of human nature.

HUNDREDS of thousands of persons are suffering from fatigue of emotional origin, which however, has no relation to their daily tasks. These are persons with a poor emotional adjustment to life in general. They are persons who "enjoy being tired," just as about the same number "enjoy poor health." These thousands who awaken feeling tired after eight to ten hours of sleep need a general probing of their inner emotional lives. Psychiatrists and mental specialists are undertaking this on a grand scale throughout the country, largely as a result of the work of the National Committee for Mental Hygiene. Specialists have been trained for this work, and wholesale clinics

Courtesy of Harrington and King (Chicago)

A ceiling designed to absorb noise; adequate artificial lighting; restful wall colors; and venetian shades, free this office from environmental fatigue

have been established in a dozen large cities. Some larger firms have their own specialists who are engaged full time in guiding their workers to emotional readjustments which have not been caused by their work, but which are nevertheless a fatigue handicap.

The following typical case of this type of fatigue has been reported by Dr. V. V. Anderson who is engaged in this work with R. H. Macy and Company in New York. This case may be taken as illustrative not only of the pernicious hidden emotional causes of fatigue, but also of the highly socialized "long view" many employers are now taking of the problems of fatigue elimination.

Mary T. was a successful sales clerk, 35 years old. For half a dozen years she had been complaining of being tired and needing a rest. From time to time she had been given short leave from work with pay, and finally took six months with pay. The family doctor reported that she "must have a complete rest."

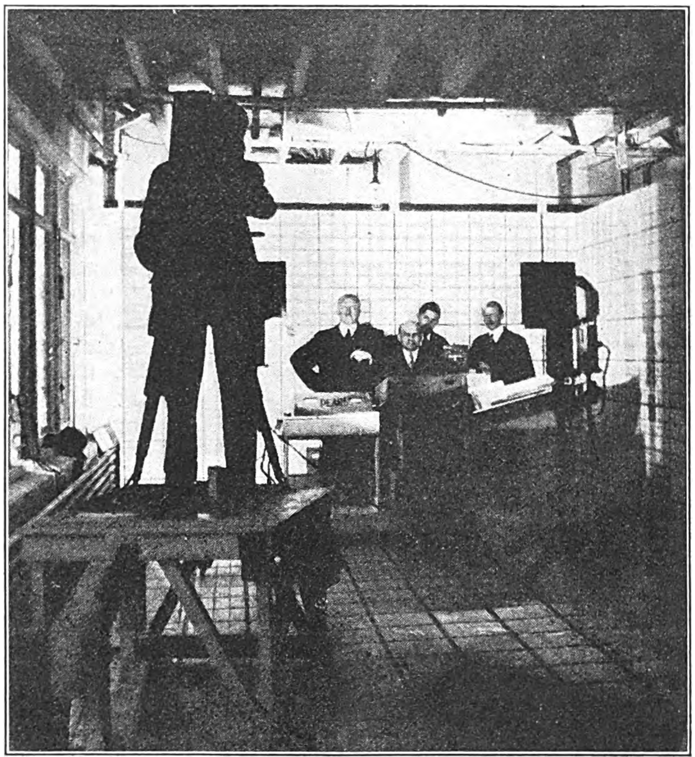
UPON Mary's return to work the store psychiatrist gave her state of chronic fatigue skilled study and found that "she acts very tired, seems exhausted, sits down a lot, leans against the counter, and seems to be a changed girl from what she used to be." Emotional causes for her chronic fatigued state were readily found. She has made but few friends, never goes out, and her only pleasures seem to center in the home of her father and mother, although her father complains a great deal about her not getting married. She is very jealous of her married sister and frequently has trouble at home with her father. When these unpleasant situations develop she indulges in a temper tantrum or appears to become ill, and thus obtains great sympathy from her mother and sister. Her "tired feelings" are another way of gaining sympathy and attention.

The psychiatrist explained her situation to her frankly, planned a scheme of emotional re-education for her, including social and recreational activities to keep her away from home, and arranged for her to have half-time employment. She needed to understand how she had been seeking pity and sympathy through appearing tired, whereas healthy emotions demanded the equivalent outlet through accomplishments and service to others.

Her entire emotional attitude toward herself, her job, her home, and life in general was altered. Her mental health improved vastly and her chronic fatigue disappeared. She is now working full time and topping her department.

According to Dr. Anderson such cases are very common, and develop easily in almost anyone. They are neither normal nor abnormal, but in the broad borderline zone.

A second important general cause of fatigue is the physical condition of the individual. The phenomenal strides now being made in general hygiene and public medicine are accomplishing near-wonders, an example being the elimination of much of the pathological fatigue caused formerly by the hook-worm in vast areas in the southern states. The growing use of routine medical inspections of employes by company physicians is also accomplishing a great deal toward avoiding fatigue which is caused by some organic trouble rather than by the work itself. Some concerns, like the Dennison Manufacturing Company, have their executives undergo complete medical examinations semi-annually.



Studying less fatiguing methods of work by means of the moving-picture camera set up in a manufactory

The activity of the ductless, or endocrine, glands appears to have a profound relationship to one's fatigue, although there is no definite single glandular mixture which is a cure-all for tiredness. This is a field both of great promise and great obscurity.

One of the most interesting aspects of the relation between bodily conditions and fatigue is the chemistry of the fatigue changes brought about by work itself. As physical work is done glycogen is consumed by the muscles, with the production of lactic acid and carbon dioxide as residual by-products. The carbon dioxide liberated is gradually breathed off, although in the case of excessively severe work some excess carbon dioxide may be stored in the adjacent tissues to be breathed away during less active moments. Lactic acid appears to be the definite cause, however, of actual fatigue caused by work. In almost every variety of steady work the lactic acid is produced more rapidly than it can be removed, bringing about a definitely toxic condition. This condition may spread to remote parts of the body. Heavy work with the right arm, for example, can readily produce an excess of lactic acid which spreads to the left arm. Working with one arm may thus tire the other arm; we also can recover from some of the fatigue of the right arm by the action of blood oxygen on the lactic acid in the left arm.

No chemical has yet been discovered which will offset these accumulations in the working body. During the World War, however, German troops were given sodium biophosphate before long marches, on the theory that this would offset the lactic acid formations.

IT is a fact that soldiers given this substance were usually fatigue-resistant, but more recent experiments have shown that the biophosphates did not produce this result by causing the lactic acid to disappear. It does help eliminate fatigue, but just how it works still is a question.

Since the body itself will attempt valiantly to remove the lactid acid, much excess fatigue has been avoided in industry by the introduction of rest periods so that the chemical factories of the body can remove much of the acid before there is such an excess that there will be the possibility of a serious fatigued state. Girls folding handkerchiefs, for instance, are least fatigued when they fold for five minutes and rest one minute. In heavier work, such as carrying pigs of iron weighing 92 pounds each, fatigue is least when each 12 minutes of work is followed by three minutes of rest. It is a paradox of mankind that by resting at the proper times they can do more work with less fatigue.

Some day a substance may be discovered which will take care of the lactic acid accumulation and take the place of rest periods. At present industry knows no such substance, hence each month sees a few thousand more workers being forced by their employers to rest during working hours.

Another paradox which is a result of the accumulation of lactic acid is that the longer workers are at work the less they accomplish. Workers who have been engaged in work eight hours a day, for example, when put on overtime which requires ten hours work a day, will do less after two weeks in the ten hours than they formerly did in the eight hours. The extra two hours work is doubly pernicious in adding to the total production of the acid, and subtracting from the rest hours during which the accummulation can be overcome.

With the shorter work week, as well as the shorter work day, large amounts of human fatigue will be eliminated—provided the worker knows how to use the added leisure time so that there will be no further accumulation of fatigue.

Time exposure record of movements of the hands of a worker. When given expert study this picture will reveal waste effort

The third general direction from which fatigue is being attacked is by adjusting the environment so that less indirect fatigue is caused. The poorly lighted factory and home of a decade or two ago were the cause of much indirect fatigue—not only eye fatigue, but muscular fatigue due to the increased tension of the muscles in giving attention. Muscular tension is a form of work which consumes glycogen and produces carbon dioxide and lactic acid, even though no productive work is accomplished. With the invention of the incandescent bulb half a century ago Edison paved the way for the elimination of much unnecessary and indirect fatigue.

In the past decade a great deal has been accomplished by applying scientific knowledge concerning the relationship between temperature and fatigue. When the temperature goes above 68 degrees, Fahrenheit, fatigue is abnormally increased, unless the cooling power of the air is increased by being set in motion. Thermostats and chemical refrigeration are now being widely used, not merely in those industries which are intrinsically heat-producing, but in offices as well.

Within the past year or two another cause of indirect fatigue has been stalked out into the open—noise. I am naturally proud of the part the Colgate psychological laboratory has had in discovering minimum allowable noise analogous to the optimum temperature of 68 degrees, Fahrenheit. Scarcely a new office or factory is designed now without noise control being given thoughtful consideration, and many old work places are being remodeled so that they approach the minimum allowable noise of 35 decibel units.

The three general causes of fatigue—poor emotional adjustment, bodily condition, and environmental forces—have been discovered and worked out, largely by men of science outside of industry. The fourth general cause has been attacked largely from within industry itself.

This fourth general cause is fatiguing methods of work. Research on this source of loss received its impetus in the United States three decades ago. For the following 20 years the investigation was kept up, largely to gain increased output rather than directly to reduce fatigue. The last decade however, has witnessed a shift in the approach, because it has been demonstrated thoroughly that the greatest output is achieved when the methods of working are least fatiguing. So, in place of trying directly to reach greater output per worker, the approach now is to reduce all possible fatigue in methods of working. Thus the output will take care of itself better than it would if one tried directly to improve the output factor alone. The aim should be to make the work as easy as possible; very greatly in contrast to the primary aim of the "efficiency expert" with his pockets full of colored pencils, who, thank goodness, is going out of fashion along with fatigue. I believe in general that England is more awake to this changed approach than is America.

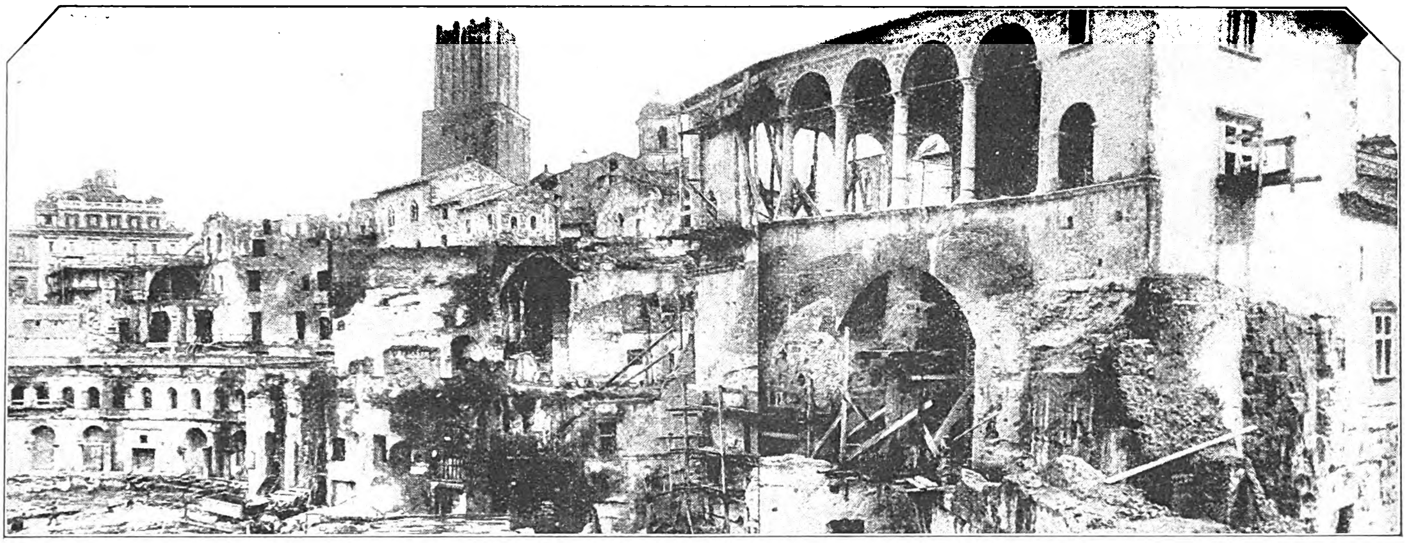
So much of the work that has been done to make working intrinsically easier is so simple and so obvious that it reflects little credit to the human mind that this has not been done years ago. Take, for example, the small metal stand on which hot irons are placed in the laundry. These metal stands are necessary to keep the cloth covering of the ironing board from being scorched while the goods to be ironed is being smoothed out. It has not been unusual for these metal stands to be six inches in height. Lifting a five-pound iron to this height an average of 60 times an hour constitutes 150 foot-pounds of work, and since the human body has an efficiency only of about 20 percent, this means the consumption of bodily energy equivalent to 750 foot-pounds. Today iron racks scarcely an inch high and sloping gently toward the point are in use, so that the iron does not even have to be lifted but is simply slid on to the rack.

In tin-plate and sheet-steel manufacture human effort is being diminished, more perhaps in American than in English mills. In feeding the heavy bars or plates to the rollers which flatten them gradually into sheet form English workers have to lift them from two to three feet. The rolls are conventionally several inches lower in American mills, and thousands of horsepower of human energy are saved daily through this difference of a few inches. An inclined runway with freely idling rollers is now being adopted to bring the sheets or bars all the way to the powered rollers by sliding the plate along rather than lifting it. Thus more fatigue and sore arms are eliminated. Similar application has been made in hand-stoked furnaces, where coal-hole doors are no longer four feet above the floor level.

Lifting, stretching, bending, stooping, sitting all day, standing all day, produce fatigue rather than effective work, and they are being eliminated with amazing rapidity in modern industry. Special departments are being established in large work-places to train new workers how to work most effectively with least waste fatigue. All these pay both financial and human dividends.

Intensive experimentation since this article was first written is now indicating definitely that a diet rich in carbohydrates and especially quick-energy sugar of the common table variety will lessen the fatigue loss which ordinarily comes from the depletion of glycogen and the accumulation of lactic acid. These experiments at Colgate University and at Temple University have shown that less fatigue is experienced when this preparation is made for exertion.

One does not have to be a carping critic to notice that the general pace of life is getting more severe during man's leisure, but one does not have to be a blind optimist to discover that the work of the world is rapidly becoming less fatiguing. Whether the diminished human strain incidental to the work of the world will compensate for the increased human strain during man's idle moments, is a question I can not answer, but is a question of grave significance.



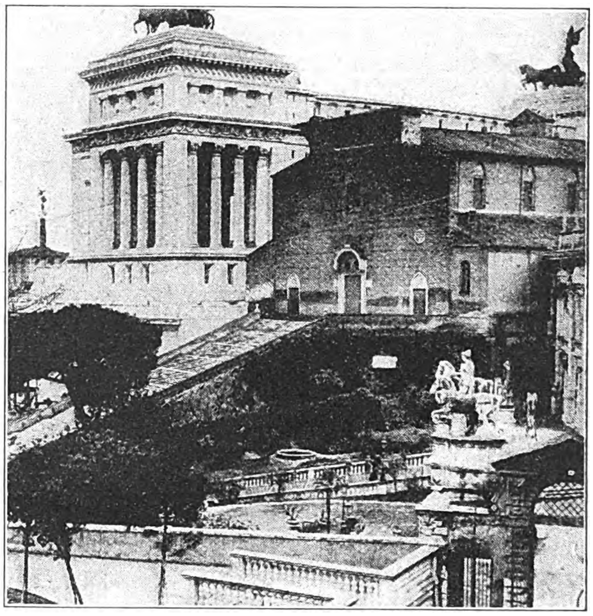
The Rome of the Caesars reappears in the modern Rome of Mussolini: The Fora of Augustus and Trajan

Rome's Slums Reveal Imperial Ruins

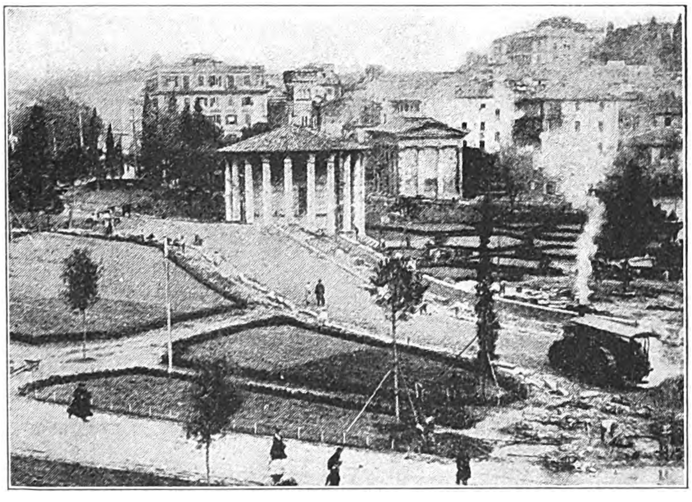
WHATEVER the Fascist government may have done or left undone, one great accomplishment stands to the credit of the great leader "Il Duce." This is the carrying on of excavations on an unprecedented scale. Excavation in a crowded city like Rome under post-war conditions presents grave problems. Where the density of population is very great, the slums can not be destroyed until the people are housed. When the ruins are uncovered they are made available to the scholars of the world, and wherever possible they are given a landscape setting.

In Italy cultural matters are receiving their due. While other countries have allowed important buildings to be sacrificed for utilitarian purposes, Italy has always looked askance at the tempter and resisted, which is hard when it is necessary to contend with national poverty.

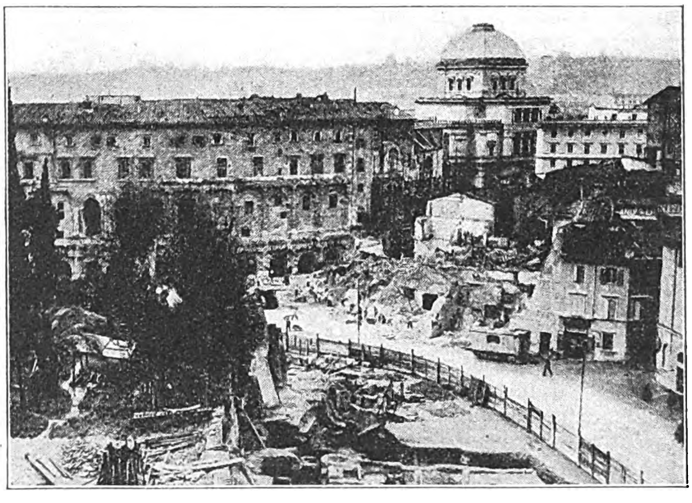
Our illustrations show how the beauty of the ancient structures has been revealed after demolition of ugly modern buildings. The Fora of Augustus and Trajan, which for centuries have been covered by later buildings, are now emerging in a remarkable state of preservation. The tower shown in the photograph above is the so-called "Tower of Nero" from which he observed the burning of Rome. Unfortunately for the story it was built in 1200 A.D. Adjacent, a great covered market with 150 shops in the Oriental style has been discovered. The "Theater of Marcellus" has been laid bare down to the foundations. The temples of Vesta and the Vestal Virgins have been freed from buildings.



A new vista opened in modern Rome, displaying the Victor Emmanuel monument towering above the Aracoeli church after demolitions



The Temples of Vesta and the Vestal Virgins now entirely cleared of old obstructions of later buildings



The Theater of Marcellus reappearing after being concealed for centuries by squalid structures now removed

The Imperious Sycamore

By WILLIAM
ALPHONSO MURRILL

> "Clear are the depths where the eddies play,
> And the dimples deepen and hurl away;
> And the plane tree's speckled arms o'ershoot
> The swifter current that mines its root."
>
> *Bryant*

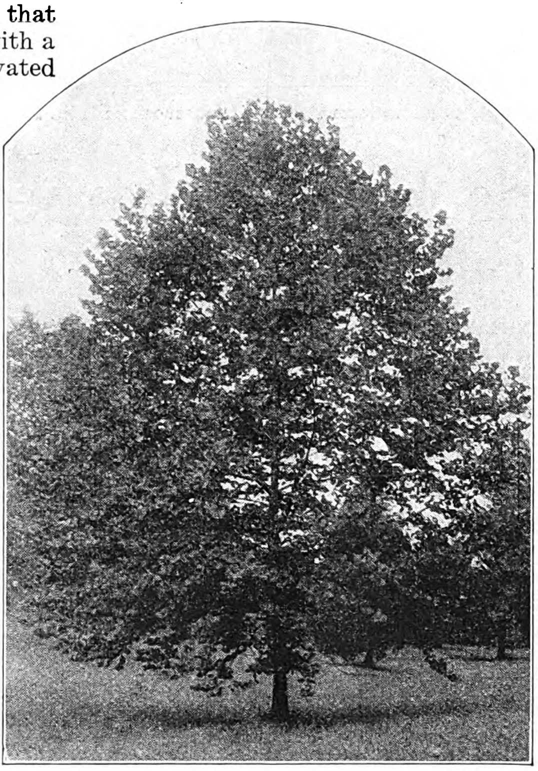
WHO has not at some time rested serenely in the shade of a big sycamore tree with scaly, white trunk and wide-spreading branches? I well remember one of these giant trees that stood alone in a fertile meadow, with a cool spring nearby and cultivated fields all about it. At noon the men would come with their horses and wagons—there was room for all and to spare—and eat their dinners while the horses finished their oats or corn and chewed contentedly at wisps of grass.

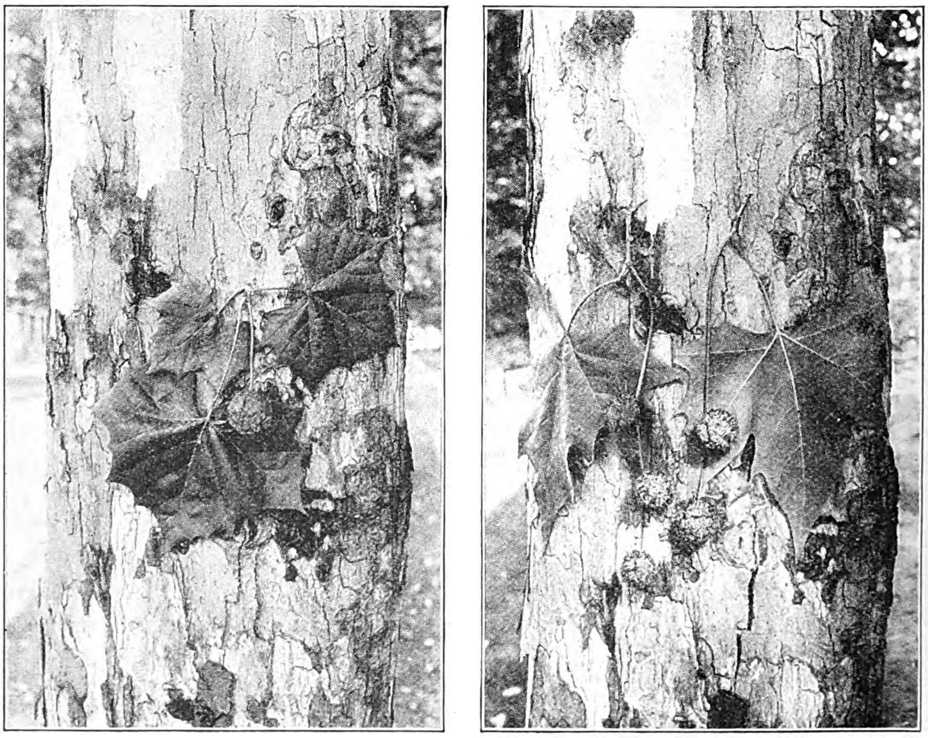
At wheat harvest and threshing time, the women-folk would meet the men at the tree and spread good things from big baskets on tablecloths laid upon the grass. Appetites sharpened by hard work would take on a razor edge at the sight, and soon a few of the older men would be taking little cat-naps while their stomachs wrestled with unusual responbilities.

THEN the "boss" would get up and squint at the sun, or peep at his big silver watch, and say, "Well, men, I reckon we've rested long enough; let's get busy."

With this scene in mind, it is not difficult for me to imagine the religious ceremonies held beneath the oriental sycamore on the plains of Persia, when splendid rugs were spread upon the ground, the roots of the tree wet with libations of fine wine, and the branches bedecked with jewels and gold. It is said that Xerxes halted his army for days just to behold a single tree of this species, which was so imperious and shapely that he had its form stamped upon a medal in order to have it before him the rest of his life.

The Greeks also venerated this noble tree and planted it in groves and about their dwellings. The botanical name *Platanus* is derived from the classic Greek name, which refers to the broad leaves. In Europe, it is known as the plane tree, while the name sycamore is always applied to a maple with leaves resembling those of the plane. In still earlier times, the name sycamore was applied to a fig tree, the wood of which was used for mummy cases. The tree which Zaccheus climbed for a better view was Pharaoh's fig, *Ficus Sykomorus*, a native of northeastern Africa. Fig, maple, plane—all sycamore; but in America it is still sycamore, in spite of the wise ones.





In low, rich land, the sycamore thrives and makes a beautiful shade tree such as the one shown in the meadow at the left. Below at left are shown bark, fruit, and leaves of the western plane or American sycamore. Below at right, of the London plane tree

The American sycamore, or western plane, is the largest hardwood tree in North America, sometimes reaching a height of 170 feet and a trunk diameter of 11 feet. A specimen at Sunderland, Massachusetts, measured 22 feet in circumference and over 100 feet in height when it was three hundred years old.

A sycamore of the Wyandotte Indians, at Sandusky, Ohio, was once the largest tree between the Alleghanies and the Rockies, four acres of ground being shaded by its immense top. After the Indians ceased their pow-wows, it became a favorite place for picnics, and then a group of young men made it a Sunday rendezvous for drinking and card-playing. The owner appealed to them to quit the place but they refused, so he burned the tree. Unfortunately, its age was never computed, but its trunk was fully 11 feet or more in diameter.

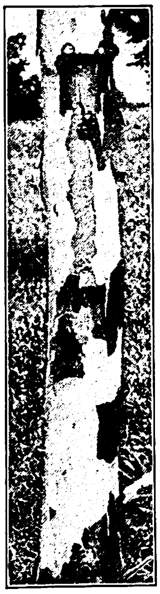
Specimens of the oriental plane have been known to have lived 4000 years. On the Greek island of Cos there is one so old and ponderous that its branches had to be supported with marble columns. It stands in a public square and is held in great veneration by the inhabitants.

Our American sycamore tree occurs wild from Ontario to Florida and westward to Minnesota and Texas, preferring open meadow land or low woods. The bark is very characteristic. On the young trunk it is smooth and greenish gray. The outer bark flakes off annually in large patches, exposing the white under bark. Near the base of old trees, the bark becomes thick, deeply furrowed, and dark brown. The trunk appears at times like an old warrior covered with battle scars.

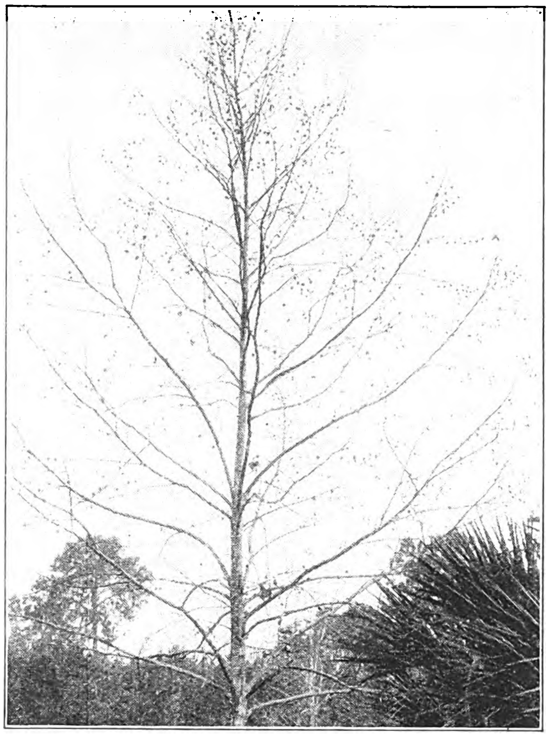
The large, simple, somewhat star-shaped leaves are sometimes seven inches broad; and the fruit is a ball an inch in diameter hanging by a slender stem during the winter and breaking up in the spring, when the small seeds are widely scattered by the wind.

THE wood is rather strong but decays rapidly in contact with the ground. It is used for butchers' blocks, tobacco boxes, furniture, interior finish, crates, tools, and rollers. The reddish-brown color is attractive, but the logs are "mighty hard to split."

The plane trees form a family all by themselves with only eight species, natives of the north temperate zone. We have one native species in the eastern United States while there are two others in the west and three in Mexico.



***At right:* peeling bark of the American sycamore. The bark that is exposed is a creamy white**

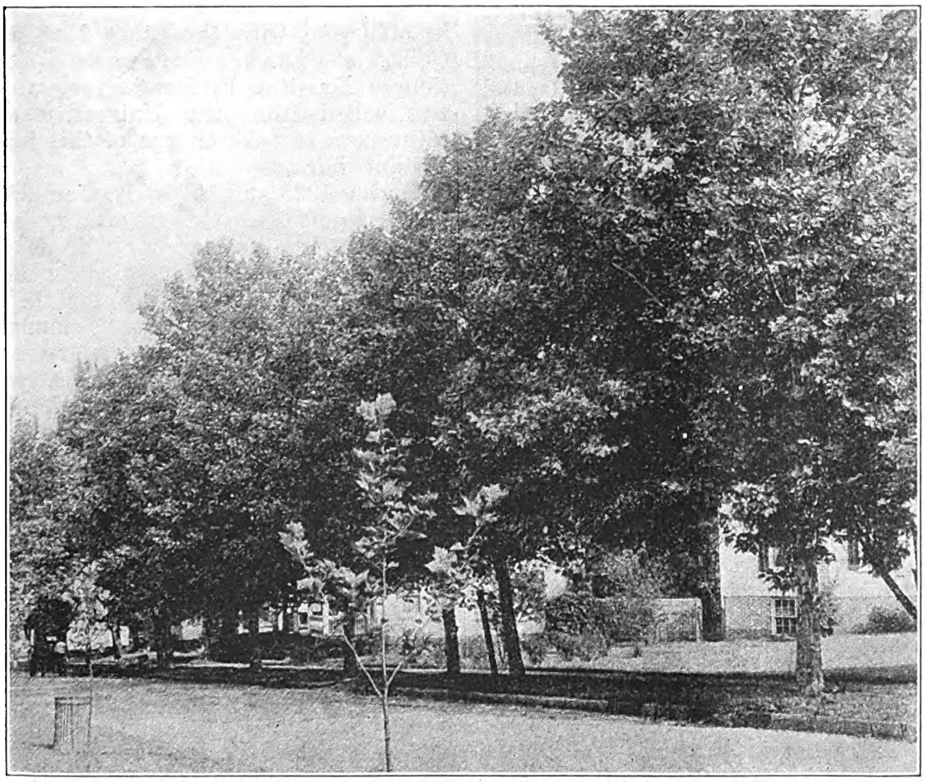


The American sycamore in winter presents an appearance of sleekness and fruitfulnes

The oriental plane was brought to Europe by the Romans from its home in southern Asia and has been abundantly planted as a shade tree in cities. A hybrid between it and our western plane, known as the London plane, is the most abundant and thrifty tree on the London streets and is very popular in this country. Our tree was introduced into England early in the 1600's and at one time the French were quite fond of it.

The sycamores, or plane trees, are all more valuable for shade and ornament than for lumber. They rank next to the oaks as street-trees, and are preferred by many. With the annual scaling of the bark, the tree rids itself of the smoke and dust of cities. The branches may be cut back as often and as freely as desired without permanent injury to the tree. The sycamore blight disfigures our tree in the spring, as well as the London plane, but the leaves come out again in time to keep off the hot summer sun.

In Paris, at least one third of all the street trees are planes. With plenty of good soil and water, these trees keep vigorous in spite of the severe conditions of city life. They are large enough for wide avenues, and they can be cut to fit the narrow streets on which they are often planted.



Either the American sycamore or the London plane makes a sturdy street tree. Often they are trimmed and shaped somewhat in the manner of hedges

For the benefit of those who find it difficult to distinguish between our native western plane and the London plane—which is still called the oriental plane by most of our nurserymen—I would say that the two trees differ in their bark, leaves, and fruits, as well as in their general form; but a glance at the bark and fruits of any doubtful tree will at once decide the question. When the London plane sheds its bark, the patches beneath are pale greenish, instead of white as in our species. The fruits of the western plane are usually borne singly, while those of the London plane are in clusters of two to four, with the balls often arranged one above another.

THE long, tapering single seeds are tightly compacted within these balls, radiating out from a hard core. The minute flowers are borne in pendulous heads containing either male or female flowers.

The leaves of the oriental plane are five-lobed, hairless, of a bright green color, and are arranged alternately on the twigs. The leaves of the London plane are usually three-lobed. The western plane—the American sycamore which is also sometimes called the buttonwood—has leaves that are more leathery and less deeply lobed than the oriental plane. Other common varieties under cultivation are the maple-leaved plane and the *variegata*, which has variegated foliage.

Typical of South Carolina's produce farms. Snap beans on a farm near Charleston

Vegetables That Defeat Goiter

By M. BISHOP ALEXANDER

"IODINE." This word stands out prominently on the labels attached to shipments of fresh and canned vegetables from the state of South Carolina to all parts of the nation. We are frankly puzzled. What does it mean? Why iodine? The answer is found in the wording on the label. We scan it closely and find thereon the statement that:

"South Carolina fruits, vegetables, and milk naturally contain sufficient iodine to provide for the requirements of nutrition."

The explanation of the answer and its importance is readily seen in the authoritative statement from scientific and medical sources that all animals require certain amounts of iodine to prevent goiter. The importance of the discovery and announcement that South Carolina grown products contain iodine, which in proper quantities is a goiter preventative and cure, is further indicated by the following official statement:

"THERE are 30 million persons in the United States who have an iodine deficiency and two thirds of the states are in the iodine deficiency area."

Dr. Weston, a prominent physician and baby specialist of Columbia, is credited with discovering and calling attention to the mineral value of South Carolina grown products. Observing in his practice that goiter was exceedingly rare in South Carolina and being familiar with the work of American and European investigators on the relationship of iodine to this malady, he conceived the idea early in 1923 that the foods grown and consumed in South Carolina must be responsible for the very low percentage of goiter in that state. He discussed this idea with several of his friends and finally prevailed on the General Assembly of the state to provide for a commission to study the mineral elements in foods grown or produced in the state. Thus came into being the South Carolina Food Research Commission.

GOITER is an abnormal condition of the thyroid gland caused by iodine deficiency. And since the substances secreted by the thyroid govern the growth of all cells, promote metabolism, and perform many other useful functions in the body, it is vitally important to maintain this gland in healthy condition.

In an article in our April, 1926, issue, Dr. J. W. Turrentine pointed out that America is a goitrous nation and urged the use in foods of marine algae as a preventative and cure. The present article is, therefore, a fitting follow-up, and especially since it indicates a more palatable food cure.—*The Editor.*

This commission consists of Dr. D. M. Douglas, President of the University of South Carolina, Dr. E. W. Sikes, President of Clemson College, Dr. Robert Wilson, Dean of the Medical College of the State of South Carolina, Dr. J. A. Hayne, Secretary of the State Board of Health, and two others: Dr. Weston, who acts as chairman, and Dr. R. R. Walker, Secretary, appointed by the Governor.

The South Carolina Food Research Commission established its laboratory in affiliation with the State Medical College at Charleston and under direction of Dr. Roe E. Remington, who was called from the University of Minnesota to take charge of this important work.

During 1928 and 1929, Dr. Remington examined in the laboratory at Charleston hundreds upon hundreds of samples of vegetables grown in all sections of South Carolina, for their iodine content. He found the amounts of iodine in them enormously greater than those reported by other laboratory workers in vegetables from northern, western, and, in fact, any other states.

THIS discovery in conjunction with the goiter survey made by the Field Force of the South Carolina State Board of Health, in which it was found that goiter was practically non-existent in the state, led to the definite conclusion that goiter will not occur if foods that naturally contain a sufficient amount of iodine are regularly eaten.

The results of the analyses of South Carolina foods for iodine content were broadly summarized by Dr. Mazyck P. Ravenel, in the *American Journal of*

Public Health, September, 1929, issue, as follows:

"While similar data (analyses) for the entire country are not available for comparison, it can be said that the vegetables grown in South Carolina contain from 20 to 30 times as much iodine as those produced in . . . . and . . . [two great vegetable-growing states—*The Editor.*] * * * * * It has already been pointed out that the vegetables which are richest in iodine are also richest in vitamins and iron."

The amount of iodine necessary in the daily ration in order to maintain iodine balance is variously estimated. The only careful experiment is that of Dr. von Fellenberg, of Switzerland, who was able to maintain iodine equilibrium over a period of four weeks in a man on a diet which contained 0.0143 milligrams per day (equivalent to 5.22 milligrams per year).

DR. REMINGTON has calculated the weight in ounces of some fresh vegetables from South Carolina which will yield this amount of iodine.

LEAFY VEGETABLES

Cabbage, average of 8 samples	7 ounces
Lettuce, average of 9 samples	8 ounces
Spinach, average of 14 samples	7 ounces
Turnip tops, average of 5 samples	10 ounces

POTATOES

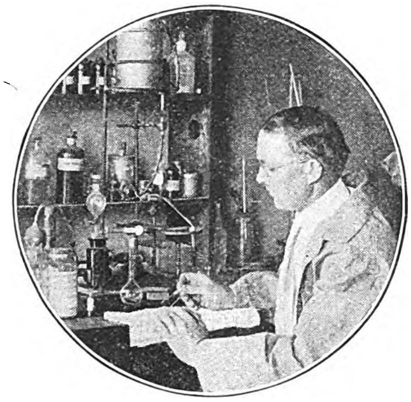
Potatoes, average of 76 samples	11 ounces
Sweet potatoes, average of 70 samples	16 ounces

ROOTS

Beets, average of 4 samples	24 ounces
Carrots, average of 8 samples	21 ounces
Turnips, average of 12 samples	23 ounces
Asparagus, average of 22 samples	27 ounces

On this basis, a diet containing four ounces of green vegetable, eight ounces of potatoes, and four ounces of root vegetable would yield 0.021 milligrams of iodine per day which is about 150 percent of the value set by von Fellenberg. Since this quantity can be, and frequently is, eaten at a single meal, it is felt that these vegetables are adequate for goiter prevention when eaten regularly.

"A sufficient amount of iodine in the food supply," Dr. Weston says, "is essential to the well-being of every individual, and if deficient there results enlargement of the thyroid gland in the neck, lowering of mental and physical ability, and ofttimes sterility.



Dr. Roe E. Remington, who directs the food research at the laboratory in Charleston

"We have learned that some foods are more valuable than others in regard to their content of chemical elements. Among the best are lettuce, spinach, cabbage, carrots, beet tops, turnip tops, kale, and broccoli." He said also that "modern methods of canning do not seriously impair, if at all, the chemical elements of fruits and vegetables."

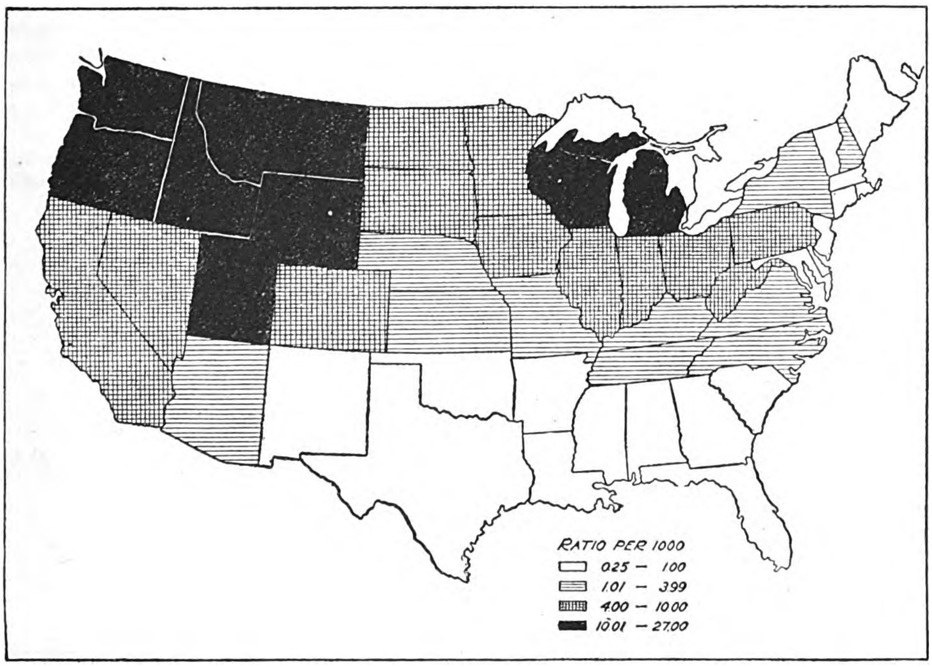
Figures compiled by the United States Public Health Service show that the goiter incidence is high and is a serious problem in large sections of California, Connecticut, Colorado, Kentucky, Illinois, Indiana, Idaho, Kansas, Louisiana, Minnesota, Michigan, Massachusetts, Missouri, Montana, Maine, New York, Oregon, Pennsylvania, Utah, Virginia, West Virginia, Washington, and Wyoming. The northwest has a high incidence.

From an historical standpoint, goiter is one of the most ancient and interesting diseases. It was a health problem in China 15 centuries before Christ, and it was then a custom among the Chinese to feed thyroid substances from animals and the ash from burnt sponges and other materials, now known to contain iodine, in the treatment of goiter.

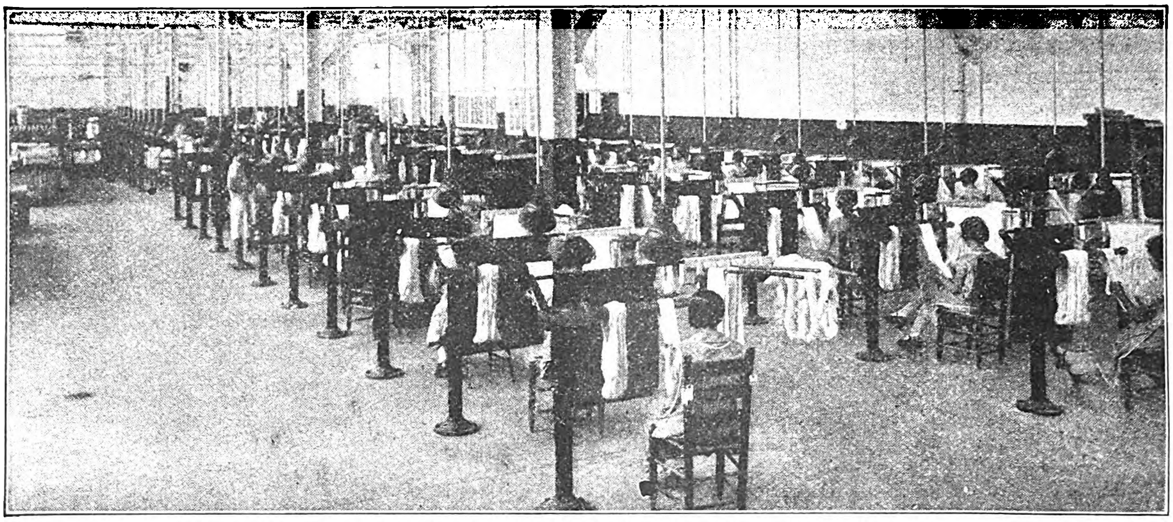
Iodine first was discovered in 1811 by Courtois, a saltpeter manufacturer of Paris, and its first deliberate use as an element in the treatment of goiter was by Coindet, a physician of Geneva, in 1820. Thirty-two years later, Chatin directed attention to the fact that goiter was more prevalent in regions where soil and water were low in iodine content. Between 1922 and 1927, Dr. J. F. McClendon, Professor of Physiological Chemistry in the University of Minnesota, published a series of articles which were largely responsible for definitely crystallizing the relation between a deficiency of iodine in the food supply and the incidence of goiter.

THE South Carolina Food Research Laboratory was made ready in 1928 and after a number of analyses had been made it was decided to seek expert advice as to checking the equipment, methods, and laboratory results. In a conference in Chicago between Morris Fishbein, M. D., editor of the *Journal of the American Medical Association* and a Contributing Editor of the SCIENTIFIC AMERICAN, Dr. Clifford Grulee of the University of Chicago, and Dr. Weston, all agreed that, because of his international reputation and high standing among chemists, Dr. McClendon was the man for the task. Negotiations were entered into with him and later he visited the laboratory. After carefully checking the apparatus, methods of analysis, and the results, he enthusiastically stated that he believed the solution to the serious goiter problem had been found. In 1929, he spent his summer vacation in the laboratory and again freely confirmed the results obtained there.

Since the endorsement of Dr. McClendon, the reports made by the laboratory under Dr. Remington have been accepted without question by the American Medical Association and the American Chemical Society. Dr. Mazyck P. Ravenel, Chairman of the editorial committee of the *American Journal of Public Health*, has also expressed the opinion that the laboratory has "found the solution of the gravest health problem confronting the people of the United States."



Ratio of simple goiter found in men examined for service during the World War, based on 2,510,701 examinations. From U. S. Public Health reports



Inspecting hanks of artificial silk in a large American plant

Mechanical Silkworms

By GRACE LOCKHART

"WILL you walk into my parlor?" said the spider—and man walked in! Ever seeking new worlds to conquer, he carefully examined "the prettiest little parlor that ever he did spy." And then he walked out—to compete with his spider-host.

Silk is a liquid substance secreted from their food by various insects, of different families, but principally by the spider and the silkworm family. The silk of the spider family is of most exquisite quality, and is the finest spun filament produced in nature. From time to time it has been used to make fragile silken articles. But the small amount of the product and the difficulty of controlling spiders have made its commercial use in large quantities impractical.

YEARS of patient experiment followed by many practical tests resulted recently in perfection in the scientific laboratories of the American Bemberg Corporation at Elizabethton, Tennessee, of the closest approximation yet made by man to spider filament.

The diameter of spider filament measures 0.00023 of an inch, the diameter of the man-made filament 0.0004 of an inch. An ordinary newspaper sheet is nine times the thickness of a single filament of the man-made product, and in a single pound there are 4227.5 miles of filament. Out of it are being woven the filmiest of laces, the sheerest of chiffons, exquisite fabrics for modern womankind—at once beautiful and enduring.

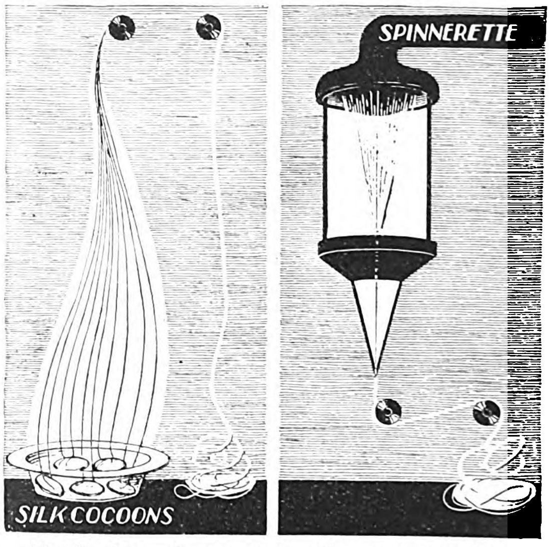
The size of yarn is designated by the term "denier," this yarn being 15 denier. The inventive mind, however, is seldom content to rest on the laurels of past achievements, and it is said that a 5-denier yarn was successfully spun in the Elizabethton laboratories to the astonishment even of the spinners themselves. It was so fine that those who watched could not see it. The hand could feel it, but the filament was invisible to the unaided eye.

THE basic raw material used in the manufacture of the yarn is cotton linters, that very unprepossessing gray fuzz that clings to the cotton seed after ginning. By a stretch-spinning cuprammonium process of manufacture, unnumbered tons of linters, formerly a waste product, are now being transformed into soft, shimmering multi-filament strands of Bemberg. So similar to silk thread, both in internal structure and external appearance is the produced yarn, that, woven into hosiery or into fabrics, experts cannot by sight or touch distinguish between the man-made fiber and the product of the silkworm.

Curiously, an order was recently received, the first of its kind recorded in history, for man-made spider webs. They were woven by hand with infinite patience in the laboratories of the American Bemberg Corporation and used for decorative purposes in "Old Algiers," first unit of a new chain of restaurants at Broadway and 102nd Street, by the well known restaurateur, William Childs. The interior reproduces an old Algerian village and in this very interesting manner modern scientific skill was called upon to heighten the illusion of antiquity by supplying artificial spider webs with which to decorate odd corners of the restaurant.

The cuprammonium process of manufacturing these ultra fine filaments was perfected after patient investigation of the interior of the silkworm and careful study of his spinning technique. The silkworm's product is made from the cellulose of mulberry leaves, the man-made fiber from cellulose of cotton linters. The dissolved cellulose of linters is drawn through tiny perforations in the mechanical "spinnerette" exactly as it is drawn through minute orifices called "spinnerettes" in the neck of the silkworm.

From the point of view of volume, however, the machine distinctly has



Similarity of natural silk and artificial silk: a number of fibers make one thread the advantage. One silkworm during its lifetime can produce from two to six filaments of silk thread about 1000 yards in length, whereas the machine produces 112 filaments at one time and in a thread that is endless. Cuprammonium yarn produced last year throughout the world would more than reach from the earth to the moon —a mean distance of 238,857 miles.

In the chemical process by which these miles of glistening filaments are produced, the linters are washed, bleached, and then dissolved in a solution of ammonium copper oxide. After being aged, the solution is filtered and pumped to the spinning machine. As it passes through the spinnerette into a fixing bath the surplus stretch is taken out of the filaments before they unify so that they emerge in a thread of unusual strength and pliability.

DUE to the minute accuracy of the machine, it has been possible to improve upon nature's product. Microscopic cross-sections of silk threads and threads made of Bemberg show an amazing similarity of structure, with greater uniformity of filament structure in the man-made fiber. Fiber and fabric have the same appearance, the "hand," texture and bloom, the scroop and crunch, and the subdued luster of pure silk.

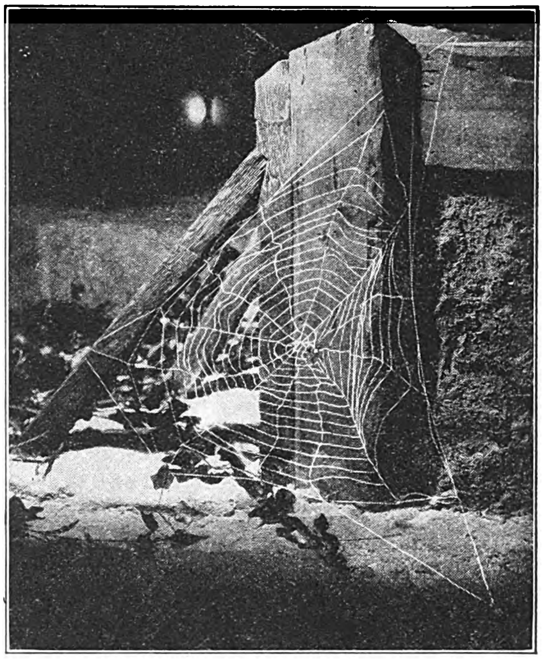
Besides the cuprammonium method there are three other important processes of manufacture used today for making these yarns. They are known as the viscose, cellulose acetate, and nitro-cellulose processes. The resultant fibers and fabrics woven from them differ considerably from each other in characteristics and qualities. The volume output, known generally to the public as rayon, is made by the viscose process, sometimes of wood pulp, sometimes of linters. About 85 percent of the chemical yarns manufactured in the United States are made by this process.

The United States has invested more than 120 million dollars in plants for the manufacture of synthetic yarns, while the world investment is estimated to be one and a quarter billion dollars. The total world production last year was over 468 million pounds, of which the United States, both the largest producer and the largest consumer of chemical yarns, produced more than 100 million pounds. Less than half a century old, man-made yarns have been developed and perfected until today they rank in importance with the ages-old silks, cottons, woolens, and linens.

Looking backwards, we find, in the year 1734, an ingenious Frenchman named Bon making hosiery and gloves out of spider web; not, however, with spectacular success and not, certainly, for mass consumption. A century later one George Audemars of Lausanne, Switzerland, obtained a patent for transforming dissolved nitrocellulose into filaments which he called, descriptively, "artificial silk."

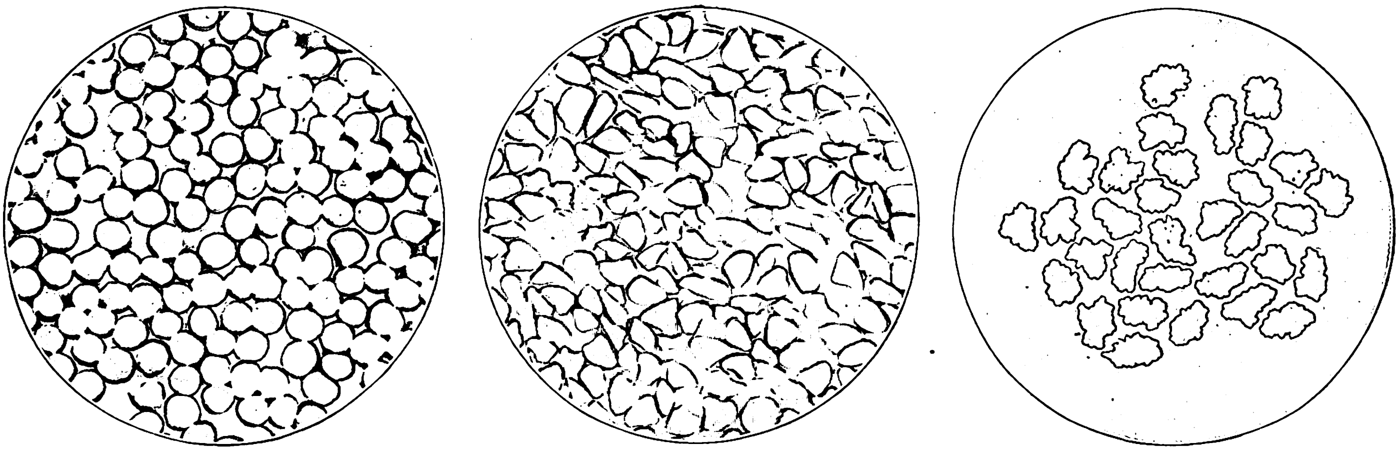
Efforts to produce this material, however, did not assume commercial importance until 1884, when Count Hilaire de Chardonnet, called the "father of the rayon industry," perfected a practicable process for manufacture. His achievements were viewed by the public for the first time at the great Paris Exposition of 1889, and excited much interest.

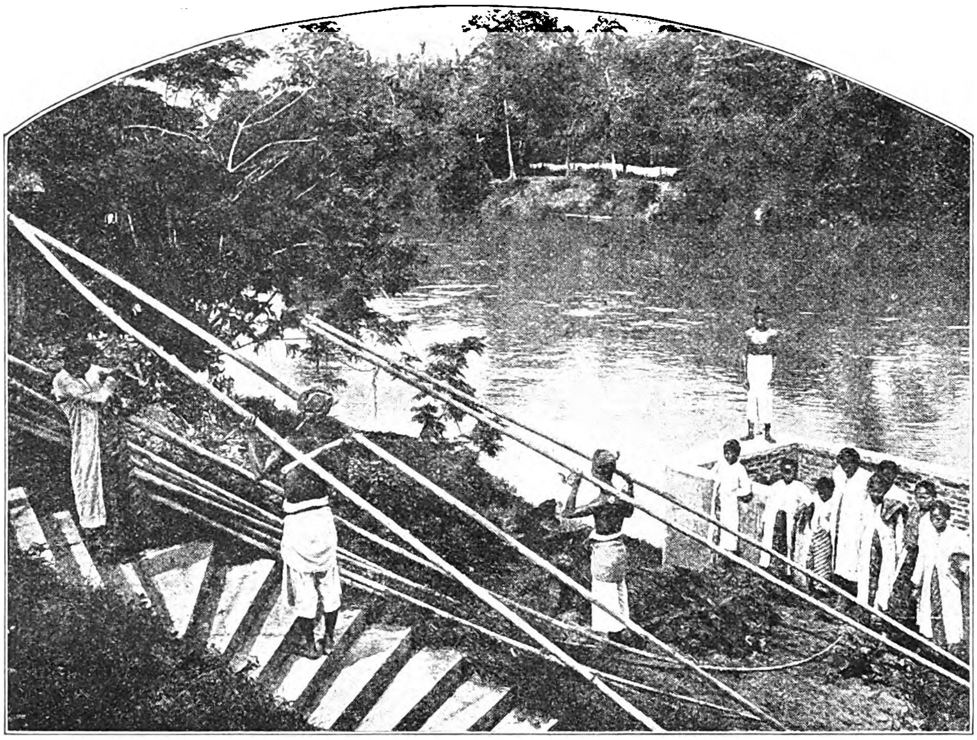
COMMERCIAL production of synthetic yarn was begun in Germany, in France, and in Great Britain at the opening of the 20th Century. Plants were established in Italy in 1908, in Holland in 1912, and in the United States in 1910. During the last five years constant experiment with resultant improvement in technique and the rapid development of new uses for chemical yarns has resulted in a spectacular increase in their production. In 1927 the world production was 269,822,000 pounds. In 1929 it had increased to 467,330,000 pounds.


Spider web of man-made filament in the courtyard of a New York restaurant

The establishment of the American Bemberg Corporation plant in 1927 in Elizabethton, within two years time transformed a sleepy little village of 2400 inhabitants into a flourishing industrial town of 12,000. Thousands of mountain folk on foot, on mule, and on horseback followed in the wake of science. Thousands of men and women set themselves the task of feeding and tending the giant mechanical silkworks. Thousands who had watched the spider spin his silver web in the blue-green shadows of southern hills, engaged in the task of spinning, with steel fingers, the same infinitely fine filaments at the foot of Smoky Mountain.

The spider toils on, weaving nets to trap his prey. The industrial chemist also toils on, weaving silken garments for the Colonel's Lady and Judy O'Grady, displacing the old with the new, displacing spider and silkworm with men and machines.


Inspection under the microscope of the internal structure of natural and artificial silks shows the filament contours. At the left is Bemberg filament; in center, natural silk; and at right, viscose rayon—all magnified 300 times



Transporting bamboo to the market. Often it is floated down the river, then carried by the natives

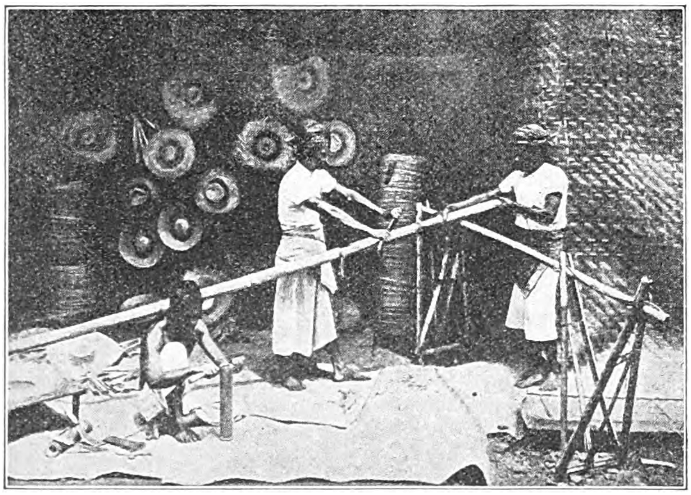
By HENDRIK de LEEUW

'Panama' Hats From the Pacific

THE American farmer who uses the old-fashioned floppy "straw" hat does not realize that he is perhaps indebted to the deftness of slim brown hands in the far off Dutch East Indies for the sunshade that protects him from the blistering sun. Likewise, milady of New York, London, or Paris may not be aware of the fact that her blocked, or basket-weave, or rough "straw" is from the same source. Hats of many different shades and colors, in almost countless models and shapes, and of a variety of materials—15 to 20 millions of them—are made yearly in these distant islands for the markets of the world. The United States purchased over 8,000,000 of one kind in 1927.

The Dutch East Indies are richly endowed by nature with the materials of which these hats are made. Bamboo in many varieties is found in Java, Madura, Bali, and Lombok; rattan in the outer islands; pandanus in Sumatra; lontar palm in the eastern archipelago; and various grasses in many localities. Pandanus grass has long, strong leaves and is famous for its use in the Sumatra solid plaiting. Lontar leaves have long been used by the natives as writing paper, while in the Celebes and in Borneo, the natives have used *foeja*, or beaten bark, in their crude cloth and hat manufacture. In fact, the various fibers and growths of the jungle play an important role in the lives of the natives. The young roots of the sago palm and twigs of the liana serve as material for baskets, mats, and crude harvest hats; unopened leaves of a wild banana are used in making garments; and other fibers, leaves, and bamboo strips are fashioned into fishing nets, cages, ornaments, war garb, old-fashioned payongs (umbrellas), and so forth.

The hat industry, so the story goes,



Bamboo is harvested before the branches bud, cut into lengths of six or seven joints each, and then scraped

The natives cut the bamboo into blades and these are split again and again until divided into thin strips dates back to the 1850's when a Chinese migrated to the Dutch East Indies from the Philippines, at that time the center of the hat industry. He settled in Tangeran, in Java, about 14 miles from Batavia, and started in a small way the manufacture of so-called Panama hats. As the new industry showed signs of a lucrative future, a Frenchman named Petitjean took it up on a larger scale. Rivalry ensued and the competition stimulated the growth of the business until it had spread to all the islands.

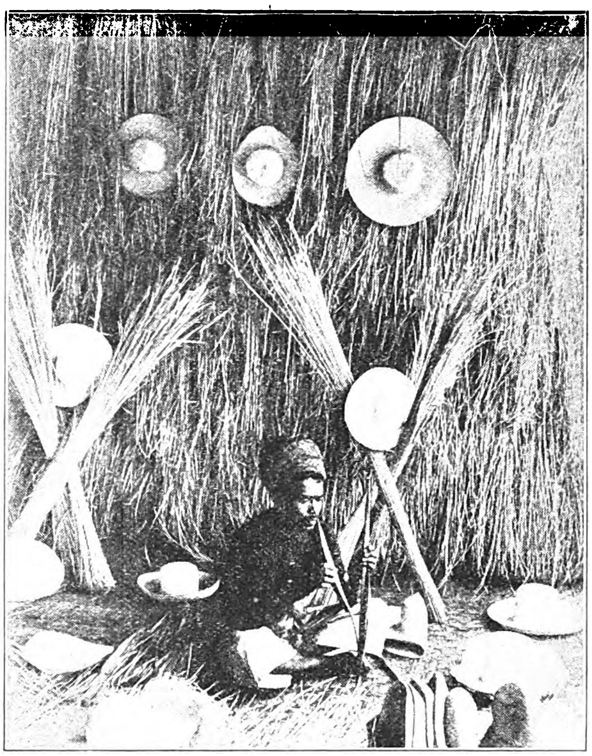
THE hats originally produced were rather crude, but as the industry developed, more up-to-date methods were adopted although the greatest part of the work is still carried out in the homes of the natives. The whole family assists in the work, the men usually preparing the material while the women and children do the plaiting of hats. The men do the final stitching and ironing.

In making hats of bamboo strips, the bamboo stalks are cut before the branches bud and are carefully handled, since bruising causes red spots. Those that are floated down the river are used for inferior hats because they reeive many injuries. And although bamboo is plentiful in the islands, most plaiters buy it in the markets.

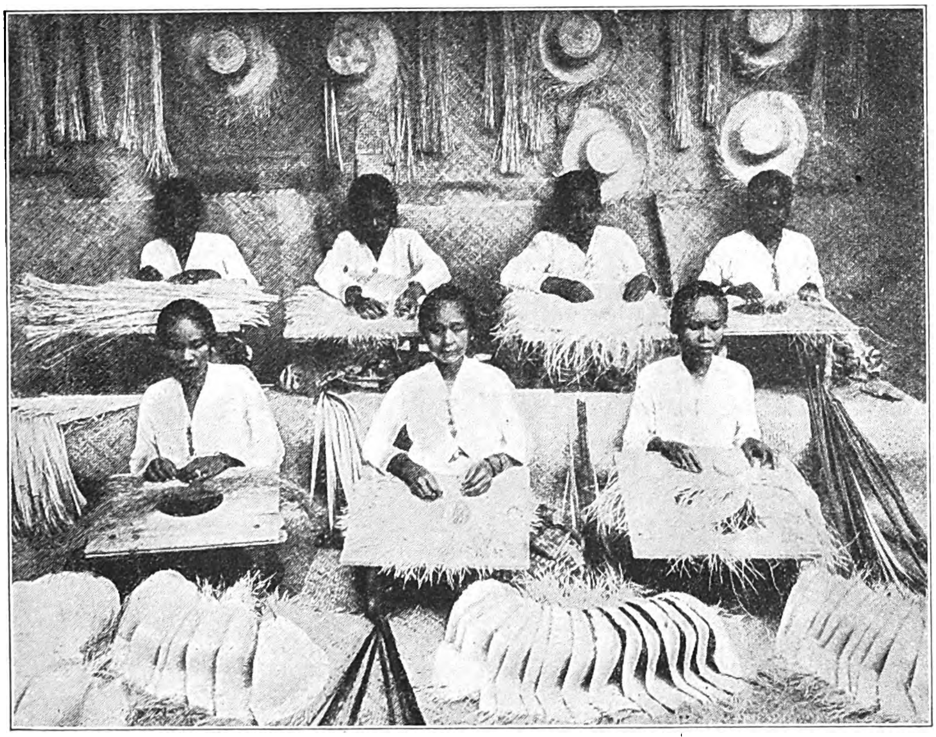
In preparing bamboo for plaiting, the stalks are first cut into pieces six or seven joints long and the green rind is removed. These pieces are exposed to the sun and the dew of night to whiten them. The following day they are split into blades three or four inches wide. These, in turn, are split into laths about one inch wide and the splitting is continued until finally five to nine strips are obtained from one piece. After a further exposure to the sun and dew—to make the strips flexible—they are divided into "straws" by means of a wooden or a bone knife.

At this stage, a peculiar thing happens. The prepared bamboo "straws" are sent to Europe for bleaching by a jealously guarded secret process, and are then returned to the islands for plaiting.

The pandanus grass leaf is prepared for plaiting by removing the midrib, cutting the halves thus formed into strips, and removing the outer surface of the leaf. The strips are then boiled for a night, dried, and also sent on a trip to Europe for bleaching. The grayish fibrous leaves resemble raffia at first, but when finally ready for plaiting, they assume the creamy white color of the Panama hat.

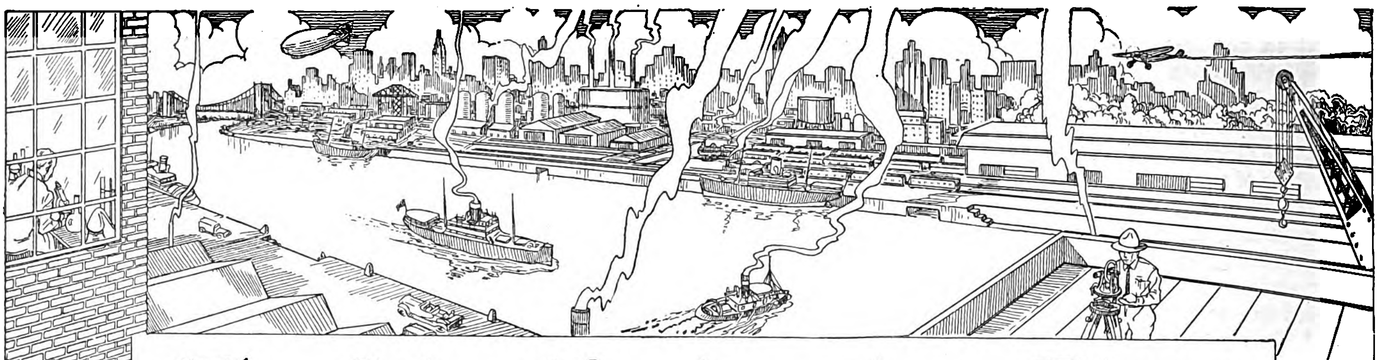

Further splitting. Prepared material, together with several finished and one unfinished hat

A hat of ordinary quality generally takes about two days to manufacture. One of higher quality may require four days or even longer. In plaiting them, the crown is begun first on a round board in which a flat-headed nail has been driven as the central starting point. Only the most experienced plaiters do the work on the apex of the crown. As the plaiting progresses, the hat is placed upside down on a board through which there is a hole large enough to receive the crown. The "barrel" of the crown is then plaited within this hole, which acts as a pattern or guide for the size. When this is finished, the brim is plaited flat or curled, as may be desired. Finally the hats are washed, air dried, and packed for shipment.


Native women doing the intricate work of plaiting, at which they are very proficient. Their hands move so fast that one can hardly see their movements

Besides going to countries of the western world, hats from the Dutch East Indies are sold to Australia for the fruit pickers—in this case being one yard in diameter, to the Orient in fez shape, to Singapore for children, and to many other places in the form of topees, blocked, unblocked, bleached, or colored hats. Many of them are lined with inserted hats of coarser variety, the brims being woven together at the edge.

IN the Dutch East Indies, there are as many styles of home-made hats as there are tribes. One finds in some localities, hats with beaded borders; in others, hats beautifully embroidered with gold or other precious metals and used by native princes. Some of the Dajak tribes make plaited hats with intricate decorative patterns worked into them. Some of these are worn only by persons of high standing or are given the dead to take with them to "Apo Kasan," the Dajak hereafter. The *songko,* a flat, stiff, bamboo-plaited cap—also sometimes made of lontar fiber—is the original headgear of the certain tribes of Celebes and is worn by grandees and officials. It is often elaborately embroidered with gold and silver braids. Select specimen's of the native hatter's art become heirlooms and are presented to married couples as prized gifts.



The Scientific American Digest

Conducted by F. D. McHUGH

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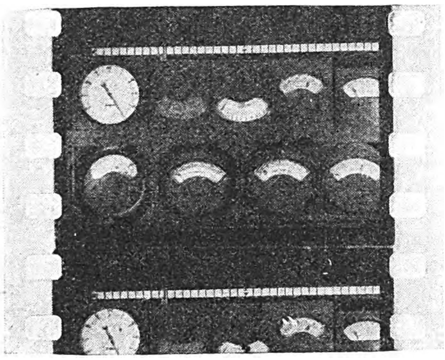
Movie Camera as an Aid in Testing

ENGINEERS, whatever their field of operations, often are required to carry out tests of various kinds where it is necessary to read a number of meters simultaneously. In such cases, several men may have to be employed to do the reading at each recording period but the results obtained are frequently difficult to coordinate. Should the test extend over, say a six-hour run, and five-second or half-minute readings be required, then the observers would probably make trouble.



Section of movie film showing how meters are read by photography

This is the substance of an address presented to the Association of Certificated Mechanical and Electrical Engineers, of South Africa, by Mr. L. B. Woodworth. To overcome the many difficulties, he advocates the use of a camera, preferably a movie camera, for taking the readings. The accompanying illustration, obtained from Mr. Woodworth, will show at a glance the effectiveness of his method, and anyone familiar with tests of this nature can realize its many possibilities. As will be seen, the record obtained in this manner is permanent and may be filed away for reference at any future time. With the addition to the set-up of an ordinary clock or watch and a placard showing the date, so arranged as to be included in the picture, the resulting record would contain all facts necessary to be known, perfectly co-ordinated, and absolutely accurate. And one man can do the job in but a moment at each recording period.

Fire War on Pests

FIGHTING one forest menace with another is the solution for winning the war with bark beetles, according to David Arrivee, assistant supervisor of Targhee National Forest in Northeastern Idaho. Fire was the medium he and the Targhee forest officers used in exterminating the insects which are as deadly to the trees they infest as fire itself. He explains, in *American Forests and Forest Life*, magazine of the American Forestry Association, the method employed and compares its advantages of speed and reduced costs to the tedious felling and burning of infected trees.

Yellowstone National Park itself might have been infected by the insidious enemy had the officers of Targhee National Forest not been successful in their crusade.

"Unlike fire," points out Mr. Arrivee, "insect infestations send up no black and pungent-smelling smoke signals. The myriads of little black beetles, each smaller than a grain of wheat, show themselves only during the short midsummer mating flight, attack a tree at the rate of one pair for each of the hundreds of pitch tubes that usually exude from the entrance holes on the trunk, and then attend strictly to business under cover of the bark."

Bark beetles work swiftly both in killing the tree attacked and in spreading to others in the vicinity, and their damage is often as deadly as fire. In the race for winning the territory back from the enemy the foresters hit on the scheme of fighting with controlled fire.

"In this treatment," says Mr. Arrivee,

In the war against the bark beetle, the man whose job it is to exterminate the pests, is equipped with a small pump tank of kerosene. He sprays this liquid on the tree, lights it, and burns out the insects "oil is sprinkled evenly over the trunk of a tree with a small pressure pump carried on the back. The oil is lighted and the tree trunk is enveloped in a sheath of flame, which chars the bark and cooks the beetles, larvae, and eggs. Directing the oil stream quickly up and down the trunk, the treater gives it an even, thin coating, with an extra dash around the base where the bark is thick. Striking a match, he tosses it at the foot of the tree and with the oil stream carries the flame up and around it, placing an additional amount of the fuel as high as he can reach up tall trees to make the fire 'crown' through to the tip."

That this method is economical as well as efficient is borne out by Mr. Arrivee's statement that, "Computing the cost of equipment, labor, hauling, team hire, fuel, camps and supplies, the 1929 Targhee projects cost forty-six cents a tree, compared to the reported cost of $1.70 a tree on similar projects where the method of cutting, piling, and burning is practiced. Also, the oil-burning treatment takes only about one tenth as much time."

The tree, of course, is killed but the insects would do the job anyway and, were they not checked, would multiply and kill many other trees.

Air Traffic Control Systems

THE Aeronautics Branch of the Department of Commerce has appointed a special committee on standard signal systems for airports, in an endeavor to bring about uniformity in such systems. The results of the inquiry so far have emphasized the facts that the existing systems leave much to be desired and that they lack uniformity.

Sirens are in use at a few of the larger airports and are quite effective in conveying information to ground operators. Sometimes varicolored flags are in use. At a western airport, red and green semaphores are operated from a control tower. The Very pistol, red and green illumination of the wind tee, and blinking of the boundary lights are night-signaling methods.

The majority of those canvassed in the inquiry stressed the value of radio communication.

One authority proposes separate areas for landing and taking off, and stop-and-go lights at the head of the take-off runways. An airport engineer favors a visual system complete in itself and aural and radio signaling as auxiliaries. A system employing steam jets to be illuminated at night will be installed at an eastern airport. At another in the middle west it is proposed to install a panel of lights which will indicate the number of planes in the air at any particular time.

The committee invites suggestions from all persons interested in this topic.—*A. K.*

Elmer A. Sperry

ON June 16, Elmer A. Sperry, who has been ranked second only to Thomas A. Edison in the field of American invention, died in Brooklyn, New York, at the age of 69. During an active life, he had taken out nearly 400 patents. Among these, the most notable, perhaps, is the Gyro-stabilizer for ships, a device which he later modified for use on airplanes and aerial torpedoes.

He invented the Gyro-compass which is used widely on ships of many nations, and "Metal Mike," the automatic steersman which keeps a ship on a set course. He applied the gyroscope to airplanes to give pilots an artificial horizon for flying in fog. Some of his other inventions are: systems of street lighting, lighting system for motion picture projection, high-powered searchlights, and electro-chemical processes.

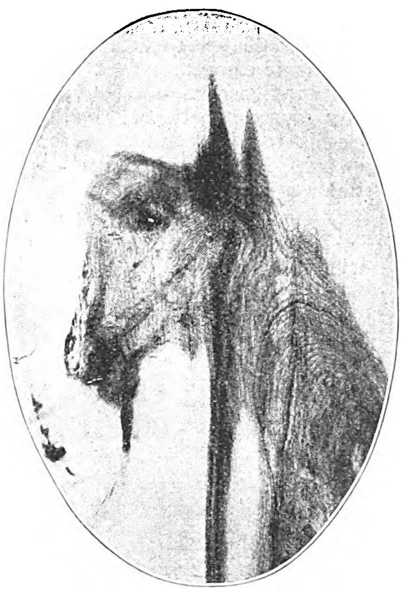
Mr. Sperry was President of the Sperry Gyroscope Company until January, 1929, when he sold out. He was the founder and a charter member of the American Institute of Electrical Engineers and of the American Electro-chemical Society. He was also a member of many of the most important scientific and engineering associations and societies in this country, and had received many awards and medals both at home and abroad.

New Alloy in Plumbing Industry

THE British discovery of a new ternary-lead alloy—with which it will be possible to produce sheets and water pipes superior to and cheaper than those made of pure lead, and having only two thirds of the weight, has been announced. The new alloy, which was discovered by the British Non-Ferrous Metals Research Association in the course of investigations to find the cause of breakdowns in lead cable sheathings, consists of 98.25 percent lead, 1.5 percent tin, and 0.25 per cent cadmium. Tests show that it possesses the following advantages over pure lead: Pipes made from it will be cheaper, having only two thirds the weight; its ultimate tensile strength is 84 percent greater; its resistance to vibration is 217 percent greater; in certain corrosive waters its resistance is superior to lead iself.

A ton of ternary alloy costs 10 percent more than lead, taken on the basis of metal costs, but the ternary alloy will give 33⅓ percent greater length and superior mechanical strength of pipe, for the same weight of lead, so that there is a gross margin of saving amounting to 23 percent. There is a small extra manufacturing cost but the net savings make the alloy pipes considerably cheaper. Another saving will be on carriage charges. Lead sheets are subject to "creeps." The tin-lead alloy, which has a greater resistance to corrosion, is 300 percent less ductile than lead.

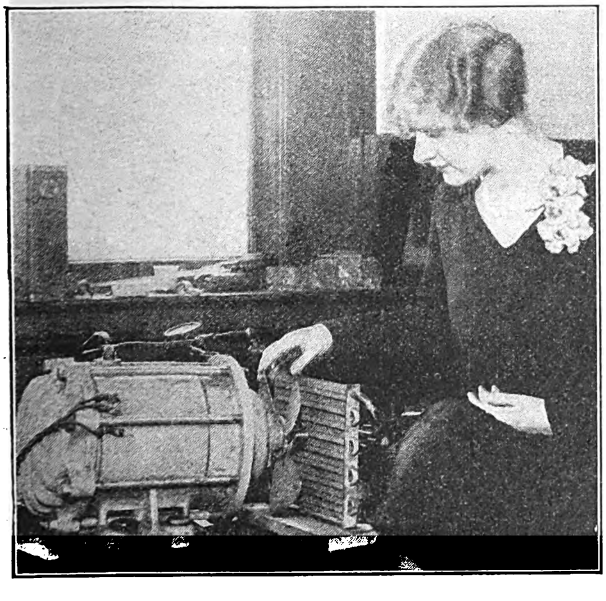
There seems to be good reason to believe that this alloy will take the place of lead pipes and sheets throughout the world.—*A. E. B.*



This curious animal portrait, found on a maple board in a shop of the Forest Products Laboratory, Madison, Wisconsin, was produced solely by a natural discoloration around a cluster of knots. The teeth and the high light around the eye were produced by reflections from the light used by the photographer

Food Poisoning

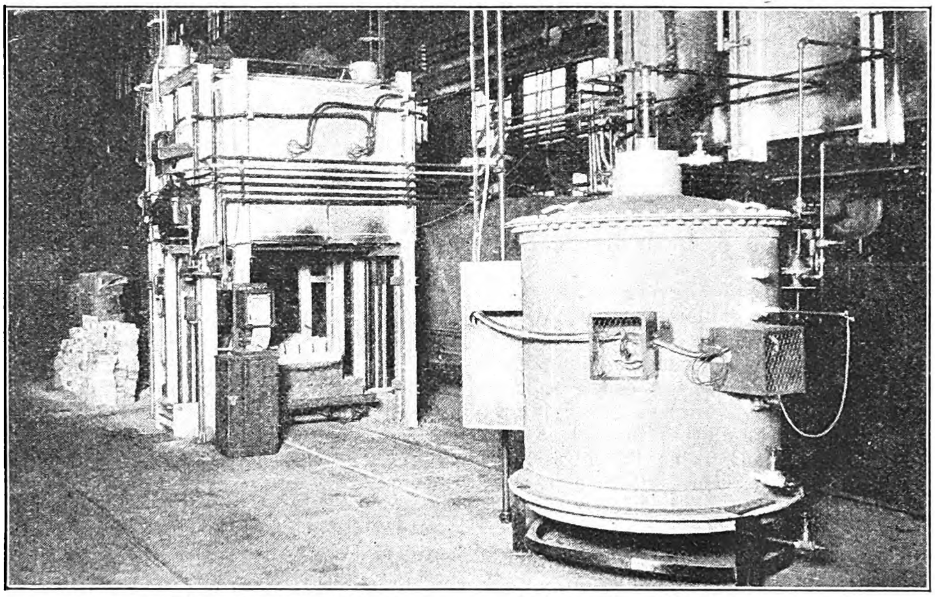
A CONSIDERABLE number of people in Chicago were poisoned after eating cake. It was formerly thought that food poisoning was due to the development of strange chemical substances in the bowel. Recent investigations have proved, however, that the effects are almost invariably due to bacteria or bacterial production. The most serious type of food poisoning is that following the ingestion of the botulism germ or of its poisons. Investigations made by Prof. E. O. Jordan of the University of Chicago have shown that other forms of bacteria likewise produce such



No shaft or belt turns the fan on the new Westinghouse electrical refrigerator. Powerful cobalt steel magnets, a recent development of the company's engineers, whirl the fan around by magnetic induction, through the end bell of the motor housing. The motor armature has no mechanical connection with the outside, as it runs in bearings within the housing. This construction allows the motor housing to be permanently sealed

changes. When samples of the cake were brought to the laboratory and subjected to bacteriologic examination, it was found that a staphylococcus of the type that ordinarily causes infection of the skin had developed a toxic substance in the cake and when a filtrate containing this toxic substance was swallowed by human volunteers they developed nausea, dizziness, and prostration, exactly as did the people who ate the cake.

In this experiment 80 feeding tests were made on 58 male volunteers who were mostly between 20 and 30 years of age.



Electric annealing furnace and Electrolene producer

In an attempt to control the psychology of the situation some of the volunteers were given milk without any of the toxic filtrate. Usually there was slight rise in temperature, then dizziness, loss of appetite, weakness in the legs, headache, pain in the abdomen, nausea, and vomiting. Following this there was looseness in the intestinal action and then gradual recovery. Such conditions emphasize anew the importance of careful sanitation in the preparation of food.—*M. F.*

Seamless, Endless Tube Made by Electrolysis

BY forever pulling off the metal sheath as it is deposited out of solution on an iron alloy core, Prof. Jean Billiter of the University of Vienna makes seamless and endless tubing of copper, zinc, and iron.

But this, his first method, was too slow, he told the American Electro-chemical Society in St. Louis recently; only a few inches of tubing could be made in an hour. Therefore a faster method was devised.

A lead core is now run continuously through the solution and metal is deposited on it as the core moves. Then the soft lead is melted away and the copper, zinc, or iron tubing left. A tube five yards long and nearly one tenth of an inch thick can be made in 24 hours.—*Science Service.*

"Electrolene" to Supply Cheap Hydrogen

ELECTROLENE! There's a new, synthetic name for a brand new arrival in the industrial chemical family. An appropriate name it is too, for electricity is its daddy. Electrolene is the name given by F. P. Wilson, Jr., of the General Electric Company to the new industrial gas produced by the latest ingenious contrivance of the famous Schenectady laboratory. The machine will also produce carbon monoxide or carbon dioxide or a mixture of all of them.

Briefly, the Electrolene producer is an electric furnace in which hydrocarbon gases, with or without steam, are partially decomposed to produce mixtures having carbon monoxide, hydrogen, and carbon dioxide as the main constituents. The relative quantities of these gases in the mixture depend upon: (1) The hydrocarbon being treated; (2) The temperature to which it is heated; (3) The amount of steam used.

The hydrocarbon used as raw material may be butane, propane, ethane, city gas in which methane is the principal hydrocarbon, or a great variety of other gases.

There are dozens of operations in the chemical industry where chemists would use large quantities of hydrogen except for the high cost of the gas that forces them to adopt other expedients. Now comes an electrical device which supplies, not pure hydrogen, it is true, but a gas mixture which will, in many cases, do just as good a job, at about one tenth the cost. If methane is fed into the producer operated at 1400 degrees, Centigrade, the result will be hydrogen and CO; if carbon monoxide and steam are fed into it, the Electrolene will be a mixture of hydrogen and carbon dioxide, the proportion depending on the temperature of the producer. The electric heat supply is automatically controlled to maintain any desired temperature, and the steam supply is also automatically regulated for any rate of output, so that one valve controlling the Electrolene flow from the producer is the only part of the equipment requiring manual attention.

In every case an appreciable increase in volume of raw gas supplied appears as Electrolene. In the case of complete dissociation of coke-oven gas with steam one cubic foot of raw gas becomes approximately two cubic feet of Electrolene, having an approximate analysis of 72 percent hydrogen, 23 percent carbon monoxide, and 5 percent of "inerts." From butane, a volume increase of 13 times is secured, the resulting Electrolene analyzing approximately 69 percent hydrogen and 31 percent carbon monoxide. With methane, the volume increase is four times, and the Electrolene analyzes about 75 percent hydrogen and about 25 percent carbon monoxide.

For a great variety of industrial uses, Electrolene promises to be an effective answer to the chemist's prayer for cheap hydrogen.—*A. E. B.*

Canned Salmon Prevents Disease

CANNED salmon contains the substance which will prevent the frightful hard-times disease, pellagra, the United States Public Health Service has just announced. Canned salmon may therefore be substituted for meat in localities where pellagra is prevalent but where meat is scarce.—*Science Service.*

Detecting Dangerous Sewer Gases

ABOUT a year ago, a series of explosions in a sewer in London ripped up pavements and shattered building fronts over a wide area. Just a few weeks ago, a similar explosion in a sewer on Broadway, New York, caused considerable damage. Such accidents emphasize the ever-present danger, not only of serious property damage but also to the men of maintenance or inspection crews due to the accumulation of various gases such as carbon monoxide, ordinary sewer gases, and the fumes from oil wastes, in manholes or sewers beneath our streets.

To check up on this gas accumulation, the Mine Safety Appliances Company has developed the Jones Gas Detector, an easily portable outfit mounted in a small stand. It consists essentially of a bomb in which a spark plug is inserted and to which a pressure gage is attached. In addition, there are the following component parts: A measuring device, cylinder of propane, water cup, aspirator bulb, two dry cells, an automatic spark coil, ignition switch, necessary valves, and so forth. (One cylinder of propane, in compressed liquid state, is sufficient for making approxi-

Testing for carbon monoxide gas in a manhole with an ampoule

mately 300 tests as described below.)

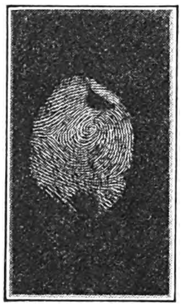
In operating the Jones Gas Detector, a sample of the air to be tested is drawn up from the sewer and forced into the apparatus through a suitable length of sampling line by means of an aspirator bulb. The sampling line is then detached and the aspirator bulb is connected to the rubber inlet tube which traps the sample in a closed system. Stopcocks on each side of the bomb are closed and a spark introduced into the bomb by snapping the ignition switch momentarily to the "on" position and then to the "off" position. In this manner, an explosive gas-air mixture is ignited and the pressure developed by the explosion in the bomb is indicated on a drag needle pressure gage. If no pressure in indicated by this procedure, the sample is enriched by the addition of a measured volume of propane which displaces an equivalent volume of sample. After this propane is thoroughly mixed with the sample by aspirating through the closed system, the stopcocks are closed and a momentary spark is introduced. An explosion in the bomb indicates that the original sample is not less than 75 percent explosive since the measured volume of propane added is equivalent to 25 percent of an explosive propane-air mixture. If no explosion is indicated in the bomb after the first enrichment, it may be necessary to make three more individual additions of propane to the original sample, following the same procedure as with the first to determine if the original sample is approximately 50, 25, or less than 25 percent explosive.

If there is no initial explosion in the bomb and no further explosion upon the addition of a fully explosive concentration of propane, the original sample consists either of an inert atmosphere or explosive gas in concentration above the upper explosive limit. To determine which of these two conditions exists, further simple tests are made according to directions supplied.

To detect the presence of that most treacherous and deady gas, carbon monoxide, the above company produces the M-S-A Carbon Monoxide Detector Ampoule. This consists of palladium chloride in an acetone-water (non-freezing) solution, sealed in a small glass tube which is surrounded with absorbent cotton. The ampoule is first attached to a string, crushed between the fingers until the cotton is fully saturated by the escaping solution, and then suspended in the manhole for 10 minutes. The solution turns the cotton a yellow color. In the presence of carbon monoxide, it turns black. The degree of grayish or black discoloration, compared to a chart, indicates the carbon monoxide concentration. It is claimed that concentrations as low as .03 percent can be determined with this ampoule.

City Trees Often Gassed

SHADE trees need pure air just as people do. Trees are often killed by illuminating gas from leaky pipes in the soil, says the United States Department of Agriculture. Recent experiments show that gassed trees may be saved, if they have not been exposed too long, by forcing air or oxygen under pressure, through a specially constructed nozzle, well into the ground at different points around the tree so as to displace the gas. It will be necessary, of course, to find and stop the gas leak or the procedure will have to be repeated.

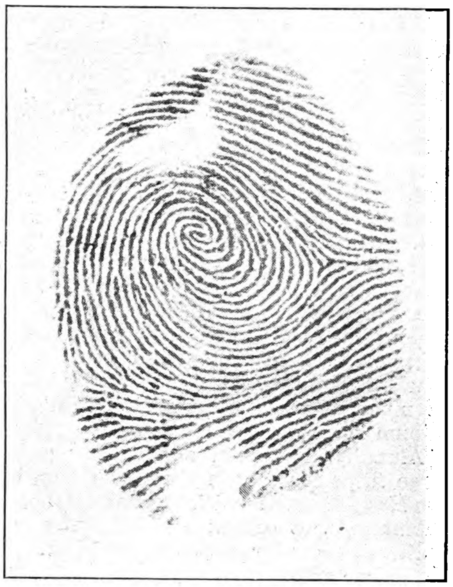


At the left is a fingerprint raised from the irregular neck of a bottle by means of the new fingerprint lifting tape. At the right is the same print (reversed) as it appeared when the lifted print was photographed on bromide paper enlarged for comparison

Fingerprint-Lifting Tape

A SPECIAL tape of black rubber which simplifies the raising of a latent fingerprint, has recently been invented and patented by Major Richard M. Joyce, Superintendent of the Bertillon and Criminal Identification Bureau of the St. Louis Police Department. Latent prints are to be distinguished from those intentionally made on suitable surfaces for record purposes; they are those which are inadvertently left behind by criminals at the scenes of their crimes.

The old photographic method of obtaining permanent records of latent prints has many disadvantages. Prints left on curved, angular, or reflecting surfaces or in restricted recesses are almost impossible to photograph, and when a camera is used the resulting images are distorted or indistinct. By Major Joyce's method, the print is first powdered with aluminum bronze powder, the tape is pressed over this, and the gleaming print is lifted. The image is then covered with a transparent shield which protects it until it may be conveniently photographed.



This new transfer system extends fingerprint recording facilities to small towns or rural districts not able to purchase and operate the usual photographic equipment.

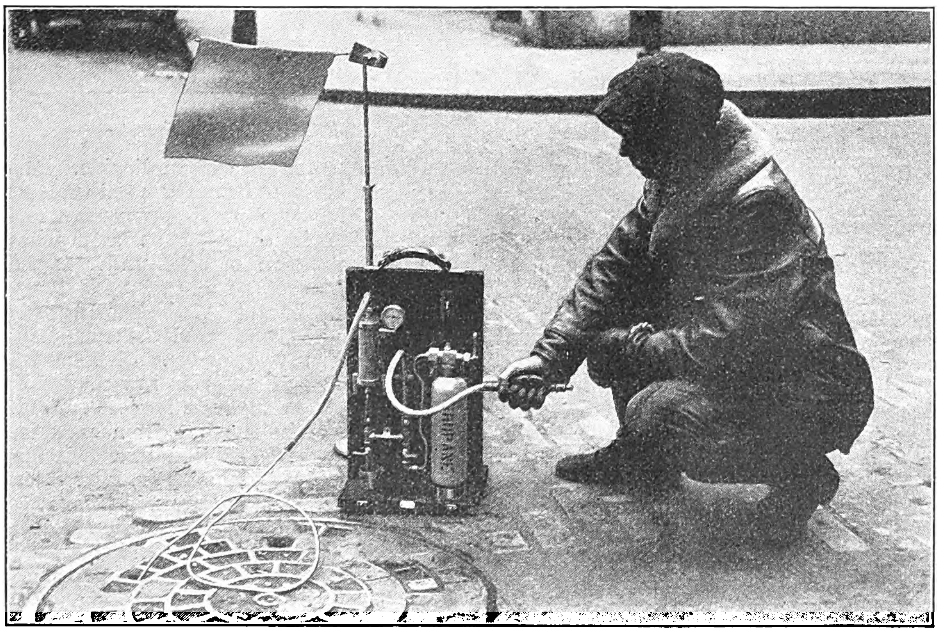
Aluminum in Colors

WHILE aluminum, together with its alloys, has been adopted for a wide variety of uses, (see SCIENTIFIC AMERICAN, June, 1930), its many possibilities have only begun to be realized. With the production of aluminum in colors by a recently developed process, some of the advantages of the metal have been enhanced and some of its disadvantages overcome so that interesting new fields for its application have been opened up.

Colored aluminum, called Alumilite, was developed by the Metals Protection Corporation. The process is an electrolytic method of applying protective and decorative coloring to aluminum and its alloys, the colors available being silvery white, jet black, and various shades of red, blue, yellow, brown, green, and purple.

The developing company makes the following claims for the new product:

The coating is an integral part of the aluminum itself, will not crack or peel, and sheets so treated may be stamped and formed into such shapes as camera bodies, hub caps, trim, et cetera, without marring the finish. Alumilite offers unusual resistance to atmospheric and salt-water corrosion; and although not recommended for use in protecting aluminum against acids and alkalis, it is effective against certain



The gas detector which measures the accumulation of deadly gases in sewers

chemicals. Alumilite will not withstand cutting by a sharp instrument but offers considerable resistance to it. A blunt instrument will force the coating into the softer metal beneath without rupturing. Alumilite-treated metal can be heated above the melting point of aluminum, 1214.6 degrees Fahrenheit, and the metal within will melt while the coating remains intact. The treated aluminum surface will absorb certain lacquers as well as oil and is, therefore, a good base for such materials; ordinary aluminum is not.

Some of the suggested uses of Alumilite are: cameras, scientific instruments, novelties, electrical appliances, switch plates, fittings, automotive trim, airplane propellers, marine equipment, optical goods, toys, aluminum shingles, and many others. Black, for example, has been suggested for the bottoms of cooking utensils, since black absorbs heat more readily than any other color. Water in an aluminum kettle blackened by the Alumilite process will boil in much less time than in a plain aluminum kettle.

Alumilite has been adopted by many large firms for use on their products; by the Navy Department for use on airplanes, submarines, et cetera; and by Army aircraft engineers for use on Army airplanes.

Overweight Children

THE fat baby has always been a pride to its parents, but the fat child of eight to 20 years of age is a problem for its parents. Many cases of fatness or obesity are due to disturbances of the glands of internal secretion, or to the fact that the body does not dispose properly of the material that is taken into it. In many instances, children are fat because the parents and grandparents were fat. This is known as constitutional obesity and is the type that is absolutely resistant to all treatment. In those cases of obesity due to glandular disturbances, the basal metabolic rate or the rate at which the body carries on its chemical process is lower than it should be. However, in many cases of constitutional obesity the basal metabolic rate seems to be normal.

Drs. Anne Topper and Hannah Mulier have made a study of the basal metabolic rates of 35 boys and 35 girls whose ages ranged from six to 14 years, but whose weight exceeded normal by from 13 to 75 percent. In many cases there was a definite indication that the children had been overfed. Naturally only a few confessed to laziness. In some cases the obesity followed recovery from acute infectious diseases or following removal of tonsils or the appendix. In the large majority of these cases, however, it was found that the metabolic rate was normal, in a great many cases being toward a high normal rate. The authors believe that the tendency toward a high normal rate is probably due to overfeeding and to the fact that the body is forced to speed up its activities in order to take care of the excess food.

It should be recognized that these examinations were made in many instances just before the time of adolescence when the child begins to change toward the adult type. At this time the glands in the body undergo various changes and these changes may be associated with the rather high increase in the speed of metabolism.

Obviously, the practical lesson to be derived from this discussion is the necessity of determining how much food is necessary to keep the child at normal weight and thereafter to avoid overfeeding.—*M. F.*

Light Alloys

THE lightest element solid at ordinary temperatures is the metal lithium. It is only a little more than half as heavy as water. While technically a metal, it is too soft to be of any use in the ordinary applications of metals and too active chemically, for it tarnishes rapidly in the air and is completely changed by contact with water, which it decomposes.

In recent years, however, says R. M. Santmyers, of the United States Bureau of Mines, considerable research has been made to determine the possibilities of alloying lithium with other light metals such as beryllium and aluminum. A patent has been issued to Frank A. Fahrenwald for an alloy of extreme lightness, fair permanence, and considerable hardness, in which the component parts were lithium and beryllium. The beryllium protects the lithium from oxidation by moisture or heating and from further action if oxidation has begun, by producing upon the surface of the alloy a closely adherent, finely textured insoluble oxide that prevents further oxidation. The lithium content may be as high as 25 percent. This alloy apparently does not corrode faster than iron, and its specific gravity is only about 1.5.

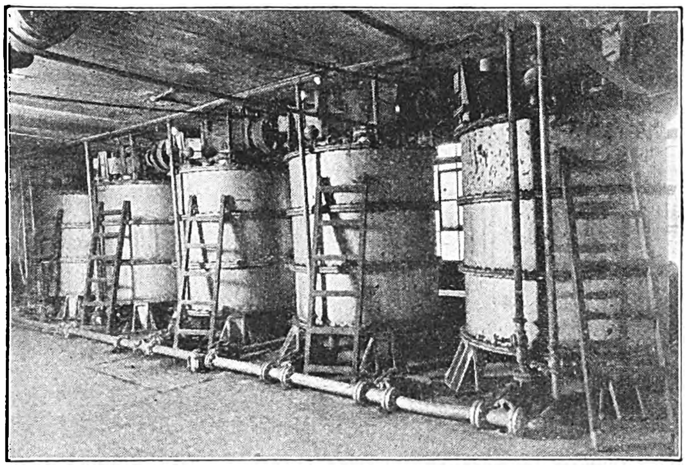
By increasing the proportion of lithium to about 65 percent, an alloy as light as water can be produced, and although such an alloy corrodes fairly rapidly in the presence of water it can be protected sufficiently for many purposes by plating or covering. If the percentage of lithium is increased slightly above 65 percent, small quantities of aluminium or zinc may be added to increase the hardness and strength, but the alloy will retain a specific gravity little or no greater than that of water.—*A. E. B.*

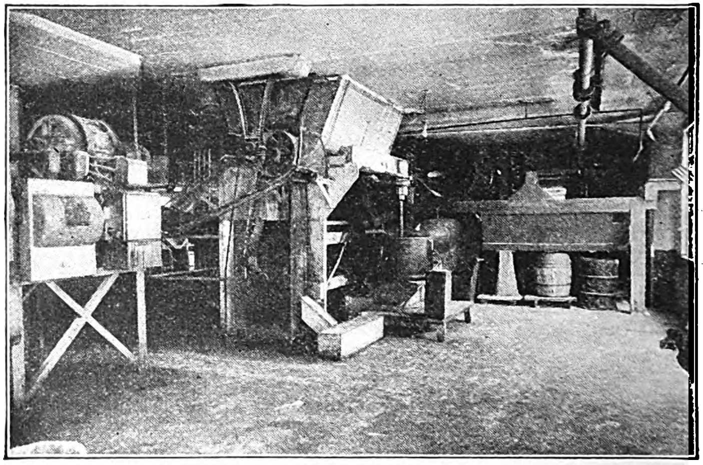
Making the Sparkle for Soft Drinks

IN these hot summer days, the soft-drink dispensaries once more come into their own, and it is an appropriate time to consider the chemistry that creates the sparkle or "fizz" in the bottled beverages that quench the great American thirst. The sparkle is due to dissolved carbon dioxide gas—the gas that gives soda water its effervescence. While carbon dioxide is one of the most abundant gases in nature, being generated wherever coal or wood is burned, its manufacture for beverage purposes presents certain problems to the chemical engineer which are described by W. P. Heath in a recent issue of *Industrial and Engineering Chemistry.*

"Before prohibition," says Mr. Heath, "carbon dioxide was collected and compressed as a by-product of the fermentation of beer. The most recent method is to pipe it from wells. In California, prospectors drilling for oil ran into large pockets of carbon dioxide under pressure. Under government lease these pockets are now yielding their store of carbon dioxide. Most of the gas thus collected is used in the manufacture of solidified carbon dioxide. Perhaps the most universally used process today is the coke process, whereby carbon dioxide is collected as a product of the combustion of coke under forced draft."

In Atlanta, because of the proximity of raw materials, the Crystal Carbonic Laboratory uses the wet process, with dolomite, sulfuric acid, and water as raw materials. The stone called dolomite is most suitable on account of its freedom from excessive amounts of oxide of iron and alumina, carbonaceous matter, sulfides, and silica. The stone is pulverized and then treated with sulfuric acid. Carbon dioxide is given off rapidly, and the gas is piped to a 2500-cubic-foot rubber gas bag in the basement, where it is ready for compression. The gas is drawn from the gas bag into a three-stage compressor where the pressure is


Lead lined carbon dioxide generators


Driers and screens for Epsom salts

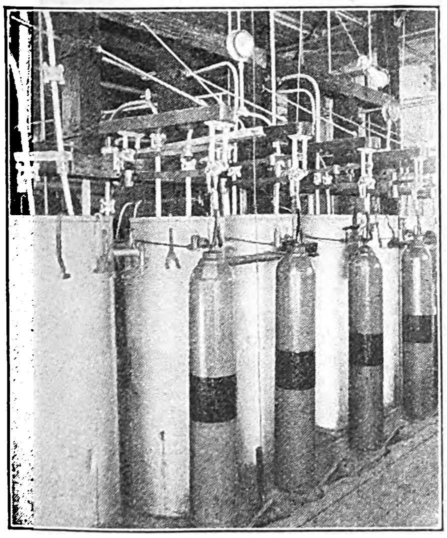
stepped up to 75 pounds in the first stage, 250 pounds in the second stage, and 1000 pounds or more in the third stage. The third stage of this machine is of the solid-plunger type, outside packed, and the gas emerges at over 1000 pounds pressure into brass cooling coils, where the temperature is reduced to below 88 degrees, Fahrenheit, the critical point of carbonic acid. The gas is then forced into 50-pound steel drums. Gases under pressure are classed as hazardous and the filling is carefully regulated so that all excessive pressure may be avoided.

At ordinary temperature the drums are about two thirds full of liquid and one third full of saturated gas. The average purity is 99.5 percent and there are traces of air. Such impurities as may give an odor or taste are not permitted in carbonic acid to be used in the beverage industry.

One of the most interesting features of this process is the fact that it produces Epsom salts as a by-product. The dolomite contains 45 percent of magnesium carbonate, and after the sulfuric acid has acted on this substance, releasing the carbon dioxide gas, there remains a solution of magnesium sulfate—Epsom salts. Although the Crystal Carbonic Laboratory is primarily in the business of manufacturing carbon dioxide for use in the beverage industry, the quantity of magnesium sulfate obtained as a by-product makes this company one of the largest Epsom salt manufacturing concerns in the United States.—*A. E. B.*

Bread

THE battle of cultists against white bread continues. The millers oppose the attacks by pointing out that the American people seem to prefer white bread to whole wheat bread. Furthermore, they are annoyed because there has been a general decrease in the consumption of cereals, since these represent a cheap source of energy and the American people have become accustomed to expensive diets. The bread of today is not the bread of the past generation. Today it is made by the addition of milk, nuts, raisins and other substances which add greatly to its nutritious value.

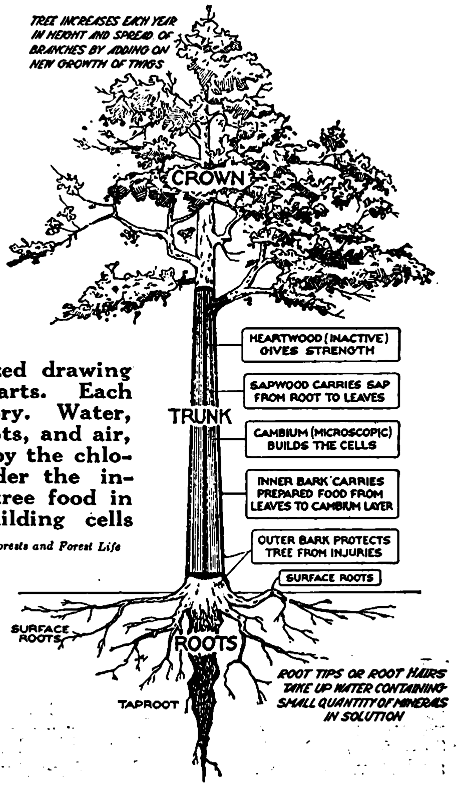


Compressed carbon dioxide being loaded into cylinders for shipment

Whole wheat is preferred by some because of its bran content and its greater proportions of vitamins, due to the fact that the whole wheat germ is present. On the other hand, whole wheat bread does not keep well and the bran is irritating to persons having inflammations of the gastro-intestinal tract.

Under the auspices of the Medical Research Council in Great Britain, Drs. R. A. McCance and R. D. Lawrence made a special study of this problem. Their views are succinctly stated:

"In advocating whole-meal bread for general use, whether in times of need or in times of plenty, it should be remembered that not only men but also women and children are concerned, and that all the experiments on which the arguments are based have been carried out on animals or adult males. Children are very intolerant of high cellulose diets, and, for some, brown bread is far too irritating, even if given with the idea of relieving constipation. Appetite is such an important factor in all digestive considerations that no one who dislikes a food of unproved value should be forced to eat it if it can be avoided. In time of peace, of course, the grown-up population, if they have the choice, will never eat whole-meal bread unless they like it, no matter how specious the advertisement, but they may force their children to eat it in the belief that they are doing them good. One should, therefore, be cautious in advising whole-meal bread generally, and wait until careful unbiased experiments have been done on a sufficient number of men, women, and children. Thus only can accurate conclusions be drawn."


TREE INCREASES EACH YEAR IN HEIGHT AND SPREAD OF BRANCHES BY ADDING ON NEW GROWTH OF TWIGS
CROWN
HEARTWOOD (INACTIVE) GIVES STRENGTH
SAPWOOD CARRIES SAP FROM ROOT TO LEAVES
TRUNK
CAMBIUM (MICROSCOPIC) BUILDS THE CELLS
INNER BARK CARRIES PREPARED FOOD FROM LEAVES TO CAMBIUM LAYER
OUTER BARK PROTECTS TREE FROM INJURIES
SURFACE ROOTS
SURFACE ROOTS
ROOTS
ROOT TIPS OR ROOT HAIRS TAKE UP WATER CONTAINING SMALL QUANTITY OF MINERALS IN SOLUTION
TAPROOT

How a tree grows: A partly sectionalized drawing showing the functions of the various parts. Each leaf is essentially a tiny chemical factory. Water, with its dissolved minerals, from the roots, and air, which the leaf breathes, are acted upon by the chlorophyll—the green coloring matter—under the influence of sunshine and the result is tree food in the form of sugars and starches for building cells

Courtesy *American Forests and Forest Life*

It must be remembered that man does not live by bread alone. In a suitable diet, bread constitutes only a single part and is supplemented by meat, vegetables, fruits, and many other cereal products. In the light of present dietary habits, there seems to be no reason to believe that white bread is in any sense of the word a harmful constituent of an average diet.—*M. F.*

Navigation in the Air

AERIAL navigation is not a matter largely of astronomical observations. It is, particularly for cross-country work, a matter of dead reckoning, with compass, drift and speed indicators, and a few simple calculations as its basis. It is not a difficult art, but an immensely important one. The subject is splendidly covered in "The Navigation of Aircraft," by Lieutenant Logan C. Ramsey, U. S. N., himself a naval aviator and an acknowledged authority on aerial navigation.—*A. K.*

A Novel Landing Float

IN *Aviation* is described a novel form of semi-circular "button" float which has been placed in use on the Air Ferries [See page 379, May 1930 SCIENTIFIC AMERICAN. *Editor.*] between San Francisco-Oakland and San Francisco-Vallejo; more than 85 landings are made on it daily.

The float is rigid, with a smooth rounded top which slopes gradually into the water. A sand surface is provided to keep the planes from skidding. The float is supported by a pontoon and fitted with an overhanging platform. Along the rim are four solid ballast pockets to regulate the depth still more accurately. At the water line 18 buoyancy tanks are installed to correct any tendency of the float to be too lively. The surface of the float is a variable curve for the purpose of breaking rough water and to give maximum freeboard. The weight of the float is 100 tons and it extends 4½ feet under water. It is built of creosoted Douglas fir and is moored by a cable from a king post to keelsons leading to the rim and then to anchorage. It cost 10,000 dollars to build.

When the amphibian alights on the water, its wheels are dropped and it climbs out of the water on to the button under its own power. It can approach from any direction without the help of landing crews, and can also make a get-away unaided.

Experiments have shown that a complete circular float, slowly rotated, will divert the wave, kill a hollow and make the approach of the plane easy even in a high sea. This makes the use of the float promising even at sea.

It was developed by B. L. Haviside and Joseph J. Tynan, Jr., both of San Francisco, and is arousing much interest.—*A. K.*

Max Valier: Rocket Martyr

THE month of May saw the sad crash of Max Valier in a venturesome plane flight propelled by liquid rocket. The whole fuel charge detonated at once.

The internal combustion engine, the cannon, and the rocket are all heat engines operating on the same fundamental calorific principle. A 16-inch shell, for example, has the energy of an express train; a rocket may possess the energy of an ocean liner.

In the 90's a German and a Russian (Ziolkowski) were developing on paper the concept of space ships, rocket-propelled;

and in 1913 Robert Esnault-Pelterie, the distinguished creator of the French aeronautic engine, delivered a mathematical paper on "Astronautics" before the St. Petersburg Academy. The science, or art, has been more fittingly renamed by a German "Kosmonautics."

Parallel, then, with the laboratory work of our own Dr. Goddard, a close group of Germans and Austrians, and a corresponding group of Russians of the Hydrodynamic Institut, have been working systematically toward the solution of the problem. In the German group were prominently: Dr. Oberth (Hirsch-REP prize 1928-9); Ingr. Hohman (Honorable Mention); Max Valier, Ingr.; Fritz Opel, manufacturer; A. Scherschewski; Sander, pyrotechnist; Willy Gail and Frau Harden, writers; Rhoen-Rossiten Gesellschaft; pilot Stammer, and a number of others. Their headquarters are at Breslau. The UFA has collaborated, and even made a "moon" film. The equivalent American society is the American Interplanetary Society, at the American Museum of Natural History.

Mr. McEachron with a sectionalized Thyrite lightning arrester

Valier was the principal proponent of working toward the space craft or vehicle from the known forms of surface or air craft. For example, he proposed first to drive a boat with rockets (which Opel tried); then an automobile (reported speed 230 miles per hour); then a rail car (reported speed 300 miles per hour); then an ice sledge (still faster); and recently a light plane (60 miles an hour by Stammer, July 1928, the first man so to fly). Valier at the time of his death was substituting oil fuel for gunpowder in the expulsive jet, preparatory to hopping the channel at a speed hoped to be about 100 miles per hour.

A National Advisory Committee report has demonstrated that jet propulsion is not efficient at aircraft velocities—indeed at less than the speed of sound, for flame jets. But beginning with projectile velocities, and up to a mile or so a second, the jet principle approaches an efficiency of 70 and 80 percent, or better than any other heat engine. It is this happy circumstance, more than any other factor, that gives one confidence in the ultimate solution of Kosmonautics.

The name Valier should be placed beside those of Icarus and Lillienthal.

Two Freak Metals Find New Uses

TWO rare metals, caesium and rubidium, formerly known as chemical curiosities, have found their first important commercial use as a result of the development of radio and photo-electric cells. Both these queer metals, members of the alkali group, are soft enough to be cut with a knife and have to be kept in a vacuum, else they ignite spontaneously, due to their extreme chemical activity. This very property is now being utilized in the manufacture of radio tubes. The caesium is introduced into the tubes in the form of chloride, mixed with magnesium or calcium, and compressed into small tablets or "pills." At one stage in the manufacture of the tube the pill is flashed, eliminating the last trace of air and thus securing the desired vacuum. The caesium chloride supplies positive ions at the surface of the filament.

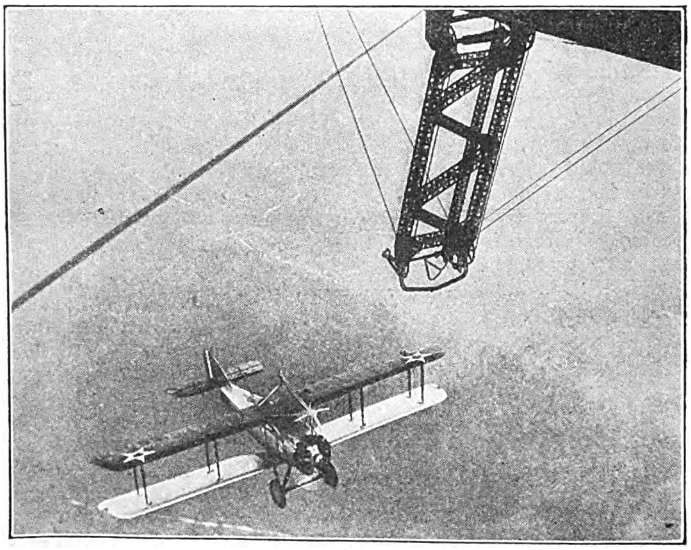
Both caesium and rubidium are employed to a limited extent in the manufacture of photo-electric cells. Rubidium, however, appears to be more suitable for this than caesium, because an extremely thin layer can be applied on the inner side of the glass. In the manufacture of these cells the metal, either caesium or rubidium, is introduced in excess but later is removed entirely except for the molecular layer that has formed on the silver or other base-metal electrode. The photo-emission of the molecular layer is greater than that of the massive metal.—*A. E. B.*

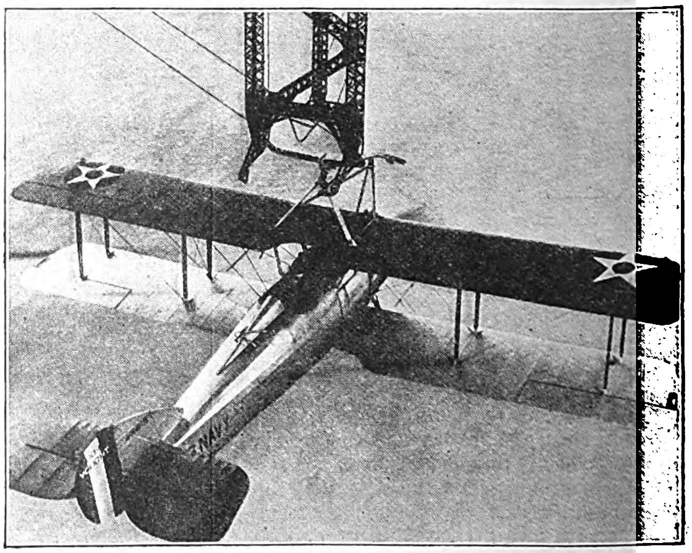
Thyrite—Both an Insulator and a Conductor

AN entirely new type of material, one that is both a good insulator and a good conductor of electricity, was announced by K. B. McEachron of the General Electric Company recently in New York City. This material, which has been called Thyrite, meaning gate or valve, has the remarkable property of changing its resistance to the flow of electricity as the voltage or pressure is changed. This change in resistance is such that each time the applied voltage is doubled, the resistance decreases so that the current flow is increased more than 12 times. This means that if the voltage is increased 16 times the current flow is increased more than 25,000 times.

The usual conductor with which electrical engineers are familiar does not change in resistance except when the temperature of the conductor changes. To illustrate: the tungsten filament in the Mazda lamp increases its resistance considerably as the filament heats up; the carbon lamp shows, on the contrary, a decrease in resistance as the filament increases in temperature. With either of these materials the resistance change is slow since it depends on the time required to heat the filament. Unlike any materials now in commercial use, the resistance change of Thyrite does not depend on the temperature, but on a change in the applied voltage. Thyrite will change its resistance as quickly as the applied voltage changes; in fact, tests have shown that the resistance can be decreased to a millionth of its original value in a time as short as a millionth of a second.

Thyrite is a manufactured product which required more than five years of intensive research to develop to the state where it can be produced commercially. Mr. McEachron exhibited some disks six inches in diameter and three-fourths of an inch thick, made for use in lightning arresters for the protection of power stations against the damaging effects of lightning. Such disks have a resistance of about 50,000


The dural framework which extends from the lower part of the airship frame, and a plane maneuvering for "hooking" position. Tests of the device were successful



The slight impact that ensues after hook and bar meet is evidently sufficient to adjust hook so that it is sesecurely attached. Note construction of plane hook

ohms when 100 volts are applied to the parallel faces; the resistance decreases to less than one half an ohm when the voltage is increased to 10,000 volts. These disks of Thyrite will carry lightning discharges as heavy as 30,000 amperes without any sign of distress.

The characteristics of Thyrite are permanent. Some of the first material made is still on life test, with no change in its characteristics, even though it has been carrying current continuously night and day over a period of several years.

Thyrite resembles black slate in color. It has mechanical properties similar to those of dry-process porcelain. In manufacturing it, the material is moulded to the shape required, and the contact surfaces coated with metal by the Schoop metal-spraying process.

It is possible to use the material successfully on any alternating or direct current circuit; it is necessary only to supply a proper amount of the material so that it will not become overheated.

In connection with lightning arresters, Mr. McEachron explained that the use of Thyrite allows a considerable reduction in the space occupied by the arrester, and that it is possible to calculate its performance accurately. This feature will be of great assistance to engineers using such protective equipment. Furthermore, it was pointed out, it is possible for anyone to determine the characteristics of Thyrite over a considerable current range, without the use of expensive equipment.

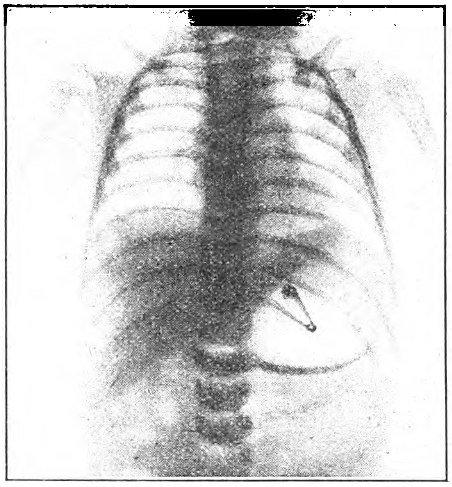
Aeronautical Equipment

THE Curtiss-Wright aeronautical equipment catalog of some 250 pages is a comprehensive compilation. Nothing gives a better idea of the number of things that go to make up aviation: airport equipment, books and maps, cable and wires, clothing, engines and engine accessories, fuels and lubricants, instruments, landing gear and parts, propellers, and so forth. It is a catalog which should be in the hands of every pilot and plane owner.—*A. K.*

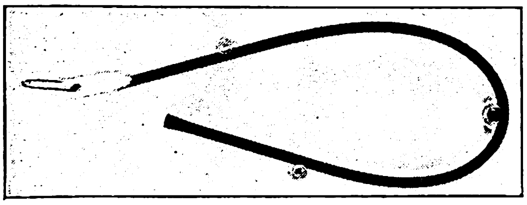
Launching Planes from Airships

ONE of the two accompanying photographs shows a Vought UO-1 Navy Observation plane approaching the *Los Angeles* prior to "hooking-on." The airplane is provided with a frame superstructure into which the weight of the airplane is transmitted without undue local stresses being set up. At the top of the superstructure is a hook which has apparently some flexibility and is controlled by a sort of large spring. From the lower part of the airship frame there extends a dural framework, suitably braced with wire and carrying a bar at its lower end.

When the airplane is about to be hooked on to the airship, the speeds of the two types of aircraft are synchronized and the pilot feels his way cautiously until he can get the hook on to the bar. When the plane is to be released the bar is pulled away. Demonstrations of the hooking-on and releasing of the plane have been made several times on the *Los Angeles* and have been entirely successful. The hooking-on process enhances greatly the military value of the dirigible. The airplane, having a seped of twice that of the airship, is valuable as a scout for transmission of information to the fleet, and also provides the airship with protection against enemy heavier-than-air craft.—*A. K.*



An open safety pin in a patient's stomach as revealed by the X ray



The rubber tube with which a safety pin was removed from the position in a patient's stomach as shown in the illustration above at right. It was not necessary to open the wall of the stomach although the abdomen was cut open

A Pin in the Stomach

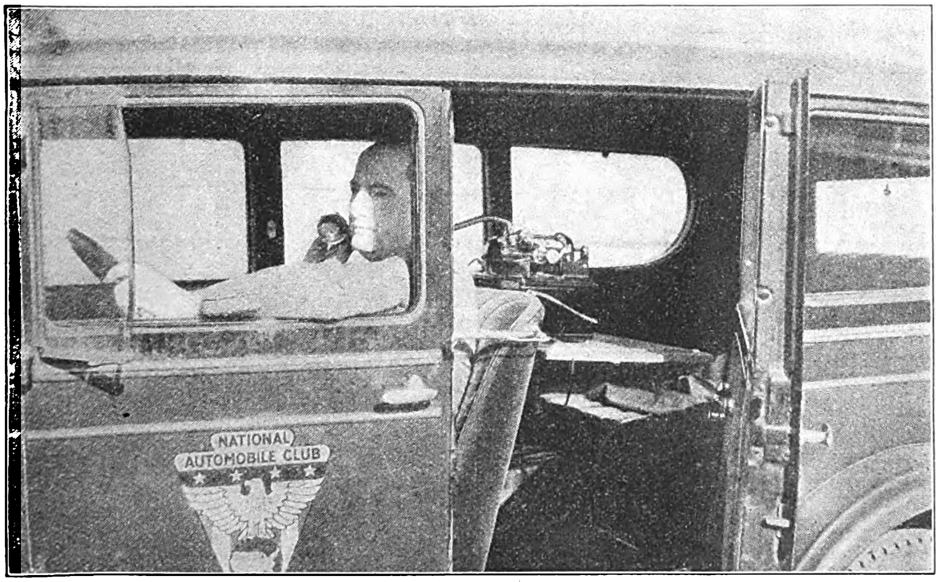
WHEN an open safety pin is swallowed it constitutes a serious menace because of the danger that it will penetrate the wall of the stomach and set up peritonitis. So serious is this possibility that not infrequently the patient is operated on immediately and the stomach opened in order that the pin may be removed.

In a case treated recently by Dr. W. B. Huff a technique was devised which enabled the condition to be handled without opening the wall of the stomach. Ingeniously the doctor introduced into the esophagus a rubber tube with a piece of gauze at the end. The abdomen was opened, the pin felt with the fingers, and then, without opening the stomach, the pin was fastened to the gauze at the end of the rubber tube and closed. The rubber tube was then slowly withdrawn, bringing the safety pin with it. In the instance described the child recovered without further disturbance. The method seems to be of value particularly because it permits proper handling of the condition without opening the stomach wall.—*M. F.*

Ediphone Used for Road "Logging"

LATEST road information for the members of the National Automobile Club, San Francisco, is being gathered in a unique, modern, and efficient manner through the utilization of the Ediphone. Traveling in an automobile equipped with an Ediphone operated by a six-volt battery, a very satisfactory trial trip proved the possibility of this method of road "logging," as the collecting of data on road conditions is called.

Instead of the necessity for bringing the car to a stop or, at least, greatly reducing the speed, for the purpose of making notes, this new system enables the driver to record conditions while traveling at the usual rate of speed. Covering ground as rapidly as safety and the condition of the road will permit, the driver may collect such details as mileages, cross roads, grades, road conditions, and a general description of the country traversed. This information is recorded on the cylinder for later transcription into a typewritten report for use in the drafting of maps and the distribution of touring information to club members.



When road "logging" with the Ediphone, the driver does not have to stop his car every time he wishes to make notes; he dictates his notes as he drives

Strength of Prehistoric Monsters Dwarfed by Huge Testing Machine

THE supposed strength of the prehistoric dinosaur is dwarfed beside that of a huge testing machine installed recently at the University of Illinois.

This machine crushes steel and concrete

with as much ease as a human mashes a piece of dirt beneath his foot. It stretches iron rods as if they were taffy candy. In fact, it can exert as much as 3,000,000 pounds in either tension or compression, either to pull things apart or to squeeze them together.

Building beams 35½ feet long can be tested. The screw that is used to concentrate the great pressure is more than 57 feet long and one foot in diameter. The machine stands nearly 50 feet above floor level and extends 14 feet below. It weighs 140 tons.—*Science Service.*

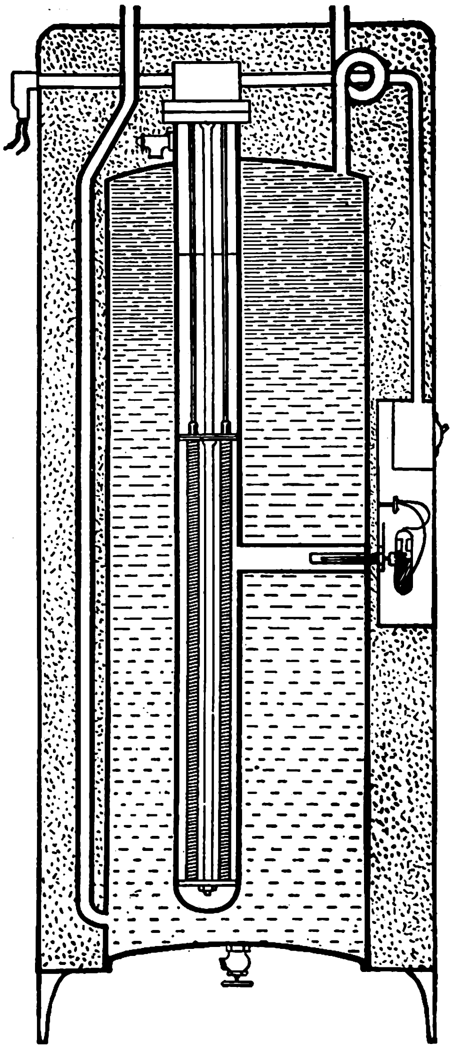
Electrical Water Heater

An automatic, electrically operated water heater for which high efficiency and low cost of operation are claimed, has recently been placed on the market under the trade name Electromatic. It is adaptable for use in homes, apartment houses, doctors' offices, barber shops, beauty parlors, soda fountains, and so forth. Once it is regulated for the temperature desired, it maintains that temperature without any further attention.

The "heart" of this system is the heating element which is immersed in oil in a vacuum tube which extends down through the center of the tank. From this, a lateral tube leads off to the thermostat control which is operated by a mercury tube. Directly above the mercury tube is the switch which turns on and cuts off the electrical supply. The cold-water supply enters the tank through an inlet near its base while the hot-water outlet is at the top. The tank is well insulated against heat losses, the material used for this purpose being a high grade mineral wool packed six inches deep at the top and three inches thick around the sides.

The advantage of the vacuum oil tube is that it becomes, in effect, the heating element and thus gives a heating surface many times greater than that of the average heating device. It can heat the water in less time at a lower unit area temperature. The heat of other devices is more concentrated and thus produces scale.

The Electromatic can be connected with any furnace or kitchen range hot-water circuit. Since it operates automatically, it will maintain the water at the desired temperature after the furnace or range heat has dropped too low to do the job.



Cross-section of new electrical water heater; controller at right

Ants in Indian Surgery

The use of "surgical ants" with powerful jaws to stitch the wounds of human beings, and other primitive medical practices developed by the Indians living far in the interior of Peru, are described in a report received recently at Field Museum of Natural History from the Marshal Field Botanical Expedition to the Amazon.

Llewelyn Williams, leader of the Peruvian division of the expedition, had just returned to Iquitos after a collecting trip along the Amazon and some of its tributaries which took him as far as the Brazilian border. Parts of the regions explored are believed never to have been entered by white men before.

"The natives of the equatorial forest show great originality and dexterity in the treatment of wounds and illness," writes Mr. Williams. "Trees, shrubs, and plants with medicinal properties are widely employed, and a surgical handicraft in which certain insects are used has been developed.

"In the case of a gaping wound, a certain ant which has very powerful jaws is sought, and the ant is made to bite the severed edges of the cut skin and thus bring them into juxtaposition. In the operation the ant-surgeon loses its own life for after it has drawn the skin closed with its jaws, its body is snipped off, and the lifeless head remains with its death grip on the skin until the wound is healed. Sometimes these Indians are found with half a dozen of these ants' heads holding a large wound closed during the long healing process.

"After inter-tribal battles, in which fighting is done with axes and machetes or bush-knives, many of the warriors return home with deep, ghastly, and apparently fatal wounds. The women, however, are usually successful in treating these wounds. After bathing them, they apply ginger as a local anaesthetic. Then a plaster is made from the pulp of a weed known as 'Santa Maria,' and the wound is bandaged with a dried banana leaf. In a week or so most of the wounds heal. Sometimes the crushed body of a certain ant is applied as a salve. The injured men are placed on a diet eliminating salt and fats, and made to drink large quantities of an infusion prepared from the bark of a tree.

"Long thorns are sometimes used as surgeon's needles. The skin at one side of an open wound is pierced with the thorn, and it is then thrust across to and through the opposite skin edge, the protruding end of the thorn being fastened with string and left there until the two edges have fused.

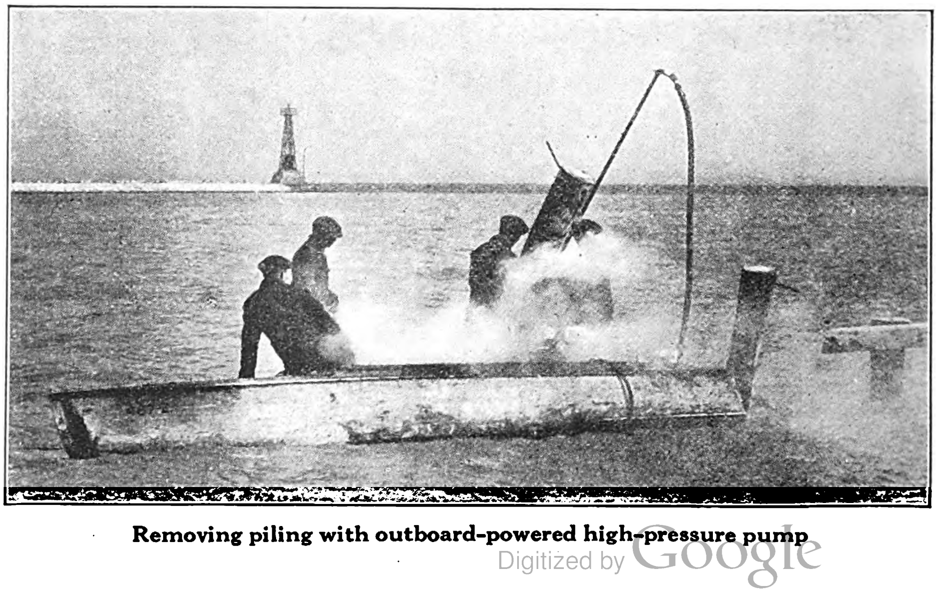
"In the wet lowlands there is a female jigger or burrowing flea which buries itself in one's flesh. There its body swells and becomes globular, being distended with a huge quantity of tiny eggs. The natives remove this by working carefully around the insect's body with a needle. Skill is necessary to avoid breaking the egg sac, for if a single egg is left in the wound the operation is valueless.

"There is also a worm which burrows into the legs of its victims, forming a swelling like a boil which breaks, and then the worm protrudes its head. Any attempt to drag it out suddenly, fails, as it tears. The natives draw a few inches out carefully day by day, rolling the exposed end around a small piece of wood. Much delicate manipulation is required, as this entozoon ranges from six to ten feet in length."

Outboard Motor Becomes a Work Horse

An outboard motor designed for pleasure outings became a work horse recently and helped to repair the ravages committed by Lake Michigan during the March storms. The pounding of the waves reduced the wooden breakwater in front of the Johnson Motor Company at Waukegan, Illinois, to kindling. When the storm subsided, the naked piling was left standing, unsightly and useless before the factory doors.

The factory manufactures outboard mo-



Removing piling with outboard-powered high-pressure pump tors capable of producing from a fraction of a horsepower to more than 32 horsepower. The engineers commandeered a power head capable of producing about 10 horsepower and used this boat engine to remove the piling. Attached to a centrifugal pump, the motor threw a stream of water at high pressure for more than 50 feet.

A raft, the power head mounted in a boat, a length of hose, and iron pipe completed the equipment used by the crew of men to remove about 20 of the piles. The pipe was thrust into the bottom of the lake alongside the piling, and the thrust of the water at high pressure loosened the huge poles. They were then pulled out by the men on the raft and dragged to shore.

New Type of Rubber Blocks X Rays

RADIO fans who happen to be located near a hospital or any other place where an X-ray machine is operated, are painfully aware of the ease with which X rays penetrate ordinary walls. In order to insulate an X-ray apparatus, it has been necessary to line the walls of the room with heavy sheet lead. Now, however, rubber chemists have discovered that certain lead compounds can be incorporated with rubber to make an ideal shield for the vagrant X rays. The new material is known as Ray Rubber and has been successfully tried out in a hospital in New York City.

Ray Rubber contains a homogeneous lead compound which has passed all tests made by X-ray machine manufacturers. Dangerous X rays cannot penetrate Ray Rubber. It provides a good-looking surface easily kept clean, making the X-ray room attractive rather than dull and drab since the material is available in a variety of standard colors.

Ray Rubber replaces the old Holland barium brick, heavy and expensive because it had to be imported; barium mixed with plaster which cracked, permitting the rays to pass through; and lead, which requires expensive burners to perfect its joints. Ray Rubber has a peculiarly fashioned reverse curve edge which permits a small lap joint through which no X rays can pass.

It is easily applied with an approved type of cement to walls and floors, doing away with troublesome fastenings of various sorts. For the floors it may be applied either to concrete or wood. Edges of the flooring and joints are made impervious to ray penetration by application of Rayproof cement.

Ray Rubber is made in blocks 18 by 24 inches and 0.5 inch thick, which has an equivalent screening power against X rays of 0.125 inch of lead.—*A. E. B.*

Blind Spots and Collisions

IT is an interesting fact that three important aeronautical publications, *Aviation* in the United States, *The Aeroplane* in England, and *L'Aéronautique* in France should discuss at about the same time the question of blind spots on the airplane and their effect in increasing the possibility of collisions.

In the early days of flying, when traffic was very slight, pushers with nacelles forward of the wings were quite common. An example of such design is the Farman F.40, which was quite famous during the World War. In this plane, both pilot and observer were seated so as to be practically clear of all obstructions to vision. The disadvantage of this type was the placing of the heavy engine behind the crew, and so it was gradually discarded. Yet from vision considerations, this type was well nigh perfect—or at any rate far superior to the airplane of today.

Monsieur Henri Bouché, Editor of *L'Aéronautique*, illustrates the collision dangers of the modern airplane in some graphic diagrams, which we reproduce in these columns. In one diagram is shown the "parasol" monoplane; that is, a monoplane with the wing placed at some height above the fuselage. The range of vision is indicated by the lines. When two parasol monoplanes meet they may readily strike head-on.

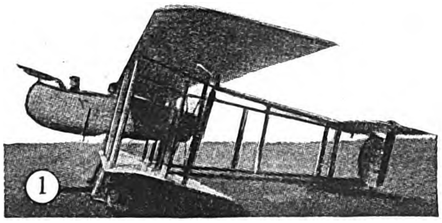
In another diagram, the upper machine, with enclosed cabin, may be struck by the parasol monoplane approaching it from below.

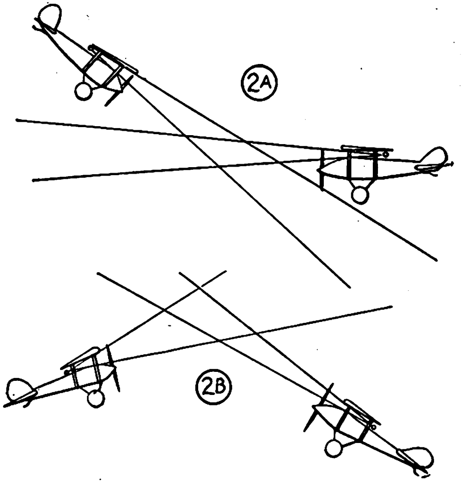
It is not difficult to imagine similar difficulties when machines are landing or taking off on a busy field.

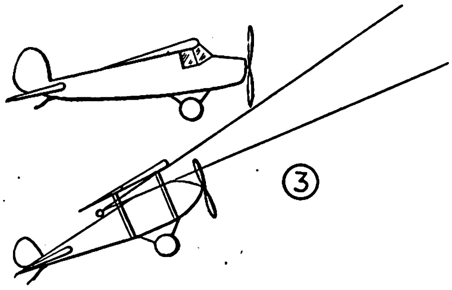
Two engineer-pilots, also writing in *L'Aéronautique*, suggest a number of remedies, some novel, some borrowed from the practice of other designers.

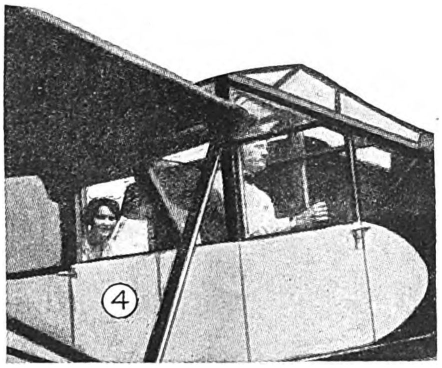
Suppose that the designer, for a variety of reasons, has decided to build a high-wing cabin monoplane. Then the pilot should be placed well forward, ahead of the wing, with the wing somewhere about the level of his eyes. The entire cabin should be provided with non-shatterable glass—ahead, above, at the sides, and below far toward the rear. The Berliner-Joyce cabin

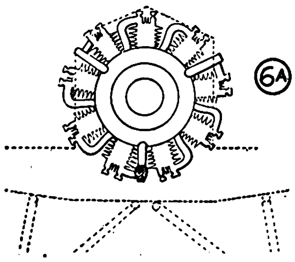
In the famous Farman war-time plane, *1*, the pusher nacelle made possible almost perfect vision. Parasol monoplanes, *2*, may collide head-on because of restricted area of sight. A parasol plane coming from below may get into difficulties as in *3*. The pilot's position in the Berliner-Joyce monoplane, *4*, affords an almost unobstructed view. The open cockpit, low-wing Aeromarine-Klemm monoplane is at *5*. A comparison of the obstructing qualities of engines is given in: *6A*, a radial; *6B*, a conventional in-line; and *6C*, an inverted in-line. A conning tower, *7*, has been suggested for flying boats

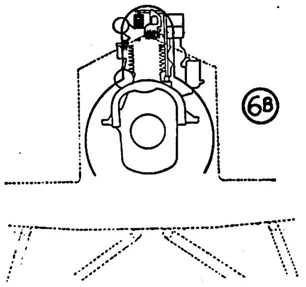


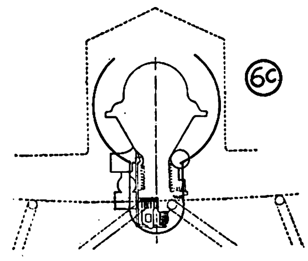


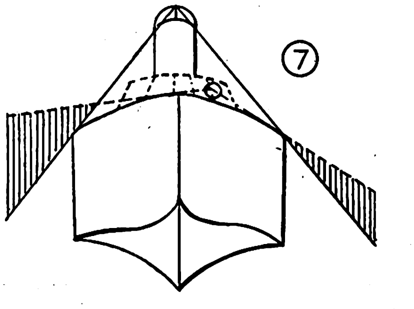


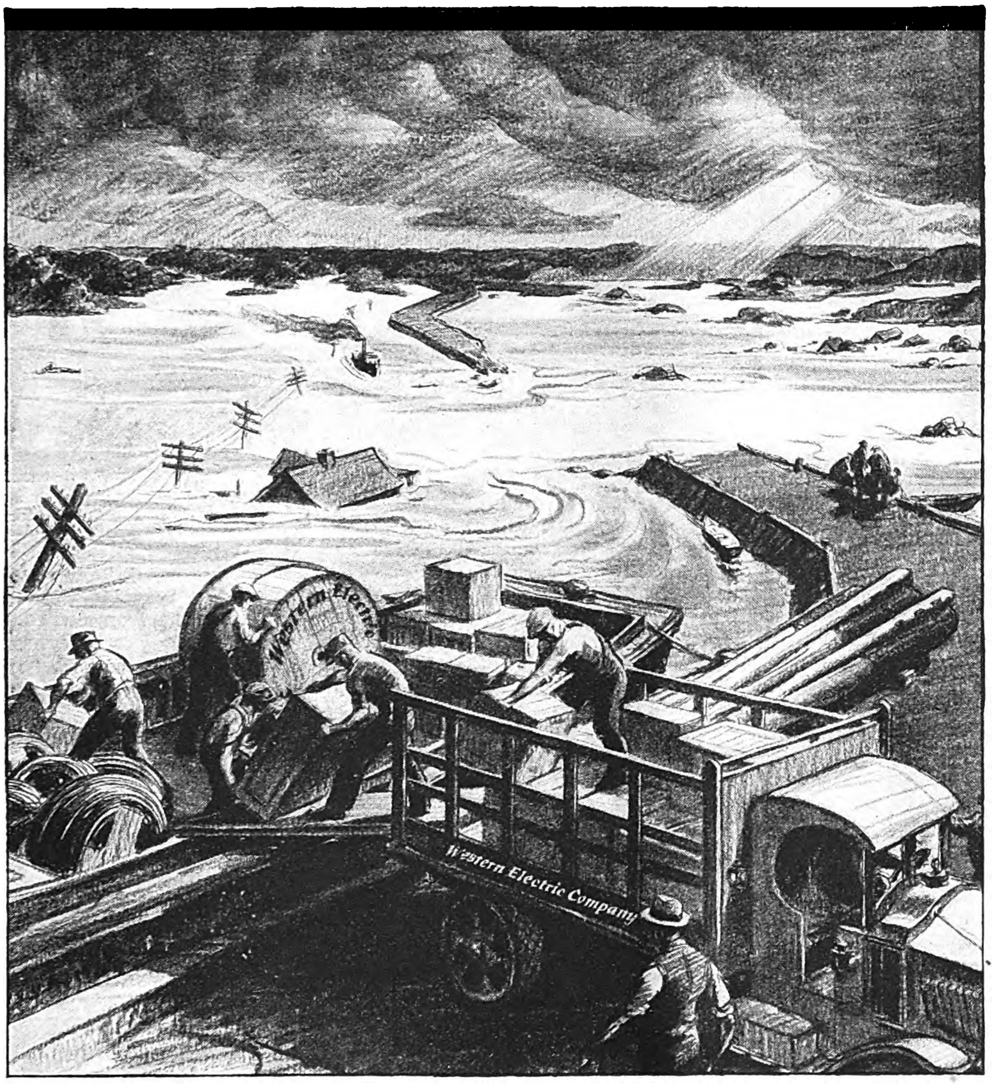












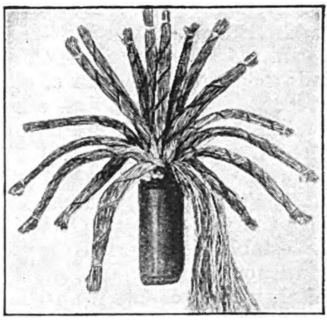
In fair weather or foul . . .

Western Electric backs up your telephone service

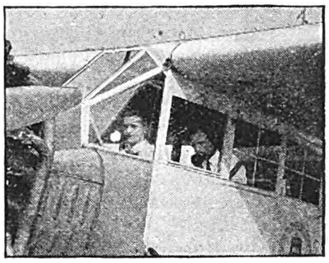
In foul weather, just as in fair, Western Electric backs up the Bell System with all the apparatus and supplies needed to restore, maintain or expand your telephone service.

This Company manufactures telephone equipment of every sort, with a skill acquired through 50 years' experience. At 32 warehouses it holds great reserves of telephone material available for shipment day or night. It delivers and installs the apparatus when and where needed.

The large scale manufacture of standardized equipment, too, is an economy. So is the concentrated purchasing—a responsibility that Western Electric undertakes for the telephone companies of the Bell System. All in all, here is a work of mass production, purchasing and distribution which for size and complexity has no parallel in industry.



1818 conversations at one time can be carried on through this new type cable. It contains 3636 insulated wires within a diameter of 2⅝ ins.



The flying telephone laboratory in which Western Electric airplane telephone equipment has been developed by the Bell Laboratories. Provision for communication between ground and plane marks a great forward step in flying.

One of the 18 materials in your telephone is rubber from the plantations of Sumatra. Western Electric goes to market in every corner of the world.

Western Electric

THE MAKERS OF
BELL TELEPHONES

tion did not show any change. However, in the third generation dwarfism, degenerations, and bent leaves and blossoms, appeared. Thus it is obvious that factors affecting the human cell may actually have their influence not only to the third generation but primarily in the third generation.

Before a German society for the advancement of science, Prof. Ernst Rüdin announced the fact that several of the children of people with hereditary chorea developed chorea at an early age. Among the children of people with manic-depressive insanity, 33 percent of the children are affected; among the children of epileptics, 10 percent are affected; and among the children of parents with hysteria, 13 percent are affected. The mental health of the child is clearly the reflection of the mental health of its parents. Notwithstanding the fact that this inheritance is clearly established, persons continue to marry without any attempt at investigation of their antecedents from the mental point of view and without any realization that the offspring are bound to reveal the effects of the mentally weak heredity.—*M.F.*

A Plane Price War

THE Stinson Aircraft Corporation, recently acquired by the Cord automobile interests, threw a bombshell into aviation circles, at the time of the St. Louis show, by announcing some startling price cuts. Our photograph shows the Stinson four-place cabin plane, powered with a 210 horsepower Lycoming radial air-cooled engine. The plane is of neat though conventional design, and has excellent performance and flying characteristics.

The airplane builders are now rivaling the automobile builders in the completeness and luxury of equipment. The Stinson has an electric self-starter, adjustable metal propeller, wheel and emergency parking brakes, cabin heaters, hydraulic and spring shock absorbers, broadcloth upholstery, shatter-proof glass, rubber-insulated motor mount, gasoline gages, dual wheel control, adjustable pilot seats, balloon tail wheel, navigation lights, and smoking sets.

Last year planes of this type were selling at about 9000 dollars. Now the Stinson company announces a price of 5775 dollars. In some aviation circles the opinion is held that the Stinson Company will lose money rapidly. Others hold that increased sales and better production will justify the reduction in price and that eventually a plane of high finish and performance will sell to the private owner at prices no higher than those of a really first-class automobile.—*A.K.*

A four-place Stinson Junior cabin plane that sells now for only 5775 dollars, a price far lower, for this particular type of plane, than ever before quoted

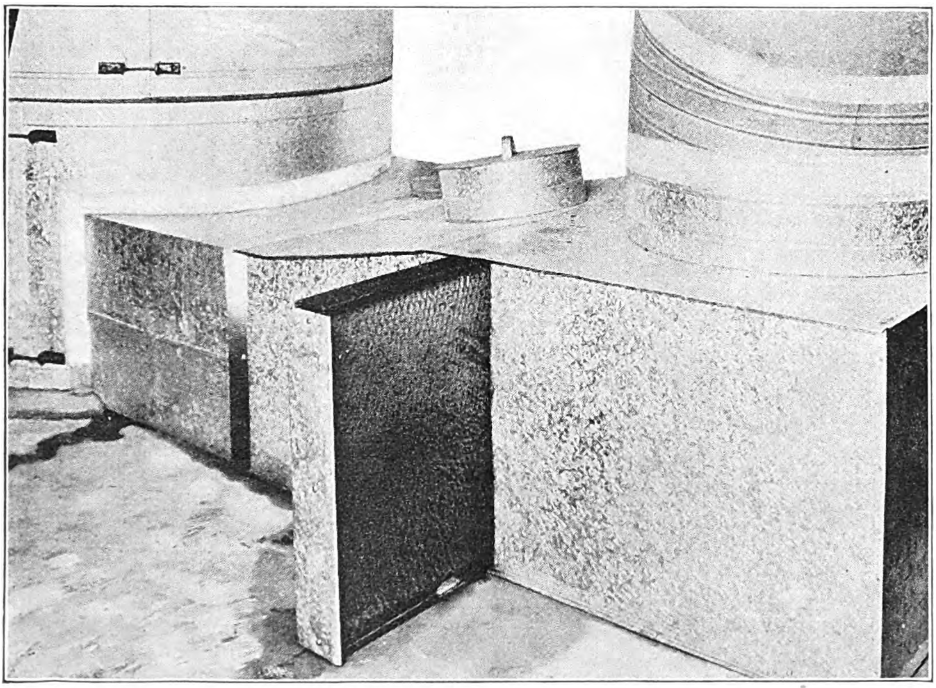
Fever and Radio Waves

FEVER is the reaction of the body to disease. Heat developed in the body helps to control germ activity. In the attack on general paralysis by the malaria injection method, one of the results of the injection is to produce fever. In the treatment of other conditions like general paralysis the production of fever may be an important factor. Fever in the human being follows the injection of any foreign protein substance. When such injections are made, their actions are sometimes severe.

Attempts have been made by the workers in the Research Laboratories of the General Electric Company to develop some system of raising the temperature of the body without injecting anything into the body. Drs. C. M. Carpenter and A. B. Page have been developing a method of raising the temperature by the use of short wavelengths. In this method the energy is concentrated between two condenser plates made of aluminum covered with hard rubber to prevent arcing should the patient or any attendant come in contact with the plates. The person whose temperature is to be raised is suspended on cotton tapes stretched across a wooden frame and surrounded with Celotex so that there is a fairly tight air chamber around the body. The plates are placed at each side of the Celotex box and the waves oscillate through the body from one side to the other.

It has been possible to raise the temperature of a man five degrees in one hour with this apparatus. Indeed, it would be possible to raise the temperature much higher than 104 to 105 degrees, but this has not been done because of the possible danger.

When the temperature of the body is raised rapidly by such a device, the person begins to have a fast pulse and to breathe more rapidly. Usually the blood pressure falls. In some instances high temperatures were maintained for one hour without apparent distress or fatigue to the patient. It is believed that the development of the heat in the body is due to the resistance made by the body to the conduction of the current. The evidence thus far available from studies in some 25 human beings and of many laboratory animals indicates that the heat within the body makes it less favorable for the multiplication of germs and that the increased rate of the various chemical processes in the body aids the resistance to disease and infectious agents. —*M.F.*



Filtered, forced warm air for heating and ventilation is now possible with this combination of filter, shown here partly withdrawn from its housing, and electrically driven fan. The fan draws cold air through the filter for cleaning, and delivers it to an ordinary hot-air furnace for heating

Welding Copper Made Easy

UNTIL recent years it was considered that the satisfactory welding of copper was impossible. The high thermal conductivity of the metal gave rise to grave practical difficulties, and even if these were overcome it was found that the copper became brittle by the action of the gases in the acetylene flame. As the result of recent research work, however, a process for welding copper has now been evolved which renders the operation simple and safe, provided the correct materials are used.

A demonstration of this welding was carried out recently at Swansea, England. At this demonstration copper pipes were welded together without difficulty and the joint subjected to severe flattening and bending tests, the results of which proved conclusively that the weld would withstand conditions of service as satisfactorily as the pipe itself. Sheets of copper were also joined together by the welding process, and it was shown that these would withstand a considerable amount of work and stretching; in fact, as much as the solid copper itself could be expected to withstand. The welding of varnish-pot seams was also demonstrated, a process which eliminated a great deal of troublesome riveting. It was observed that the welding operator worked quickly and as easily as if he were merely brazing the pieces together, and after the weld had been made and trimmed it was difficult to see where the joint occurred, while it had a tensile strength equal to that of rolled copper.

The demonstration proved that the difficulties previously associated with the welding of copper had been overcome, and it is certain that there is a wide field in industry for the application of the process. Riveting will be largely eliminated, and vessels which previously had to be forged out of solid copper—a very expensive procedure—can now be built up by welding sections together. All this has been achieved by means of slight modifications in the technique of welding ferrous metals, by the use of copper alloy filler rod and flux of the appropriate type.

The copper that has been developed for welding purposes is not attacked by the gases of the acetylene flame, and it is essential to use this copper if the weld is to be perfectly satisfactory. The copper is a modification of the tough pitch variety, supplied at the same price, but not inferior to it in any way; in fact, it might be expected to give better service generally. The filler rod, again, is of specially modified copper, which is very fluid when molten, and so runs well into the joint, leaving no air locks or gaps. It is essential to use this filler rod in order to obtain a homogeneous weld. The flux is used in order to hinder the formation of scale on the red hot copper as the scale prevents good metallic contact, and hence a solid joint, from being obtained.

Using these materials, it was demonstrated that with an hour's practice a welder could acquire the technique of copper welding and produce sound joints as easily as he could with ferrous materials. —*A. E. B.*

Regulating Air Transport Services

IN the continued depression of the aviation industry, there is one bright spot—the continued and rapid growth of the transport service; mail, passenger, and (to some extent) express.

We believe that the new regulations of the Department of Commerce regarding transport services will help rather than hinder this growth. These regulations provide that before scheduled operation of passenger air transport is established, a Certificate of Authority must be obtained from the Secretary of Commerce. To secure and retain such a certificate the service must provide satisfactory aircraft and equipment, an adequate number of qualified airmen, a high degree of maintenance efficiency, good airways and navigation facilities, and a first-class ground organization.

Nothing is so well calculated to inspire the traveling public with confidence as regulations of this character, well and diligently administered.—*A. K.*

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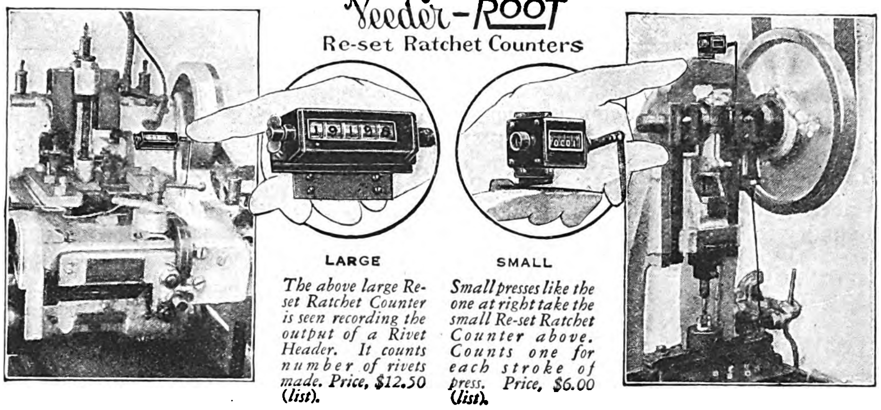

LARGE

The above large Re-set Ratchet Counter is seen recording the output of a Rivet Header. It counts number of rivets made. Price, $12.50 (list).

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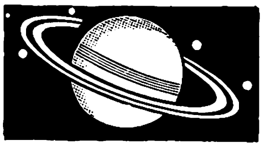

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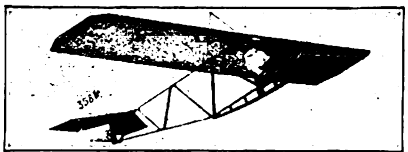

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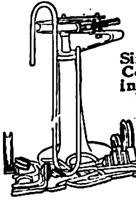

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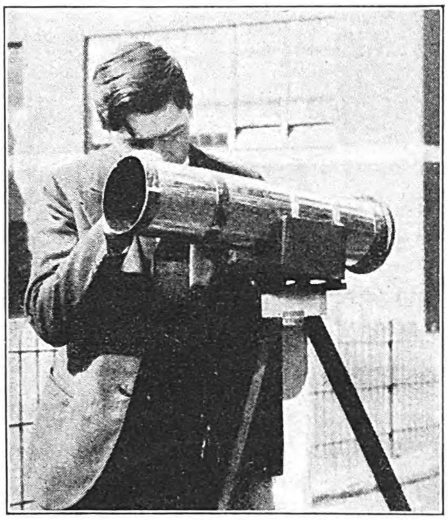
The Amateur Astronomer

Conducted by ALBERT G. INGALLS

WORD comes out of the wilds of Vermont that the fifth annual "get-together" of amateur telescope makers will be held on August 15, 16, 17 at the usual place, "Stellafane," near Springfield. Let this notice serve as sufficient excuse for all and sundry to come. John Pierce and the other members of the "Telescope Makers of Springfield" expect later to send out individual postcard announcements to those in the east, but do not let failure to receive one keep you away; it might be merely a mistake. "The big day," Pierce writes, "is Saturday, the 16th, with Porter, Redfield, Marshall and other illustrious people strutting their stuff." We do not know what profound secrets these entertainers have up their sleeve. Mr. Redfield's specialties are cornbread and poetry.

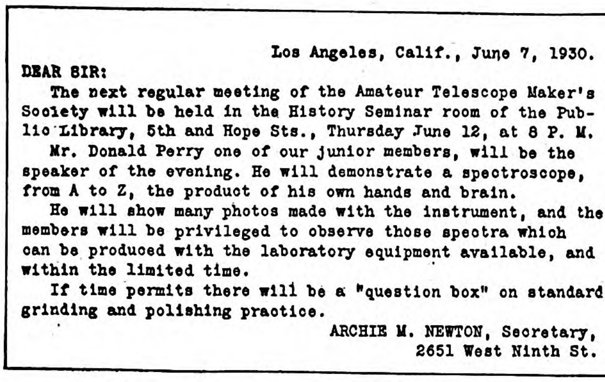


Bob Burns. He saved 80 "bob"

Last year so many attended this informal confab of amateur telescope makers and astronomers that it was a question whether to rent a circus tent next time. People came from all over the east, and some from greater distances, to commune with other enthusiastic telescope fans. There is a small hotel in Springfield, also very limited "quarters" (for men) at "Stellafane." A good many come in their cars, bringing their families and tents. There is all sorts of room to camp, and a good spring of water is nearby. Leave your dress suits in mothballs, as this is not a "high hat" affair but just a friendly, comfortable gathering of "folks." If you have made a telescope or invented any kind of optical dingbat of which you are unashamed, bring it along and give the other fans a chance to knock it. If you wish to make any special arrangements write to the Secretary of the "Telescope Makers of Springfield," Oscar S. Marshall, 135 Wall Street, Springfield, Vermont.

WHEN the hot months come people usually let up their efforts in telescope making; they had rather be out of doors than working in the cellar workshop. About September the orders for the instruction book "Amateur Telescope Making" always begin to come in thick and fast, and then we know the game is on again. However, to judge from the postcard announcement which is reproduced on this page, telescope making activities never wane, even in hot weather, in lively Los Angeles. Fragments of information reach us from time to time about the various activities of the Amateur Telescope Maker's Society of Los Angeles, the latest being that they have gone in heavily for refractor making. The seed that was dropped in that city four years ago is growing—in fact, already has grown—into a thriving tree. We wish the amateurs of "L. A." would send in accounts of their doings, with photographs of the jobs done, for publication.

Some of the telescopes made by amateurs have been pretty elaborate affairs and some are not so elaborate. However, we publish them all because we do not wish merely to feature the finer ones. A worker who builds a small instrument may lack facilities for making a large one, he may not happen to have had special training in machine work, he may not be rolling in wealth, but he derives as much fun from making it as the fellow who puts together a big one. One thing, however, is that we have found that the work is not suited to boys. Very few have made good at it, and those, we suspect, were unusually bright lads with an aptitude for mechanical work and for thinking.



Los Angeles, Calif., June 7, 1930.

DEAR SIR:

The next regular meeting of the Amateur Telescope Maker's Society will be held in the History Seminar room of the Public Library, 5th and Hope Sts., Thursday June 12, at 8 P. M.

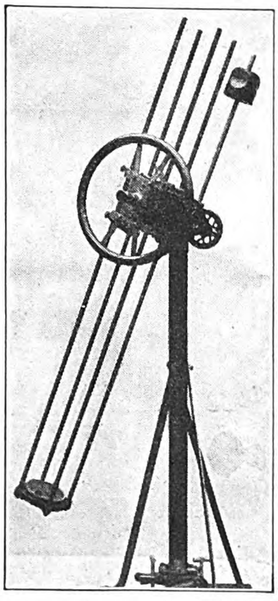
Mr. Donald Perry one of our junior members, will be the speaker of the evening. He will demonstrate a spectroscope, from A to Z, the product of his own hands and brain.

He will show many photos made with the instrument, and the members will be privileged to observe those spectra which can be produced with the laboratory equipment available, and within the limited time.

If time permits there will be a "question box" on standard grinding and polishing practice.

ARCHIE M. NEWTON, Secretary,
2651 West Ninth St.

Thriving amateur activities in "L. A."

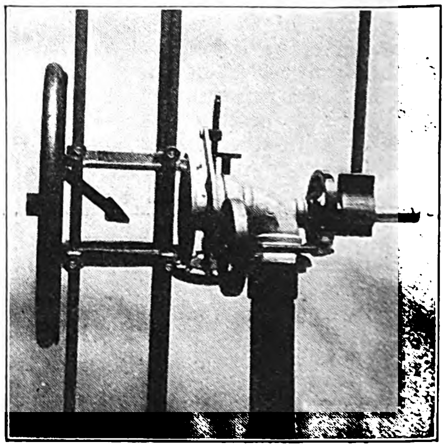


Above and at right, "Friday" Angier's unique design

JUST how inexpensively a telescope can be made never has been settled, but Bob Burns, of 326 Courtland N. E., Atlanta, Georgia, has shaved a big chunk off the average cost of a six-inch reflector. The materials for a six-inch telescope which will magnify from 50 to 200 diameters usually cost about 25 dollars. The initial outlay is ten dollars for a prepared package containing the glass disks, abrasives, and pitch. With these the mirror is made and then after some time the eyepiece and diagonal prism, each at six dollars, are obtained. The average amateur worker can be trusted to pick up the remaining parts, chiefly secondhand, for little or no more than the remaining three dollars. Often we are asked whether there is a way to make a telescope still more cheaply than this. There is. If one can pick up a microscope eyepiece this will save six dollars. Other savings are possible in some cases, depending on the worker's resourcefulness.

A four-inch, instead of a six-inch mirror, provided the main solution of the cost problem, in the case of Mr. Burns, who made a telescope at a total cost of $5.35. We asked Mr. Burns to tell the amateurs how he did it. Here is what he reports.

The four-inch glass disks were cut from two pieces of one quarter inch broken windshield glass which I procured for the asking at an auto junk dealer. Cost	$ .00
Cutting and grinding the edges of these disks, at an automobile glass service station, was	.25
The American Optical Company furnished me three grades of emery (No. 60, 120, 302) and the rouge for	.65
Silver nitrate, one quarter ounce, cost	.25



I used household ammonia and formaldehyde to reduce the silver nitrate, when silvering the mirror. Cost to me	.00
A wood turning shop made the wooden mirror cell for	.50
The 24-inch tube is made of polished sheet zinc, and cost	.90
For my diagonal I used a piece of one quarter inch plate glass of oblong shape, 1¼ by ¾ inches, corners rounded, the supports being soldered to the inside of the tube. The cost of this was	.00
The eyepiece was taken from a "pencil" microscope which cost	1.00
Brass tubes for eyepiece (plumber's shop)	.15
Lumber for tripod, cut to size	1.25
Bolts for tripod	.20
Lacquer and brush for painting tripod and inside of tube	.20
The total expenditure came to	$5.35

I polished my mirror by gluing the crown of an old felt hat to my tool and polishing on this pad. It finished out in about 1½ hours. I made no attempt to change the curve from a sphere to a parabola.

With the three quarter inch, double-convex eye lens the telescope gives about 50 to 60 diameters magnification. The innumerable craters on the moon are very interesting

PHIL E. CHURCH, 104 East LaRue, Streator, Illinois, sends in a few pictures of an unusual telescope. He says: "Three of us did the work, but 'Friday' Angier conceived and built the mounting. The steering wheel is for rapid control in directing the telescope but there are slow-motion screws and these are turned by means of sewing machine flywheels. The three of us, 'Friday,' Herbert Prafcke, and I, are greatly satisfied with this arrangement and we invite comment from other amateurs." Are there any who want to break a lance with these three musketeers?

THE following hint is from the April number of the *Journal of the British Astronomical Association* and was contributed by Walter E. T. Hartley, 11 Manor Road, Edgbaston, Brimingham, England. Birmingham is one of the great industrial centers of Great Britain and much bitumonious coal, with its inevitable content of sulfur which quickly tarnishes silver, is used. He says, "I keep two layers of cotton wool in the cover, and while observing put the cover in front of the fire—this ensures a dry film, but I have now between the wool and the mirror two thicknesses of blotting paper which have been soaked in a strong solution of lead acetate and then dried. As a result my last silvering was done in 1923, and the mirror is only now beginning to show signs of tarnish." Try it, someone, and see how it works, for soft coal sulfur in America is the same as soft coal sulfur in England.

HERE is an interesting hint. Harold A. Lower, 1032 Pennsylvania Avenue, San Diego, California, who is always trying out something new in amateur optics, writes: "I discovered a new use for a microscope the other day. The mechanical stage makes an excellent arrangement for controlling the knife-edge when making the Foucault test. Just attach the razor blade to the mechanical stage by means of a small D-clamp, and it works as if made to order."

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Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Longleaf Pine Primer (Farmer's Bulletin No. 1486, U. S. Department of Agriculture) by W. R. Mattoon, describes the growing of longleaf pine as a crop, pine timber being so scarce. The pamphlet is fully illustrated. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Porcupine Control in the Western States (Leaflet No. 60, U. S. Department of Agriculture) by Ira N. Gabrielson and E. E. Horn deals with a pest, for they girdle trees and injure forests. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Properties of Soils which Influence Soil Erosion (Technical Bulletin No. 178, U. S. Department of Agriculture) by H. E. Middleton gives valuable light on an old problem. *Superintendent of Documents Washington, D. C.—5 cents (coin).*

The Cofee Industry in Brazil (Trade Promotion Service No. 92, U. S. Department of Commerce). *Superintendent of Documents.—20 cents (coin or money order).*

Bismuth (Circular of the Bureau of Standards, No. 382, U. S. Department of Commerce) gives very full information on the metal and its alloys. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Geology and Oil Resources Along the Southern Border of San Joaquin Valley. (Bulletin 812 D, Geological Survey, Department of the Interior) by H. W. Hoots. *Superintendent of Documents, Washington, D. C.—50 cents (money order).*

Breeding Tobacco for Resistance to Thielavia Root Rot (Technical Bulletin No. 175, U. S. Department of Agriculture), by James Johnson, is a study of a common and important disease of tobacco. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

New Brunswick, Canada, by L. O. Thomas, describes the industries, agricultures, natural resources, and development of New Brunswick. *Address the Director, National Development Bureau, Department of the Interior, Ottawa, Canada.—Gratis.*

German Chemical Developments in 1929 (Trade Information Bulletin No. 690, U. S. Department of Commerce) reports the important events in the industry during 1929. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

The North West Territories 1930 is the title of an attractively illustrated handbook of 137 pages. A concise compendium of general facts relating to Northern Canada, it is accompanied by a beautiful map. *Address the Director, North West Territories and Yukon Branch, Department of the Interior, Ottawa, Canada.—Gratis.*

Tides and Currents in Chesapeake Bay and Tributaries (Special Publication No. 162, Coast and Geodetic Survey, Department of Commerce) by F. J. Haight, H. E. Finnegan, and G. L. Anderson, contains many folded maps. *Superintendent of Documents, Washington, D. C.—65 cents (money order).*

The Marketing of Nickel (Trade Information Bulletin No. 685, U. S. Department of Commerce) by J. W. Furness tells what nickel is, where it is produced, for what it is used, and where it is marketed. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Tin in 1928 (Excerpt pages 321-346 of the Mineral Resources of the United States, Bureau of Mines, U. S. Department of Commerce) by Charles White Merrill. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Preliminary Reports of the Aerial Mineral Exploration of Northern Canada gives an interesting account of investigation of large areas with the aid of airplanes. *Address the Director, North West Territories and Yukon Branch, Department of the Interior, Ottawa, Canada.—Gratis.*

Water-Power Resources of the Umpqua River and its Tributaries, Oregon (Water Supply Paper 636-F, Geological Survey, Department of the Interior) by Benjamin E. Jones and Harold T. Stearns. *Superintendent of Documents, Washington, D. C.—40 cents (money order).*

Geology and Coal Resources of the Meeker Quadrangle, Moffat, and Rio Blanco Counties, Colorado (Geological Survey Bulletin 812-C, Department of the Interior) by E. T. Hancock and J. B. Eby. *Superintendent of Documents, Washington, D. C.—30 cents (money order).*

Ultra-Violet Reflecting Power of Aluminum and Several Other Metals (Bureau of Standards Reprints, No. R.P. 141) by W. W. Coblentz and R. Stair. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

How to Build Home Radiovision Equipment explains the technique of radiovision reception and what is required by way of equipment, and then goes on to describe the construction of a practical radiovisor made from a kit of parts now on the market. *Jenkins Television Corporation, 370 Claremont Ave., Jersey City, N. J.—Gratis.*

An Electrical Method for the Determination of the Dew-Point of Flue Gases (Circular No. 20. Engineering Experiment Station, University of Illinois) by *Henry Fraser Johnstone, University of Illinois, Urbana, Ill.—15 cents.*

Standards Year Book 1930 (Miscellaneous Publications No. M 106) is a clothbound book of 301 pages. *Superintendent of Documents, Washington, D. C.—75 cents (money order).*

Nation Building and Beyond (The Richard Cobden Lecture given at the Royal Society of Arts, London, May 7, 1930) by Nicholas Murray Butler is a very famous lecture which made a great sensation both here and abroad. *Carnegie Endowment for International Peace, 405 W. 117th St., New York City, N. Y.—Gratis.*

The Kyoto Conference of the Institute of Pacific Relations (No. 260 of International Conciliation, May, 1930) by Chester H. Rowell. *Carnegie Endowment for International Peace, 44 Portland St., Worcester, Mass.—5 cents.*

Weights and Measures References (Miscellaneous Publications No. M 103) including an index to the reports of the National Conference on Weights and Measures, from the first to the twenty-first inclusive. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

The Commercial Standards Service and its Value to Business (Commercial Standard CSo-30, Bureau of Standards, U. S. Department of Commerce) gives the whole idea in a nutshell and is an exceedingly valuable little pamphlet. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Trailside Conversations. Parts One and Two (New School Series Number Four) by Wm. H. Carr. Describes the nature trails and trailside museum at Bear Mountain, New York. It is beautifully illustrated. *American Museum of Natural History, 77th Street and Central Park West, New York City.—20 cents.*

Our Point of View

Navies and World Problems

(Continued from page 93)

tration and the delegation had frankly said it was the best treaty obtainable under the circumstances. President Hoover was in no way responsible for our present inferior position in cruisers and submarines, nor for the unwillingness of Japan to reduce her tonnage *already built* to the 5 to 3 ratio.

The country is under obligation to Senators Hale, Johnson, and Robinson of Indiana, for the severe scrutiny they have given the draft of the treaty. They uncovered an ambiguity in the wording about cruiser replacement that might have caused serious misunderstanding; this was cleared up by an exchange of notes between the contracting parties. More important still, the answers to their persistent questions have more fully informed the public about the effects of the treaty.

The group of admirals led by Rear Admiral Hilary P. Jones, who analyzed the treaty, who showed the extreme concessions made to Japan, and who bore strong testimony to the value of 8-inch gun cruisers, deserve well of their countrymen. Called by the Senate committees, they were obliged to bear true witness to their beliefs; and though we support the treaty, we have no doubt of their sincerity or sound judgment. We believe with them, that 8-inch gun cruisers would better serve our purpose; but can't believe that 6-inch gun cruisers will not serve us well in any war that we might be drawn into. Important political factors have to be considered as well as naval, and with those in mind, we reluctantly conclude that our best hope for a navy within the next five years is to ratify the treaty and commence to build ships, instead of indulging in more conferences.

INSTEAD of frightening tax payers by talking about an 800,000,000-dollar program that will be spread over 8 to 10 years, the Administration should explain that the appropriation for this program will be about 90,000,000 dollars a year or about 75 cents per capita annually, a paltry sum for the protection it affords our country and its sea-borne trade.

A disquieting fact disclosed by the Senate testimony is the scant heed paid by the delegation to their naval advisers—apparently even Admiral Pratt was consulted only after the decisions were made by the delegation. There is a current opinion in the United States that in the past too little attention has been paid by the State Department to Army or Navy advice. The results of this rather disdainful attitude of the State Department is expressed loosely by the phrase heard in so many places "We never lost a war, and never won a conference." The country believed that Mr. Hoover, himself an expert engineer, would insist that the naval experts he attached to the delegation be consulted; Mr. Stimson almost airily relegated them to the rear. Democratic government is essentially a government by amateurs. Americans would not have it otherwise, but they believe Admiral Jones is more apt to be right on a naval problem than Secretary Stimson, and we think we would have had a better treaty if Stimson, Dawes, and Reed had not been a little over-eager to play it alone.

Fortunately, the life of this treaty is less than six years; then the whole question of ratios will be subject to reconsideration. If our people really want a navy and are willing to pay the small premium required for their naval insurance, they can build up to the treaty limits by 1936, and enter the next conference in a position to insist that our naval necessities be recognized. If we do not want a navy badly enough to pay for it, we should cease demanding that more prudent powers stop their building programs simply because we are too niggardly to build a navy that we all know we need, and need badly.

We should realize that, now having outbuilt us, Japan is unwilling to make the concessions that we made in 1922, when our ship-building program was about to give us sea supremacy. If our people appreciate the significance of this fact, and lose some of their naive belief in the altruism of other States, eventually they will be well compensated for the temporary disadvantage of the treaty.

ITALY and France are no nearer agreement than they were in London and it is quite possible that England may have to invoke the "safety clause" which allows an increase in her cruiser strength in the event that Italy and France enlarge their naval programs. We would be permitted the same increase granted England. Much more alarming than an increase in the Latin navies is the apparently irreconciliable rivalries of these two Mediterranean powers. Observers, who are usually well informed, speak in measured terms of the possibility of war between these two neighbors. Such a conflict would be bound to spread to other European States, and no one could predict its limits.

This is an uneasy period for Premier MacDonald. The unrest in India continues unabated and if this passive resistance extends as urged by Gandhi's successors, to a refusal by the great mass of Indians to pay taxes, the task of the Viceroy, Lord Irwin, will be difficult indeed. To add to MacDonald's troubles with Egypt and India, the small but strategically important island of Malta took occasion to flare up, and it is reported that considerable discontent with British rule exists within its limited confines. Unquestionably both India and Egypt have benefited by English rule; it is certain that neither could maintain law and order at home or resist foreign States unless supported by Great Britain; and yet, led by sincere but uninformed reformers, they continue their agitation for independence without any let-up.

It is one of life's fine ironies that the Labor Party which, in opposition, is fond of declaiming against imperialism, is face-to-face with one of the great problems of empire. Gladstone, England's great Liberal leader, often accused of being a "little Englander", found himself in a similar quandary on more than one occasion; and Sir Henry Campbell-Bannerman, another great Liberal, faced and solved the problem of the Union of South Africa after the Boer War. And it is not unlikely that a Labor Premier will find a solution to Great Britain's imperial problems. Needless to say, the action of the Labor cabinet in dealing with India will be no less firm than the Conservative.

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Books Selected by the Editors

Aviation Engines—*By Ray F. Kuns, Editor, Automobile Digest*

QUITE the best presentation of the very latest types of aeronautical motors that we have seen. Each engine is taken up in detail with general construction and description of the parts, including special, individual, characteristic points comprehensively outlined. Care and upkeep are covered and various "trouble" notes are added, so that the whole is a most practical manual. $2.15 postpaid.

Radio and Its Future—*Edited by Martin Codel*

A COMPREHENSIVE survey of the various phases of radio communication—commercial, broadcast, amateur, industrial—each phase being covered by an acknowledged authority in his special subject. Past and present are dealt with in a comprehensive manner, giving the reader a broad background which will aid materially when following the progress of the art. Future possibilities of radio are handled with the sane foresight of the practical scientist; particularly is this true of the concluding chapter by Lee de Forest. $4.25 postpaid—*A. P. P.*

OUR previous message to readers of these pages has been accepted so spontaneously by many book seekers, that we wish again to state, for any who did not notice the previous offer, that if you want to know what literature is available on any subject you are studying or any hobby you are pursuing, write to L. S. Treadwell, the editor who is responsible for this department and every attention will be given your request. Should there be nothing available we will be frank to tell you or advise as to the possibility of advertising for second-hand copies. Let us try to help you solve your problems.

The Radio Amateur's Handbook
By A. Frederick Collins

THIS, the sixth edition of this highly popular elementary book on applied radio, has been entirely revised, rewritten, and reset. New illustrations have been added and those of the old ones that are used have been redrawn, bringing the book up-to-the-minute in every respect. This volume is directed especially to those who desire a working knowledge of the theory and practice of radio, and who have a leaning toward home construction. Various types of receiving and transmitting (C. W. and phone) sets are described, several in such complete detail that the reader can start work with the text as the only necessary guide. Appendices of Useful Information, Glossary, Radio Don'ts, Insurance Requirements, and Radio Laws, as well as a comprehensive index make the book a valuable one to every radio fan. $2.15 postpaid.

New Building Estimator's Handbook
By William Arthur

WHETHER it be a residence or a railroad shop, a store or a school, or almost any conceivable kind of building that is to be constructed, this handbook will give information as to quantities of all materials needed and will quote comparative prices on everything from the foundation to the roof. The 15th edition of this invaluable work, long accepted as an authority by architects, builders, contractors, engineers, plant superintendents, and draftsmen, has been fully revised and enlarged. 1056 pages, 600 tables, 480 illustrations—$6.25 postpaid—*F. D. McH.*

Die-Casting Practice—*By Marc Stern, A. C. Spark Plug Co.*

A WELCOME authoritative treatise, based on the author's long and vital connection with the die-casting industry. It represents concisely detailed and practical data on the application of die castings, the principles of design, the limitations and possibilities of the many alloys in use, and the finishes suitable to such alloys. 270 pages, 128 illustrations. $2.65 postpaid.

Matter and Radiation—*By John Buckingham, Asst. Director of Scientific Research, The Admiralty*

A PECULIAR book, exhibiting a well-known English trait—it wanders casually over a large field touching with interest on this and that but without covering anything very amply. Yet the present reviewer found it so interesting that every word was read. Of the five chapters (90 pages) three are on electric waves, atomic physics, and radiation, the other two (40 pages) being on infra-red rays and their use in the detection of invisible objects, in secret signaling, fog penetration, self-steering torpedoes, navigation and so on—most fascinating things, every one—but since the author treats them with so much interest and lucidness, it is a pity that only a half portion of each could be served up. A full-sized book giving details on the same application of the infra-red if written by this author, should make reading which would defer the bed hour, for he has an evident flair for making simple things seem as simple as they really are. $3.20 postpaid—*A. G. I.*

The Aluminum Industry—*By Junius D. Edwards, Asst. Dir. Research, Francis C. Frary, Dir. Research, and Zay Jeffries, Metallurgist, Aluminum Company of America.*

VOLUME I covers the history of the discovery of aluminum and the development of the industry, the ores of aluminum and their mining and refining for the production of pure alumina, and closes with a discussion of the production of metallic aluminum. Volume II gives the reader a broad view of the various processes by which aluminum is fabricated and discusses also its properties and uses. Two volumes (not sold separately), $12.50 postpaid.

The New Evolution—Zoogenesis—*By Austin H. Clark, U. S. National Museum*

IT has been said by some that Dr. Clark's new theory of organic evolution will take rank with Darwin's original theory as set forth in 1859 in "The Origin of Species." Darwin's great book created an immediate furor and the first edition was snapped up in next to no time, and first editions are today rare and highly valuable. What effect Dr. Clark's theory will have on biologic thought no one now knows but it seems certain to provoke a great deal of argument and controversy among men of science. The present volume sets forth the theory in detail and in language comprehensible to the reader of average schooling. Since it is likely to be the center of a major controversy, persons having interest in scientific events are advised to post up on it in advance and be in a position to comprehend the arguments. $3.20 postpaid—*A. G. I.*

Exploring for Plants—*By David Fairchild*

AN intimate narrative of a scientist's adventures in little known lands, based on notes of the Allison V. Armour expeditions. Dr. Fairchild is a botanist of note with a remarkable record for doing things, the results of these expeditions being the introduction into this country of many useful new plants and trees. Ranking as a scientific book, its charm for the average reader lies in the ease of style and the joyous appreciation of life looked at from every angle. The story is so smooth one assimilates the botany with no effort whatsoever. Good science, good reading, good writing. We highly recommend it. Abundantly illustrated. $5.20 postpaid.

THE MATERIALS OF LIFE—*By T. R. Parsons, M.A., B.Sc.*

A "DEBUNKED" presentation of biochemistry, for the chemistry of the human body is certainly a pin on which loose statements have been hung from time immemorial. "An apple a day" does not keep the doctor away. One orange contains more vitamins than a basket of apples. Light treatments and backless bathing are popular but many of us will be surprised to learn that the effect of ultra-violet rays is similar to that of cod-liver oil. The book gives sensible as well as accurate accounts of such things as gland secretions; vitamins; the cycle of nature; food energy; the living fire; wear and tear; blood and iron; starch, sugar, and fat; digestion and indigestion, et cetera. The author eschews horrifying formulas in which those who deal with such matters professionally are wont to encyst their ideas and writes in a language which all can understand. $3.20 postpaid—*A. A. H.*

PRIMITIVE METHODS OF WORKING STONE—*By Alonzo W. Pond, Logan Museum*

THIS most fascinating book is based on the flint-flaking and artifact-making experiments and activities of Mr. Halvor L. Skavlem, mentioned on page 88 of the present number. It describes Mr. Skavlem's actual technique; therefore it is, as the author intended, a practical instruction book: "Any student who will take the trouble to read the foregoing," he says, "will be able to apply the principles as has Mr. Skavlem and like him will, with a little practice, be able to make arrowheads and other chipped instruments." The book, though paper bound, contains 143 large pages, is handsomely produced and there are 64 fine half-tone plates. It is suggested that would-be purchasers obtain it direct from The Logan Museum, Beloit College, Beloit, Wisconsin. $1.15 postpaid—*A. G. I.*

MY LIFE—*By Leon Trotsky*

MEMOIRS of the exile Trotsky ought to be interesting when we consider the enormous power once wielded by himself and Lenin. The whirligig of fate, however, has been exceedingly swift in the case of Trotsky who was sent into exile by the present Soviet government in January, 1928, and he writes his book from Constantinople. Trotsky makes note of his arrival in New York as follows: "*Sunday January 18 (1917):* We are nearing New York. At three o'clock in the morning. Everybody wakes up. We have stopped. It is dark. Cold. Wind. Rain. On land, a wet mountain of buildings. The New World!" He stayed in New York about two months and contrary to many stories his only occupation or profession was that of a revolutionary socialist. He rented an apartment for 18 dollars a month and the colored janitor ran off with three months' rent. It is by such sidelights that we enjoy a book of this kind. In attempting to return to Russia via Norway he was taken off the steamer at Halifax with his family, and placed in a detention camp, but was finally released and allowed to continue his journey to Petrograd—a journey fraught with so much history. The theme of his rise to power and his eclipse is a very long story which you will have to read for yourself. His life was weird and fantastic. $5.20 postpaid—*A. A. H.*

SLEEP—*By Laird and Muller, Colgate Psychological Laboratory*

THE many thousands who have taken keen interest in Professor Donald A. Laird's articles, published in the SCIENTIFIC AMERICAN during the past year or two, will find in this new book the substance of about 18 more equally interesting articles, all of which center around that rather familiar activity we all indulge in more or less—sleeping. After you have read this treatise you will be a sleep scientist. How can we get to sleep more quickly? How much sleep do we need? How does noise affect sleep? Do dreams affect the benefits of sleep? What types of covering, mattresses, and springs will best promote sound sleep? These are a few of the aspects of sleep covered in this semi-scientific work. The authors deny categorically that they were subsidized by any maker of beds, bedding, pyjamas, negligees, or cures for insomnia; they have tried merely to ascertain scientific facts about sleep, no matter whom these helped or hurt. The book makes easy reading, though it is packed full of fact, and is suited to the understanding of mere mortals. $2.65 postpaid—*A. G. I.*

PIONEERS OF FREEDOM—*By Sveinborn Johnson*

HERE we have vivid account of the Icelanders and the Icelandic Free State (874-1262) issued on the eve of the 1000th anniversary of the founding of the Althing or Parliament of Iceland which was celebrated by appropriate exercises on the ancient site where that body regularly convened for approximately 900 years. It is interesting to see how these isolated people founded and maintained governmental institutions while the rest of Europe was largely in the grip of absolute power and centralized monarchies. Iceland maintained a government strikingly free and responsive to the popular will. This far-away island was perfecting popular institutions while most of contemporary Europe was drifting towards despotism. Under the influence of civil and political liberty there flourished a legal system which in excellence rivaled that of Rome; and during the same period a literature blossomed which contained some of the finest creations of the human mind. The government finally collapsed because of elementary defects and a spirit of lawlessness. $3.70 postpaid—*A. A. H.*

VERDUN—*By Marshal Petain*

THIS is a definite record of the most heroic and spectacular last-ditch defense of the great war written by the man himself who conducted that defense to a successful conclusion. The author presents no argument, makes no bid for fame, he tells the facts with an impartiality that is amazing. Judgment on the German commanders is free from bias; the Crown Prince is given credit for a humanity the world has little suspected. But the most significant statement, in view of the comparatively quick demolition of Liege, Namur, and Maubeuge, is that permanent concrete fortifications such as Douaumont when properly manned and equipped can be of indispensable value in maintaining a defense and will resist the fire of the heaviest ordnance. The style of narrative is of such perfection and the generalizations are so clear and comprehensive as to make this work one of the literary gems of war history. $4.20 postpaid.

PRINCIPLES OF SCIENTIFIC PURCHASING—*By Norman T. Harriman, Bureau of Standards*

A LONG experience in railroad purchasing and specializing for the last nine years in the standardization of purchasing and its procedure of the Federal Government under the Bureau of the Budget, has given the author a sweeping comprehension of the fundamental necessities, the basic rules of scientific buying, and the philosophy of Budgetary Control that applies equally well to private business. A complete summary and thorough analysis of the best present day practice. $3.25 postpaid.

Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Attorney's Delay Unavoidable

A DELAY of a few months in filing an application for a patent, due to the accumulation of business before the patent attorney entrusted with the filing, does not show a lack of diligence on the part of the applicant in prosecuting his claim to an invention and a patent therefor, the Court of Customs and Patent Appeals has ruled in an appeal from an interference proceeding in the Patent Office, according to *The United States Daily*.

The court held that the Patent Office had properly awarded priority of invention to George W. Heise as against the senior applicants, Martus & Becker, for certain improvements in battery cells.

The invention, the opinion states, "relates to the addition of zeolitic agents—one of which is 'permutit'—to the electrolyte in a caustic alkali electric cell for the purpose of increasing electrolyte efficiency."

Plan to Include Patents in War Settlement Favored

THE House Committee on Ways and Means at a recent hearing agreed to report favorably a bill (H.R. 9142) to extend jurisdiction of the Arbiter under the War Claims Settlement Act of 1928 to "patents licensed to the United States pursuant to an obligation arising out of their sale by the alien property custodian."

The purpose of the bill, according to the Special Assistant to the Secretary of the Treasury, E. C. Alvord, who testified before the Committee, is to extend the Arbiter's jurisdiction to the chemical foundation patents.

The 1928 act provides for compensation to alien owners of patents for use, or licensed to be used, by the United States, the licenses being restricted to those issued by the alien property custodian. That, according to the Government, left out the so-called chemical foundation patents, and at the time the case of the Government against the chemical foundation to set aside the sale of the patents involved, on the allegation of fraud in the sale, was pending in the courts.

Limited Novelty—Limited Claims

THE Board of Appeals has held that one claim only is allowable in a patent application covering an invention relating to the production of a water-resistant, porous, rigid, coherent mass by puffing the mixture of a ground filler and a water solution of sodium silicate, according to *The United States Daily*.

The slight novelty of the invention over the prior art was held to warrant the allowance of but one claim, the others being held not to be patentably distinctive.

The finished product of the invention is said to be suitable for use as a building material. The invention is alleged to be based on the discovery that the maximum resistance to moisture is obtained under certain conditions, they being: Particle size of the ground filler, composition of sodium silicate solution, and ratio of sodium silicate to filler.

British Mail Ban on Cigarettes

GREAT BRITAIN is seizing parcels containing sweetened cigarettes made in America and other countries which are being sent through the parcel post mails in violation of British postal regulations, according to advices received by the Post Office Department and made public in a memorandum sent to postmasters, who are to advise mailers that such parcels will be accepted only at their risk.

The brands of cigarettes affected are all popular in America, and are mailed principally by individuals as gifts to friends abroad and not by the manufacturers who sweeten their products to meet the taste of smokers, it was stated orally.

The full text of the memorandum follows:

In view of the existing prohibition in Great Britain against the importation of sweetened cigarettes, numerous reports of the seizure of parcels containing these articles are received from the postal administration of that country.

As practically all brands of cigarettes manufactured in the United States contain a certain percentage of sweetening properties, postmasters will advise mailers that cigarettes addressed for delivery in Great Britain will be accepted only at their risk.

Reduction to Practice Governs Priority

AFTER an invention has been reduced to practice, the abandonment of the invention will not be inferred merely from failure speedily to file an application for patent or to commercialize the product, the Court of Customs and Patent Appeals has ruled. Abandonment must be affirmatively proved, it was ruled, according to a recent issue of *The United States Daily*.

The opinion of the court states that "the diligence required of one claiming to be an inventor is primarily diligence in reducing to practice after conception, and the law is not so much concerned with speed in filing application for patent, provided, of course, there is no secreting or abandonment of the invention."

The court affirmed the Patent Office in awarding priority of invention for a process of manufacturing formamide to Burritt Samuel Lacy, who did not file an application for patent until three years after the conception of the invention and its reduction to practice.

The subject of the invention, according to the opinion, is a "process for the production of a material called formamide, one of the uses of which is as a raw material in the production of hydro-cyanic acid much used as an insecticide for fumigating citrus trees, ships, rooms, and so forth."

In another case involving the question of reduction to practice, the Court of Customs and Patent Appeals has upheld the Board of Appeals of the Patent Office in ruling that priority of an invention of a process for vulcanizing rubber involving the use of so-called high-power accelerators should be awarded to Sidney M. Cadwell over Marion M. Harrison and Harold A. Morton, whose assignee is the owner of patents No. 1434892 and No. 1434908, for the process. The patentees were the junior parties, the Cadwell application having been filed previous to theirs, although patents have been issued to them.

The opinion describes the steps that have been taken in the art of vulcanizing rubber. Problems arising in the use of high-power accelerators were solved by both parties, it is stated. The sole issue between the parties on appeal was which had first reduced the invention to practice.

The court held that the numerous laboratory tests conducted by the appellee in the usual way for determining proper vulcanizations, which tests were in common use in the rubber laboratories of the country, constituted a sufficient reduction to practice although no factory tests were made nor commercial operations conducted.

Pay for Service Is Not Free

"FREE" spectacles to a customer who would obtain orders for glasses from other persons were offered by the Clear Sight Spectacle Company, Chicago, but the glasses were really not free, according to the findings and an order to cease and desist just issued by the Federal Trade Commission.

"Take the scientific self-tester you now have to your friends," the customers were advised. "Ask them to make a test of their eyes as you have done. They too should have the benefit of our expert service and low price.

"Tell them you are going to order a pair for yourself and that they might as well send their orders with yours.

"Collect one dollar deposit from them and they can pay the balance to the mailman upon delivery. They will receive the same, strong iron-clad guarantee of satisfaction for five years to come.

"You may keep the one dollar deposit you collect as your pay. Take only four orders and you will earn more than enough to pay for your own glasses. Take as many orders as you can. You make one dollar each."

The Federal Trade Commission has ordered the company to cease and desist from representing the spectacles as "free" when the fact is they are not given free but "in consideration of personal services rendered or performed by certain customers in securing for respondent cash orders for two or more pairs of its spectacles from other customers."

Customers were invited to take two orders with a dollar deposit on each, send in the two orders and the two-dollar deposit. The person taking such order was to obtain his own glasses "free."

"Only one free pair of spectacles will be sent into a community," read an advertisement.

In one instance the company described its proposition as a "Special Ten Day Offer."

But the commission has also ordered the respondent to discontinue representing that the spectacles "can be obtained at the prices stated for a limited period of time only, or that said spectacles can be purchased by a limited or restricted number of persons only," as these restrictions were not put into effect.

"Army and Navy Supplies" May Be Misleading

NATHANIEL ABRAHAM, trading as N. Abraham Company and Warehouse, in San Francisco, offered for sale paints, automobile oils, and varnishes as "Army and Navy Surplus Supplies," when in fact this merchandise had never been the property of the United States Government.

In his advertisements Abraham displayed the following notices: "This Merchandise is Now Offered for Sale at Warehouse, 701 Battery Street, Corner Pacific," and "Warehouse, 701 Battery Street, San Francisco; Mail Orders Promptly Attended To."

Abraham was ordered by the Federal Trade Commission to cease and desist from these misleading uses of the words "Army and Navy Surplus Supplies," or the word "Army" or the word "Navy" standing alone or in connection with the word "Warehouse" or with other words.

Parachutes Are Developing

AFTER several years of more or less stagnation, development of parachutes for use of aviators has taken place, according to J. E. Sullivan, of the Bureau of Aeronautics, Department of the Navy.

The industry is a growing one, said Mr. Sullivan, who pointed out that the latest figures compiled by the Aeronautics Branch of the Department of Commerce show that the number of aircraft pilots holding active licenses now totals 10,701. Furthermore, parachutes constitute no minor item in the equipment of an aviator, as they sell commercially for approximately 350 dollars each, although they are bought for military purposes for considerably less.

A cotton substitute for the silk used in parachutes is being subjected to experiments, which has the advantage of being cheaper than silk. While commercial interests are employing cotton to a certain extent, the Bureau of Aeronautics has not arrived at any definite conclusion regarding its use for naval purposes.

There are four major manufacturers of parachutes today while there were only one or two five years ago. A recent improvement made by one manufacturer has been to make the pack perform the functions of the pilot parachute. The pilot parachute on the ordinary parachute is the first to open and drags the large one after it. When the rip cord releases the spring on this new type the bottom of the pack opens and replaces the usual pilot 'chute.

Another manufacturer has improved his product by reducing the size, which, although it makes the rate of descent somewhat faster, opens more quickly. Still another manufacturer, it was pointed out, is working on a triangular-shape parachute, which is claimed to be steerable.

Nearly all the accidents in the past due to the failure of the parachute have been attributable to improper packing or improper operation of the releasing device by the person making the descent, or hasty release of the spring, causing the parachute to open too quickly and catch on the plane.

The present development of parachutes is being worked out to a large extent on increasing their performance characteristics—making them stronger, more durable, with smaller packs and less bulky. The features which the Navy looks for in a parachute are the certainty and rapidity of opening, slow rate of descent which must be about 20 feet per second, and non-oscillating.

"Dry Ice" Package Patent Valid

THE Slate patent, Number 1595426, for a refrigerating apparatus using solid carbon dioxide, so-called "dry ice," principally used for packing for shipment food products not damaged by excessive freezing, has been held valid by the Circuit Court of Appeals for the Second Circuit.

The defendant company, which was alleged to have supplied solid carbon dioxide for use in the plaintiff's packages, was also held by the court to be a contributory infringer of the patent.

The court over-ruled the defense of invalidity of the patent, holding that while the use of carbon dioxide as a refrigerant had been long known in the art, the arrangement adopted by the patentee in his apparatus was not anticipated.

The patentee was stated to have reversed the usual process by placing the refrigerant in the center of the package, surrounding it with ice cream or other substance to be refrigerated, and enclosing all in a packing box or insulating wrapping.

The court held that the method of utilizing by specified physical means the operation of a law of nature is patentable, thus overcoming the objection that a law of nature may not be patentable.

It was also found not to be fatal to the patent that the solid carbon dioxide is to be destroyed by its use as a refrigerant.

The doctrine of implied license to renew perishable and subordinate parts was also held not to be applicable to the perishable solid carbon dioxide, particularly where the exclusive licencee of the owner of the patent sells carbon dioxide with a license to use it in the package described in the patent.

Malt Product Mark Restrained

THE owner of the trademark "Budweiser," for malt syrup and other products, has been held by the District of Maryland to be entitled to an injunction restraining the use of the notation "Budd-Wise" on malt products. The matter was referred to a master for an accounting.

The court ruled that the defendant's allegation in answer to the suit for infringement that the plaintiff was deliberately and intentionally selling its goods for use in violation of the prohibition act and that its goods are not fit for legitimate use should be stricken from the pleadings as irrelevant and impertinent.

It was further held that the fact that the defendants had procured a copyright of their label was immaterial in a controversy as to trademark infringement, the copyright giving the defendants no trademark rights whatsoever.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co.; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

AEROPLANE—An amphibian air liner, in which the body simulates a bird, is particularly adapted for flying in sleet and snow, exhaust gases being utilized for heating the body and for preventing the formation of ice on the wings. Patent 1757879. John T. Rydberg.

Pertaining to Apparel

REAR YOKE FOR DRESSES—A reinforcement which extends from the rear opening at the neck to the sleeve openings and downwardly to the lower part of the sleeve opening for protecting the dress against perspiration without detracting from the pleasing appearance. Patent 1758852. Louis C. Rosenblatt.

Chemical Processes

PROCESS FOR RECOVERING BORAX FROM BRINE—Containing borate in solution together with sodium carbonate, which consists in treating the brine with carbonic acid gas to precipitate from the solution, and crystallizing out the borax by cooling. Patent 1756122. Henry D. Hellmers.

PROCESS FOR INCREASNG THE LUSTER OF GOODS MADE OF ANIMAL HAIR AND WOOL—Particularly felt and velour in hat bodies by bringing into contact therewith an aqueous solution containing chlorine and hydrogen ions, and an aqueous solution of peroxide of hydrogen, and causing the two to react with each other in contact with the goods. Patent 1760738. Erich Bohm.

Designs

DESIGN FOR A DRESS—Patents 81098 and 81099. Dorothy Long.

DESIGN FOR A TEXTILE FABRIC OR SIMILAR ARTICLE OF MANUFACTURE—The inventor has been granted two patents, 81252 and 81255. Joseph H. Mack.

Design for an Ensemble Suit—Patent 81139. Dorothy Long.

Design for a Suspension Bracket—Patent 81168. Robert D. W. Vroom.

Design for a Candy Doll—Patent 81245. Mildred C. Knapp.

Design for an Ensemble Suit—Patent 81251. Dorothy Long.

Design for a Textile Fabric or Similar Article of Manufacture—The inventor has been granted two patents, 81235 and 81236. Herman Haug.

Design for a Textile Fabric or Similar Article of Manufacture—Patent 81238. Christian Hoffmann.

Design for a Suit—Patent 81100. Dorothy Long.

Electrical Devices

Electric Furnace—Such as those usually employed in dental laboratories, which will be capable of generating the necessary amount of heat with much lower resistance than usual, constructed in a simple manner prolonging the life for an indefinite period. Patent 1757895. Andrew J. Asch.

Radio Tube—Which may be used in several different ways, such as a detector, an amplifier, a static eliminator, etc., provision being made whereby the characteristics of the tube may be changed to effect the desired results. Patent 1757345. Howard M. Strobel.

Thermostat—Forming part of an electrical circuit, in which a thin strip of resilient material is bent and maintaned under a predetermined stress, so that when expanded by heat it will suddenly buckle, thus instantly breaking the circuit. Patent 1758787. Arnold Escher.

Electric Water Heater—Adapted to be readily associated with or removed from a sink or similar kitchen or household fixture, whereby the water passing through coils brings it in contact with various portions of the heating element. Patent 1759774. Angelo Andriulli.

Fluid-Operated Circuit Controller—Which is capable of controlling a circuit including a signal for indicating to the operator of a motor vehicle whether or not the lubricating system of the vehicle's motor is properly functioning and sufficient lubricant circulating. Patent 1759537. Walter C. and Arthur R. Buckbee.

Of Interest to Farmers

Stalk Cutter—A farm implement which includes a frame having equal portions extending on opposite sides of a draw bar and carrying knife-equipped rotors for cutting stalks and chopping them up, over at least four rows. Patent 1757873. John F. O'Kelley.

Of General Interest

Marcelling Iron—Comprising a plurality of forks disposed one above the other and means for moving certain of the forks laterally with respect to the others, the other forks remaining stationary, may be worked in the same manner as hair clippers. Patent 1756104. Nellie Stone.

Condiment Holder—A partitioned container, wherein salt and pepper may be served from a single holder, the construction is simple, while at the same time functioning to prevent the mixture of the condiments, and keep them moisture proof. Patent 1757525. Frank A. Hart.

Easel—Comprising two strips of material forming a U-shaped frame having an L-shaped bracket capable of holding and displaying thin objects such as paintings or photographs, or thicker objects such as books. Patent 1755518. Edward M. Roberts.

Closure Cap—For milk bottles, or any form of container where disk-shaped cardboard caps are used for closures, whereby the cap may be gripped by the hand and easily removed entirely eliminating the use of an instrument. Patent 1755522. Samuel J. Smyth.

Optical Device—Primarily intended for amusement purposes, optical illusions being produced when viewed by a person, or if employed in connection with an ordinary or motion-picture camera, such optical illusions will be reproduced on the film. Patent 1758801. Bertram Moses.

Means for Acoustical Correction and Sound Deadening—For absorbing sound by causing reverberation or resonance of sound in a manner which eliminates interfering echoes, or which confines sound refection to a determinate non-interfering limit or area embodied by walled structures. Patent 1758808. Fred J. Sersen and Kenyon B. Conger.

Plant Support—For growing plants which includes a post adapted to be driven into the ground alongside of the plant and a girdle adjustable, vertically on the post and circumferentially, in order to compensate for growth of the plant. Patent 1758839. Theodore Kelsey.

Adjustable Mirror for Barbers' Chairs and the Like—Whereby the mirror may be moved to various positions so that the occupant of the chair may view the results of a hair cut, wave, or the like, the mirror being adjustable for customers of different heights. Patent 1758021. Peter D. Barakauskas.

Aspirating Head for Flowing Liquids—An aspirating head for submergence in a well or reservoir of liquid to produce a jet of suction-producing gaseous fluid under pressure causing movement of the liquid in a flow line. Patent 1758812. George McW. Williamson and Glasgow W. Haywood.

Tellurian—An orrery, specifically a tellurian having sun and earth sphere mounted for bodily movement of the earth relative to the sun in a path denoting the ecliptic circle. Patent 1758759. David Phillips.

Combination Brush, Comb, and Mirror—In which the various parts are entirely enclosed when not in use, thus keeping them clean and sanitary, the casing being divided into brush-receiving and comb-receiving compartments, one of the partitions forming a mirror. Patent 1757999. Christoph Hagen.

Price Tag or Sign Holder—An attachment for supporting tags from the edges of shelves, which affords a means for associating the tags either in an upright or depending position, an advantage where two varieties of stock are arranged on one shelf. Patent 1759781. Louis Fontannaz.

Loud-Speaker Envelope—Comprising an envelope body including conical walls secured together at the major portions of their edges, leaving an opening constituting a sound outlet, functioning to produce more individual notes and less harmonics. Patent 1759785. Roy H. Guldman.

Cooking Pot of the Self-Closing Type for the Cooking of Food—Having a cover adapted to be placed in position and removed, by sliding and rotating horizontally, thereby preventing its contact with the food and providing more food-containing space within the vessel. Patent 1759732. Moise A. Charlot.

Seat Back-Rest—A collapsible back-rest for association with board seats, such as are employed in row-boats and bleachers on baseball and athletic fields, thus producing a comfortable and rigid seat structure which may be effectively secured. Patent 1759694. Peter Greenwood.

Device for Removing Eggs from Fish Hatcheries—More particularly for the separation and removal of dead eggs from the live eggs in the hatchery troughs, thus preventing the development of fungus liable to destroy the health of the live eggs during the period of incubation. Patent 1759729. Joseph Berger.

Nested Chair—Which may be formed as a chair or a table and readily nested for shipment or storage, the structure being formed either of wood, metal, or a combination, and the parts so constructed as to telescope. Patent 1758826. Louis Dellert.

Massage Device—Which comprises a plurality of vacuum cups, one being disposed within the other, the inside one being of less height than the outside one, thus producing a greater suction and a more effective massage to the skin. Patent 1758962. Carl Miller.

Adjustable Furniture—Especially adapted for printing establishments, having two opposed edges swingable at various angles with respect to each other, so that a cut may be locked in the chase on a bias, thus obviating the use of specially cut wood. Patent 1758980. Wayne F. Rossiter.

Safety Barrier for Roadways—For placement along dangerous curves or embankments on a highway, which in the event of being hit by a motor vehicle will eliminate or reduce the shock to a minimum, both to the barrier and the vehicle. Patent 1759794. William McDade.

Oarlock—Formed integral of metal, with an oar-receiving eye supported for swinging movement by a pin and socket in upright position above the gunwale of a boat, and having means for preventing displacement of the oar during rowing. Patent 1757378. John E. Mathewson.

Combination Ladder, Step and Support—Which may be positioned wherever desired, along the length of the ladder at an angular position of a building or roof, and will also function to support a bucket. Patent 1760803. John Wirth.

Hose Coupling—Consisting of male and female members with simple means for positively locking them to form a fluid-tight joint, and whereby a worn male member may be replaced by a new one and the desired connection assured. Patent 1761352. Henry H. Logan.

Memory Pad—Having means for covering a portion of the subject worked upon, thus causing the student to recall by memory the portion covered, the entire sheet may be covered for constant repetition until the problems are memorized. Patent 1760408. Rebecca E. Hooper.

Stopper for Gas and Water Mains—An inflatable stopper which will be effective in forming a complete closure for the main, the proper emplacement not being prevented by buckling or deformation after its insertion, means are provided for ready insertion and removal. Patent 1760750. Patrick Goodman.

Display Device—Showing in miniature the reproduction of a pattern of dress material proportionately reduced to enable a purchaser to determine how the garment will look when made up, through a reduced picture of the garment and the material selected. Patent 1760792. Bernard F. Stenz.

Mounting Anchor—Particularly adapted for mounting the corner clips in decorating pocket books, bill files, wallets, or the like, serving to positively secure the clips in attached relation, without marring the appearance of the cover. Patent 1760728. Murray A. Wachs.

Comb—Characterized by being conveniently manipulated to form a compact case excluding dust and dirt, may be carried in a pocket, pocketbook, or form part of a traveling kit, the teeth are formed to be substantially self-cleaning. Patent 1760778. Henry J. Ries.

Article Support—A simple means for holding paper or other bags in open position, for dropping into the same waste material or refuse from household kitchens, the bag may be readily detached from the support and placed in a garbage can. Patent 1760752. George D. Happer.

Hardware and Tools

Hoe—Having a plurality of interchangeable blades for performing various garden operations, and a durable and interchangeable shank is provided between the blade and handle for withstanding a maximum strain; handles of various length may be used. Patent 1757882. Ernest F. and Alfred Sill.

Casing Cutter—Which is provided with automatic means for gripping the interior wall of the casing at any desired depth, the cutting means being actuated by the weight of the drill stem, and jars for severing the casing. Patent 1756128. Albert M. Monroe.

Suspension Hook—Which may be formed from a single piece of metal, will be durable and will readily support a framed picture or the like at various angles, without liability of slipping, or disengagement of the suspension cord. Patent 1757875. Thomas S. Rainey.

Locking Device—Especially adapted for windows, automatically locking the sash together when in closed position and providing means for rigidly holding the window against lateral vibration, may be readily used on doors, cabinet doors or the like. Patent 1758337. John C. Sheller.

Knob-Attaching Device—For securely holding the knobs of covers for pots, kettles and the like, may be readily screwed into place, and is automatically locked against accidental removal, may be used in connection with old covers. Patent 1759771. Otto B. Willi.

Adjustable Cutting Instrument—In which a blade is provided with two cutting edges adjustable to expose more or less of the edge as required, whereby the manual manipulation of the cutter or scraper will be greatly facilitated. Patent 1755535. Otto M. Bratrud.

Wrench—Having a jaw head which may be manually rotated to assume various angular positions, so that it may be used from different starting positions in operating a nut or bolt which is particularly difficult of access. Patent 1755486. Ross E. O'Dell.

Lock—A simple locking means wherein the bolt is projected by gravity, eliminating the use of springs, which cannot be "picked" or manipulated by a skeleton key, from the outside of the door. Patent 1758872. Robert Wheeler.

Heating and Lighting

Furnace—Having a coal hopper in open communication with the casing, and a mechanical stoker operated from the floor above adapted to force a charge of fuel onto the grate, the fuel, including the volatile products being completely consumed. Patent 1757878. Carl H. Root.

Attachment for Gas Water Heaters—A form of cowl, readily applied to the conventional type of heater, serving to direct the hot gases into intimate contact with the hot water discharge pipe, before such gases are dissipated into the air. Patent 1758788. Alexander H. Frank.

Domestic Incinerator—Which rapidly desicrates refuse and maintains a sufficiently high temperature to drive off volatile moisture without recondensation in the incinerator or in the stack, completely consuming fats, carbohydrates and other garbage without appreciable odor. Patent 1758487. Harry L. Warren.

Machines and Mechanical Devices

Centrifugal Pump—In which roller bearings and lubricating oil may be used, all possibility of the oil coming in contact with the liquid passing through the pump being eliminated by the use of wear-compensating rings, instead of packing. Patent 1757670. Herman L. Keun.

Mechanical Pencil—Wherein a thin flat lead may be employed and fed as desired, at all times producing a line of uniform width, particularly adapted for draftsmen requiring a certain kind of point for their work. Patent 1757884. Edgar C. Tuggle.

Pump—Wherein a sort of floating dam may be mounted in a comparatively swift stream, to form a double acting force pump driven by a waterwheel, for delivering a maximum quantity of water to any desired point at minimum cost. Patent 1757885. Grant Weaver.

Oil Pump—Adapted for continuous high-speed operation in connection with oil or other wells of great depth, being operable with a minimum of care, and containing few parts which are liable to get out of order. Patent 1755516. Edward P. Reynolds.

Method of and Apparatus for Reactivating Charcoal—For the revivification of charcoal laden with organic matter as in sugar refining, by passing the charcoal through a kiln and subjecting it to a continuous recirculation of pre-heated hot gases which support the combustion of organic matter. Patent 1758202. Edgar W. Rice.

Ship-Propelling Means—A form of hydraulic ship propulsion, an assemblage of mechanism whereby a jet or stream of water is directed rearwardly and downwardly for propelling a ship forwardly, or in a forward direction for reversing the vessel. Patent 1758847. Amos C. McIntosh.

Oil-Well Pump—In which the expulsion of a combustible gas is employed in such relation to the oil within the well as to subject the latter to a series of lifting impulses, until it is finally ejected from the well. Patent 1758346. Armais Arutunoff.

Fluid-Dispensing Apparatus—Characterized by its ability to control dispensing of different flavoring syrups from different sources of supply, and carbonated water, through a single nozzle, and by the employment of a single valve, particularly adapted for use at soda fountains. Patent 1758552. Philip S. Allen.

Gas and Liquid Contact Apparatus—A tower for the absorption of gases in liquids or their distillation therefrom, means for delivering liquid from one section to another, a plurality of enclosed bubbling trays, and means for controlling the temperature of particular trays. Patent 1759750. Meinhard H. Kotzebue.

Variable-Speed Mechanism—In the form of power-driven or automatic scissors intended especially for barbers' use, may be driven by any suitable means, for instance, an electric motor or other power or by hand. Patent 1760712. Tatsuji Morimoto.

Dry-Cleaning Machine—Characterized by the functional relationship of a movable body, within a casing, upon which apparel to be cleaned is supported and adapted to move in a cleaning liquid, and to circulate the liquid around and through the article. Patent 1760218. Onesime Thibault and Robert Reid.

Indicator for Wrecked Submerged Crafts—Such as submarines, boats, aeroplanes, etc., in which novel means of pressure-actuated release is used for freeing a buoy when the craft sinks to a predetermined depth, or may be manually or automatically released. Patent 1759839. Peter M. Cirimele.

Grader for Vegetables, Fruits and the Like—A rotatable sorter, in which the articles to be graded are fed to one end of the machine and during their passage therethrough are discharged at different points according to the sizes of the articles. Patent 1760742. William G. Bunker.

Curtain Holder—Which may be attached and positioned to hold a window shade away from the window so as to permit a free circulation of air without permitting a view of the interior of the room from outside. Patent 1760701. Godel Kalenoff.

Plumbing and Fittings

Copper - Boiler Outlet — Wherein the threaded portion of the outlet is welded to an extension of the boiler with anchoring means for including solder surrounding the thread, whereby a mechanically strong and air-tight structure is produced. Patent 1758869. Albert H. Trageser and Louis Hassinger.

Pertaining to Recreation

Fish Lure—An artificial bait, for casting, trolling, or still fishing, which when grasped by the fish will automatically release a hook so that the fish will be impaled thereon, a smooth surface preventing entanglement of the bait with weeds. Patent 1758817. Elwin J. Babbitt.

Stirrup—Having flexible portions for obviating the possibility of a rider's foot being held in the stirrup, should the rider be thrown out of the saddle, and which is more comfortable than the usual rigid type of stirrup. Patent 1758930. Archibald D. Cameron.

Toy Pistol—Adapted to hold and "shoot" by release, a plurality of elastic bands held under tension and successively releasable rapidly or at intervals as desired, the toy having the properties of a "repeater" or magazine pistol. Patent 1759084. Fred T. Baum and Clarence G. Norris.

Pertaining to Vehicles

Vehicular Signal—Whereby semi-flexible arms are adapted to advise traffic in front or behind the vehicle, the turning direction by mechanism positioned on the steering column, whereby the indicators may be manually controlled for visual positioning. Patent 1757869. William Lipsky.

Vehicle Spring—In which friction between the leaves is increased on the recoil, thereby damping the spring action so that the recoil is much slower, thus improving the riding quality of the vehicle and increasing the life of the leaves. Patent 1757405. Edwin Bagnall.

Reflex Spring—Wherein the action on the downward thrust is free, thereby providing a device which loses none of the easy riding qualities, one of the spring leaves acting as a fulcrum for dampening the action on the recoil. Patent 1757406. Edwin Bagnall.

Safety Valve for Tires—Whereby the inflation may be produced to any predetermined pressure within the limits of the gauge, and upon reaching the predetermined pressure an audible signal will be given preventing further inflation, thus avoiding danger of over-inflation. Patent 1759796. Albert R. Miles.

Motor-Vehicle Holddown—Constructed from lengths of iron rod bent to provide divergent anchoring barbs at the ends for penetrating the floor of a freight car, for holding automobiles or other vehicles against rolling while in transit. Patent 1759733. William B. Cook.

Road Magnet—Which may be mounted on a suitable vehicle, preferably a motor truck, and drawn over the road for picking up objects liable to puncture tires, the magnetizing motor may be readily removed and used for other purposes. Patent 1759687. Walter M. Carter.

Vending Machine—A form of tricycle, the hollow body of the vehicle being in the shape of an airplane, having storage space for commodities, and a seat from which the operator may manually propel the mechanism and control the steering. Patent 1758432. James T. Crow.

Steering Gear—Whereby steering wheels may be set in true alinement even though the steering axle bolt be sheered or otherwise defective, thus increasing the life of the tires and at the same time permitting free and easy steering. Patent 1760749. John F. P. Gillespie.

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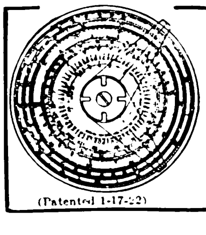

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Across the Editor's Desk

As this is written we have before us the advance printer's proofs of the feature articles for this issue. Going through them, page by page, we stopped and reread the article "Railroading Today." No less than when we first read the manuscript, did it bring us face to face with the gripping romance of the mighty networks of steel that have united the far reaches of this country by providing safe and rapid transportation. Old yet always new, the story of railroading in its ever-changing phases holds a unique fascination, probably because it is so intimately interwoven with the very fabric of our every-day existence. We feel sure that you will agree with us that Mr. Milholland is to be congratulated on the story he has written for you this month.

Another article to which we particularly want to call your attention is the one by Dr. T. A. Jaggar on "Volcanology." Dr. Jaggar spends his whole time at the crater of the active volcano Kilauea in the Hawaiian Islands. Thus he is qualified to write with the pen of authority on how the science of volcanology has a direct bearing on the daily lives of each and every one of us, and for that reason his call for amateur seismologists will not go unheeded. Whether you live in the Adirondacks, West Virginia, or on the Pacific Coast, you may, if you answer Dr. Jaggar's call, contribute valuable data to the science of volcanology. Here's hoping that many of our readers will go in for amateur seismology with the same enthusiasm that has been manifested for amateur telescope making.

As long as the evolution of organic life—animals and plants—remains uncertain, there will be two sides to each and every question that arises. Thus, when Dr. Austin Clark expounded *his* theory in our August issue, we felt it only fair to open our pages to any logical refutation of his statements that might be brought forth. And forth it came. Professor Matthew, a paleontologist of high standing, presents *his* side in a masterful article on page 192. Which authority is right? Each reader will have to study the two presentations carefully—and then draw his own conclusions. We remain open-minded.

The Peking man—or woman, to be exact—is fast growing in importance. Professor G. Elliot Smith, who is one of the world's first five authorities on the subject involved, which is called "paleoanthropology," has written an article for you on the Peking man which we feel sure you are going to find of great interest.

These are only some of the high spots that stand out as we scan our proof sheets. Other articles of equal interest and importance cover such subjects as the truth about our much abused patent system; the new type of racing car that is bound to make new history on the speedways; what surgery is doing to rehabilitate cripples; the yachts that have been built to defend the America's Cup; and a dozen or more selected subjects—not to forget the SCIENTIFIC AMERICAN Digest that brings to you the news of all the sciences in brief.

So now we turn to the schedule of the October issue. Of course it is not complete, space having been reserved for important features that are bound to come up at the last minute. But we can tell you something of the articles that are ready for release. Signaling to Mars, that much abused subject so dear to the hearts of the so-called popular magazines, has at last been treated in a logical manner. Even if we could get visual or electrical signals through to the red planet, how could we be sure that there are intelligent creatures there to receive them—humans or animals made up of protoplasm, which is the only criterion of living matter in our experience?

A 69-inch mirror has been cast for a telescope in the Perkins Observatory, as told in an article illustrated by a most unusual series of photographs. And there is a touch of human interest in the background. The funds for the telescope, 330,000 dollars, were provided by the will of the late Professor Perkins of Ohio Wesleyan University. This sum represented the life savings of an 1800-dollar-a-year professor, accummulated through numerous sacrifices on his part and that of his wife, invested judiciously and allowed to flourish at compound interest. Just as the professor devoted his life to science, so did he provide for the continuation of his work after his death.

These articles are by no means all we have to offer for October. The issue will be replete with interest for the astronomer, professional or amateur; several major articles will assure that. There will also be discourses on the cricket's chirp; a gun mount that makes a super-weapon of the 75-millimeter gun; mining of a valuable metal that is recovered from ore by evaporation; the aircraft industry; the sphere in which William Beebe descended deeper into the ocean than man has ever dived before; and other absorbing subjects. All in all, we feel that the October issue will be one of the best we have given you in many months.

Orson D. Munn

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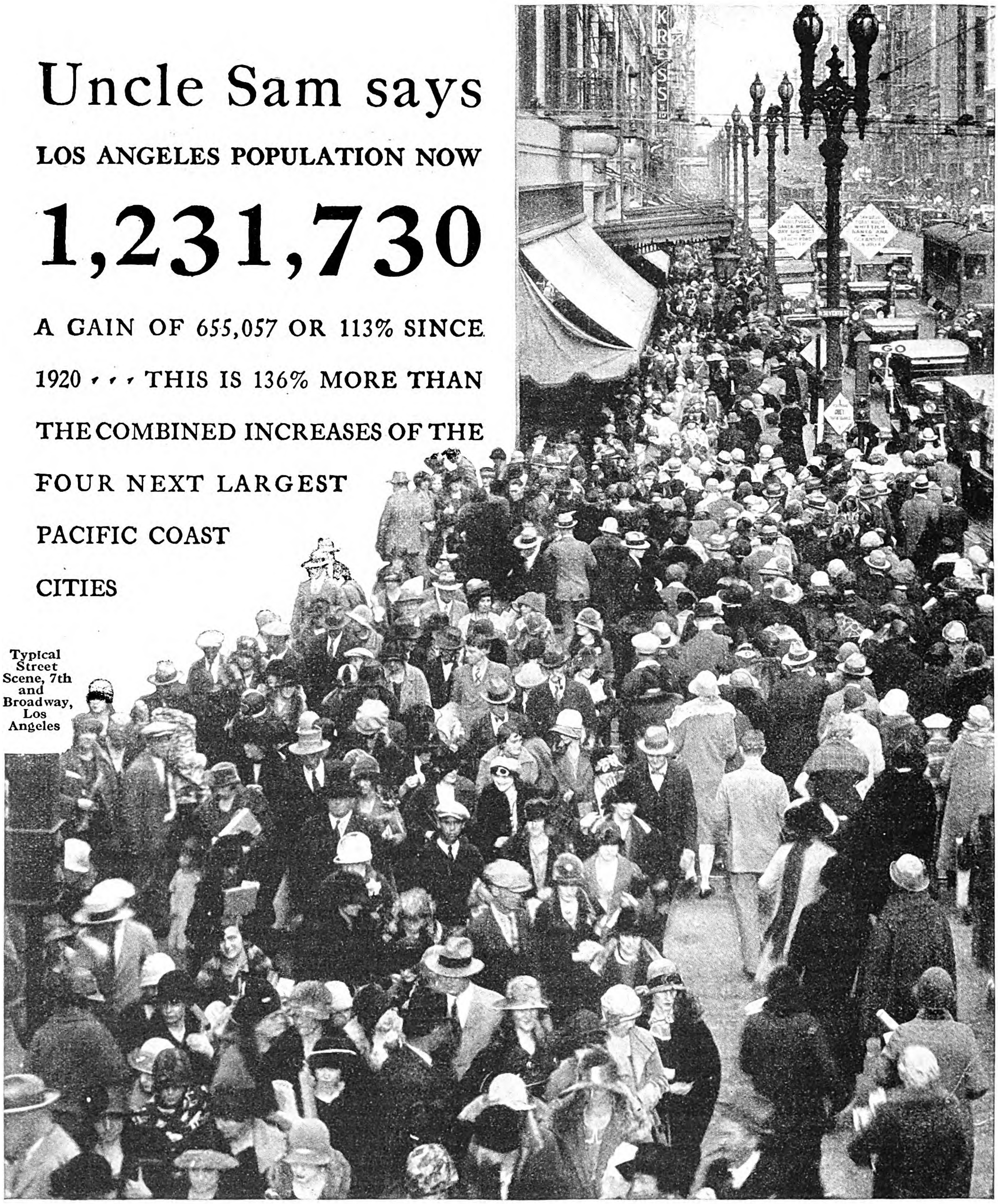
1,231,730

A GAIN OF 655,057 OR 113% SINCE 1920 . . . THIS IS 136% MORE THAN THE COMBINED INCREASES OF THE FOUR NEXT LARGEST PACIFIC COAST CITIES



Typical Street Scene, 7th and Broadway, Los Angeles

Industrial Los Angeles County

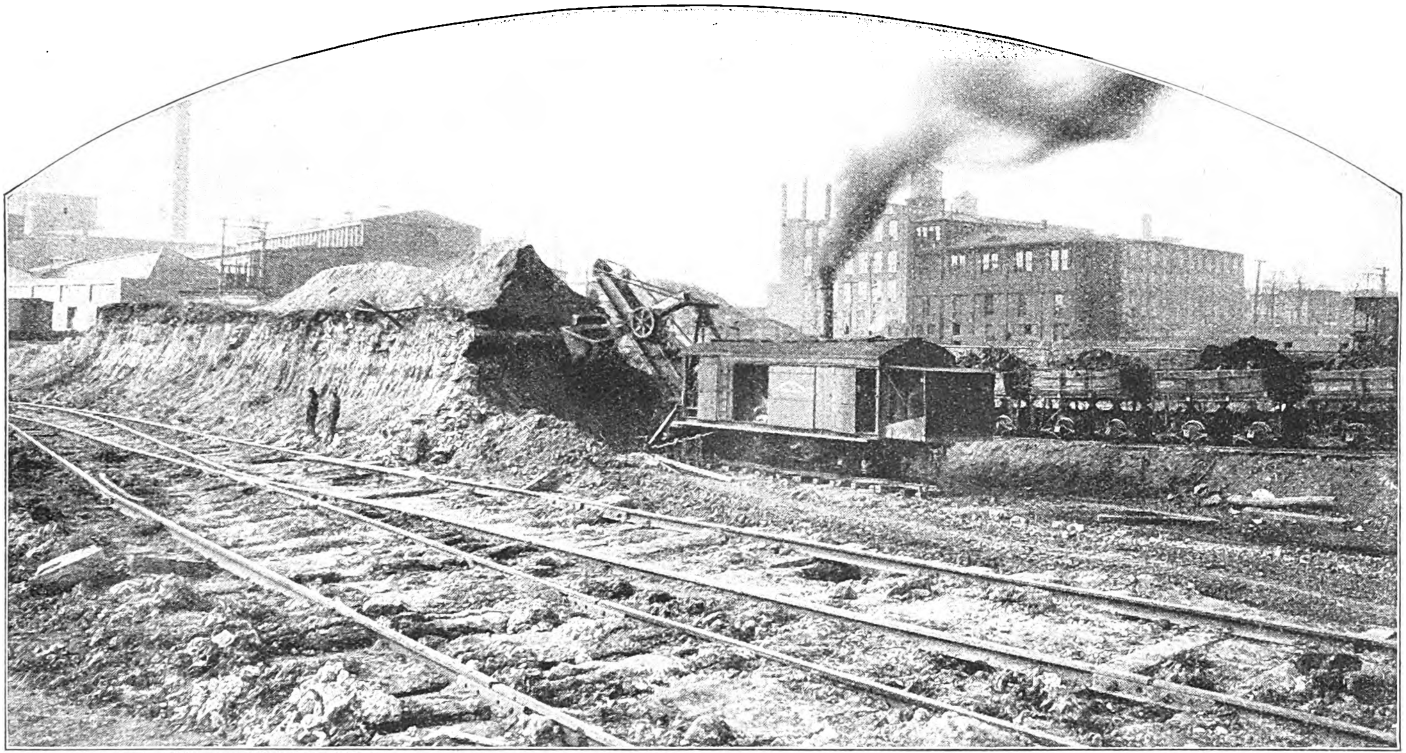
POPULATION 2,199,657

MANUFACTURING EXECUTIVES ARE INVITED TO WRITE TO THE INDUSTRIAL DEPARTMENT, LOS ANGELES CHAMBER OF COMMERCE, FOR DETAILED INFORMATION REGARDING THIS GREAT WESTERN MARKET

Courtesy Baltimore and Ohio Railroad Company

The Vanguard of Progress

WRITERS of fiction have woven many romantic stories around the coming and going of the engineers on railroad construction, their loyalty to their jobs, their unceasing efforts to conquer nature and wrest from it a route, in spite of storms, floods, and natural obstacles of all kinds. The engineers who blazed the trails when railroads were new and stretching into the timberlands and the coal fields, were inured to the hard labor of the pioneer. Now, however, the fastnesses of the highest mountains having been penetrated and the paths of commerce clearly marked, the work of the railroad civil engineer, with improved methods and machinery, is less romantic. In former years when railroads were building, these men of the rod, the chain, the level, the stake, and the transit, were found delving into the wilderness, looking for the "saddle" that would get them over the summit. Everyone of the "gang," from the engineer in charge and transitman, down to the lowly stake man and "back rodman," worked hard and long, often under trying conditions—cold and heat—often braving great dangers. Most of the territory has now been covered and the work of the railroad civil engineer is mostly on small projects and maintenance work, except in undeveloped countries of the world.



All photographs courtesy Baltimore and Ohio Railroad Company

The steam shovel does the work of hundreds of laborers and prepares the right of way for new track

Railroading Today—

Construction and Maintenance

By **FRANCIS X. MILHOLLAND**

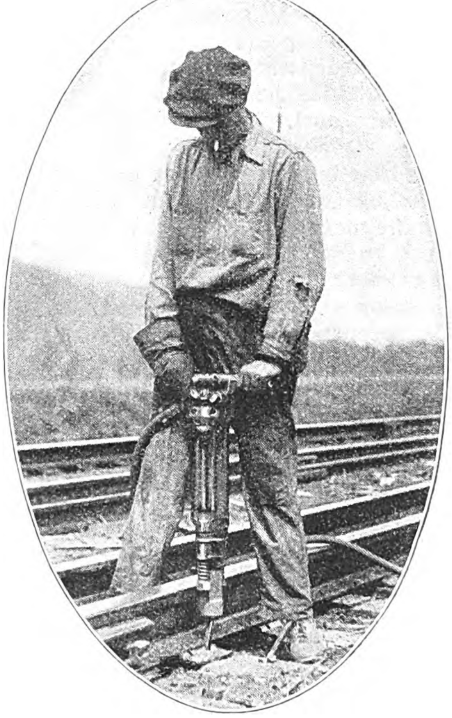
Assistant to the Senior Vice-President, Baltimore and Ohio Railroad Company

WHO has not, at one time or another, gazed down the length of a straight-away stretch of railroad track and found a fascination in watching the steel rails converge to a vanishing point in the distance? But how many of us know the story, equally fascinating, of how those rails were put there and how they are kept so straight and true—the story, in short, of the construction and maintenance of a railroad?

Let us start from the very beginning of this undertaking and consider some of the many problems involved. First, of course, there is the present or probable future need of a railroad as a means of transportation between two definite points. When this has been determined, a corps of field engineers or surveyors start to map out the best and most economical route. From their observations they prepare plans so that the necessary right-of-way can be purchased. They also draw up plans and specifications for the use of the contractor who will do the work of grading.

Now comes the big job of preparing the grade on which the railroad tracks will be built. In this work it is interesting to compare efficient modern methods with the crude means used when the first railroads were built. In former decades, when it was necessary to cut through a hill or along a hillside, the dirt was plowed loose and hauled away with a horse-drawn scraper. When rocks were encountered, the men drilled holes in them with a hand drill and blasted with slow-burning black powder. Then came the steam shovel and the dinky dump cars run on a narrow-gage track, which were big steps forward in promoting speed and economy of operation.

TODAY, automobile dump trucks are used and even the steam shovel is being supplanted by the tractor or crawler shovels run by gasoline or oil engines. Steam-operated hammers drill the rocks for blasting and dynamite takes the place of black powder.



A pneumatic hammer speeds the work of driving spikes into the ties

At the same time that cuts and fills are being made to obtain a uniform grade line, culverts and bridges have to be built, large or small, according to the size of the stream and the maximum amount of rainfall that might be expected during a given time. Particular attention is given to the

The new track is set in the proper position with the aid of a track gage and is being fastened to the ties by trackmen

possibility of eliminating grade crossings.

As the work of preparing the finished subgrade of the road progresses, materials for the construction of the tracks are assembled at the job and then distributed to place. For the track structure of today 22 treated ties are laid for every 39 feet, which is the length of a steel rail. This is followed by the distribution of the steel rails, joint fastenings, bolts, tie plates, spikes, and rail anchors.

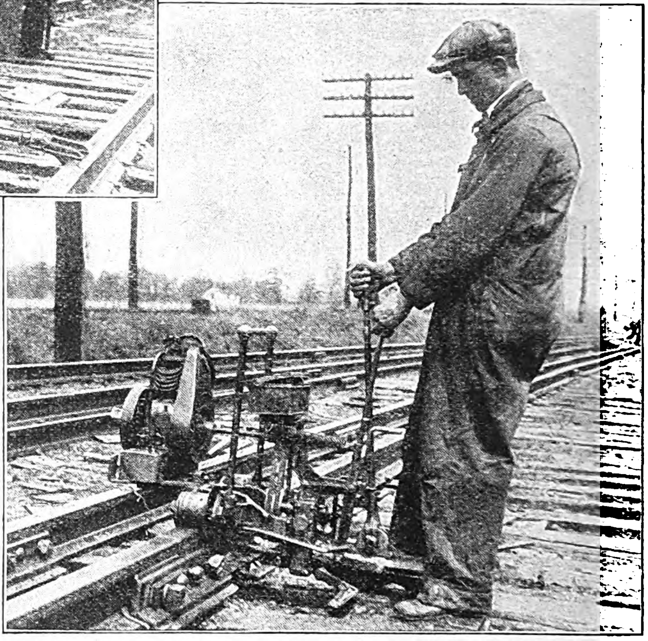
THE distribution of track material is quite an undertaking and the manner of handling depends entirely upon local conditions. Where additional tracks are built parallel with existing tracks, the problem is simple, as the material is unloaded right where it is to be used from cars handled by a work engine.

Where the track is on a new line, however, the problem is more difficult. On large jobs a special track-laying outfit is utilized, consisting of a number of flat cars with special power-driven belt or roller conveyors attached to the sides. As the train proceeds to the end of the new track that has been laid, ties and tie plates are placed on one conveyor and carried ahead of the train, where they drop to the ground. The men immediately put these in their proper positions.

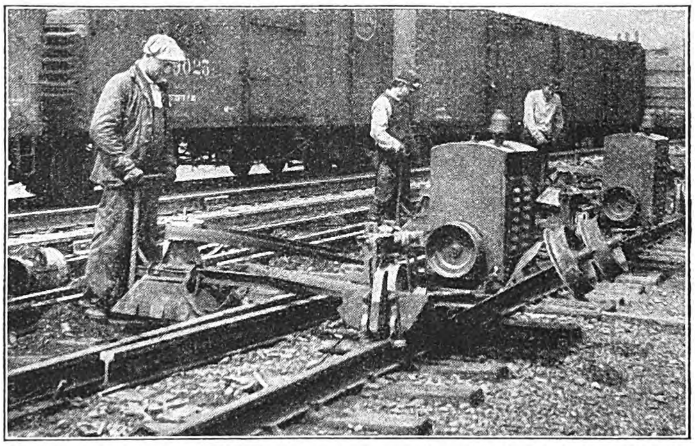
On the other conveyor, rail is carried ahead together with the joint fastenings, bolts, and spikes. A small power crane on the head end of the track-laying machine places the rail into position and the trackmen lay the joint bars and spike enough ties to permit the safe passage of the outfit.

To build one mile of single track railroad, the following material is required: 204 tons of 130 pound (per yard) steel rails; 270 joint fastenings, which with abrasion or rubbing plates weigh 141 pounds each; 5418 tie plates, weighing 16½ pounds each; 48 kegs of track spikes, weighing 200 pounds each; 15 kegs of track bolts, weighing 200 pounds each; 1650 rail anchors, weighing 2½ pounds each, or a total of 4125 pounds; 2979 treated cross ties, size, 7" x 9" x 8½'; 3600 tons of stone ballast. This represents about 89 carloads of material, the cost of which is 22,000 dollars. Labor adds 6000 dollars so our mile costs 28,000 dollars.

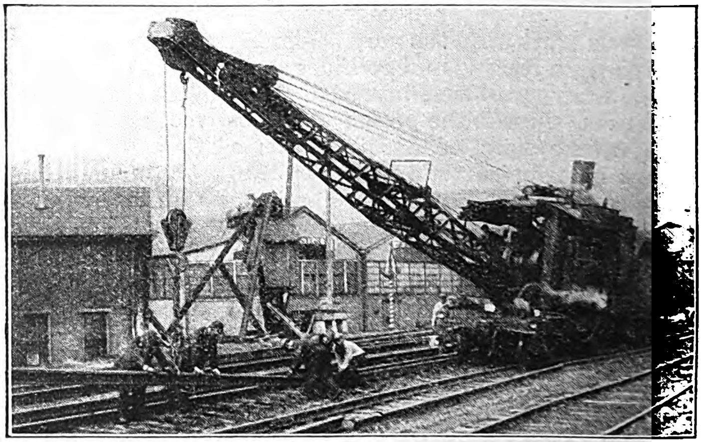
After the distribution of material, the ties are evenly spaced with the ends on one side in a straight line. The tie plates are then placed on the top face of the ties, using a gage, so that when the rail is placed on them, the inner or gage side of the rail heads will be exactly four feet 8½ inches apart. This is the distance that has been adopted as standard on all railroads in this country. As the rails are placed, "shims" or spacers are put between the ends to allow for the expansion and



The bonding drill helps to attach the bindings to ensure connections for the electrical currents

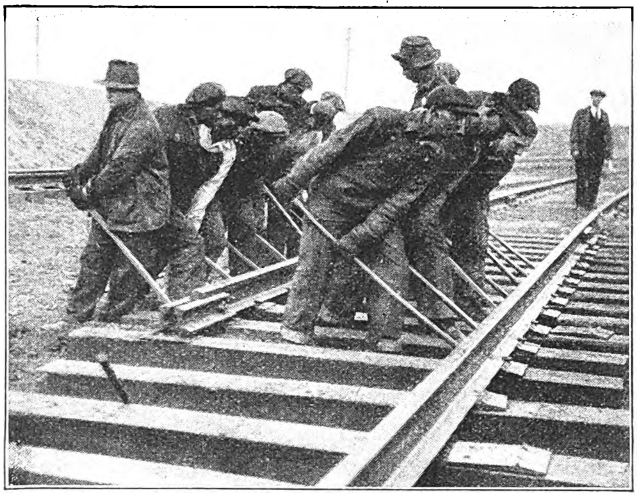


When the old rail is removed the ties are trimmed to a level bearing by power-driven adzing machines



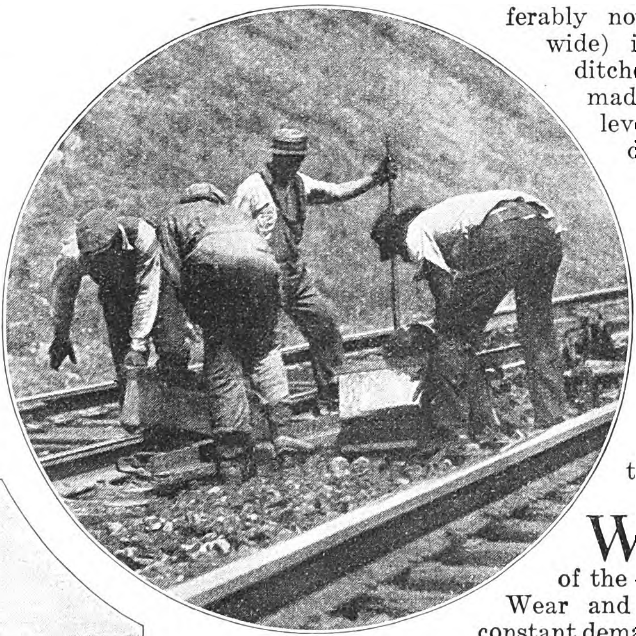
The locomotive crane is seen putting a new rail in position. Rails are now too heavy for hand handling contraction of the steel, the size of the shim depending upon the temperature at that time.

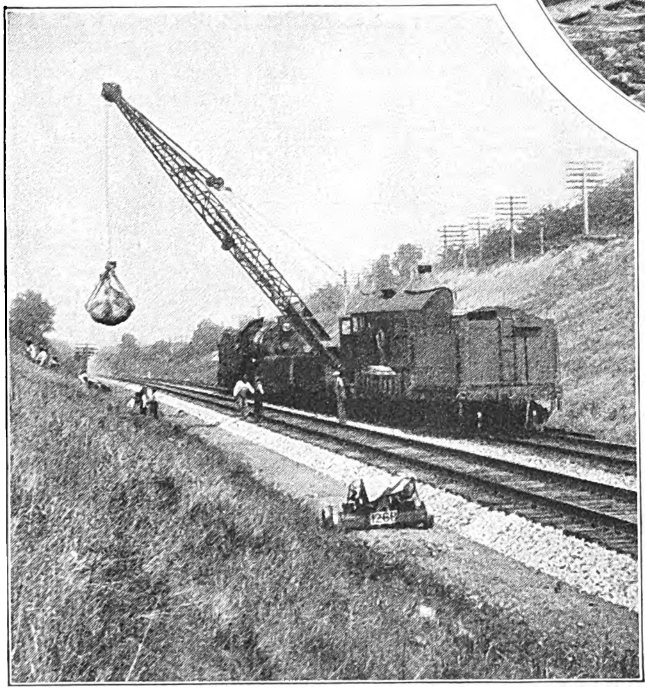
With the rails set and the joint fastenings applied, one line of rail is spiked into place. The second line is next spiked to the ties conforming to the standard gage. Rail anchors are then placed to hold the expansion space between the rail ends uniformly. Next, the track is aligned according to the stakes set by the field engineer, and it is then ready for the ballasting operation.


A picturesque operation is the placing in exact position of a new rail on the leveled cross ties

CARLOADS of engine cinders are brought in and dumped on the track. The trackmen raise the rails on these cinders until there is a mat 12 to 18 inches thick, extending over the width of the roadbed. Time is now allowed for settlement of the cinders and then when the roadbed has become stabilized, the cinders are "cribbed out" or cleaned out and used to widen the banks of the roadway, and new ballast, of stone, gravel or crushed hard slag, is distributed. The stone ballast is generally used in heavy-traffic high-speed territories. It is necessary to have from six to twelve inches of ballast between the bottom of the ties and the cinder foundation. This takes between 2200 and 3000 cubic yards of ballast, or from 55 to 75 carloads per mile of single track railroad. Ballast is normally handled in drop-bottom cars and as the work train moves ahead, the ballast, released through the bottom doors, drags out practically even with the top of the rails, giving a surplus on which to raise the track. The ballast is generally unevenly placed in this way, however, and the labor of distributing it where it is wanted and needed is quite an item.

This difficulty has been largely overcome by the automatic ballast spreader, a device designed to control the unloading of ballast from railroad hopper cars. It consists of a trough, the bottom of which is equipped with movable plates, permitting openings of the area required to distribute the quantity of stone needed. At each end of the trough are sheet steel plates also equipped with gates for regulating the flow from the end of the pan onto the ballast shoulder. Suspended from each end of the trough is an auxiliary pan called a shaper, which dresses the ballast shoulder to a section. A lever control lowers the distributor when in operation so that it rests on rollers which move forward on the rails. When not in operation, it is raised and carried suspended from the car. It is a great labor-saver.


A small machine called a "mole" is used to remove ballast between the tracks for cleaning and replacing


Shaping the hillside so as to intercept drainage from the tracks. A locomotive crane is used

After the material is distributed, the ballast is impacted under the ties either by hand (using shovel or tamping pick), or mechanically with pneumatic or electrically driven tools. There are two types of electric tampers, one using the direct hammer blow and the other employing vibration, to settle the ballast under the ties. To give a neat appearance to the job, the "berm" or shoulder of ballast outside the tracks (preferably not less than 12 inches wide) is built up uniformly, ditches are cleaned out and made regular and the ballast leveled off and dressed to a definite standard section.

In addition to the building of the track structure, a very important item is that of drainage. Wet spots encountered in cuts are tiled and cross-drains installed. Ditches are cut to keep water away from the tracks, and every precaution taken to prevent undermining.

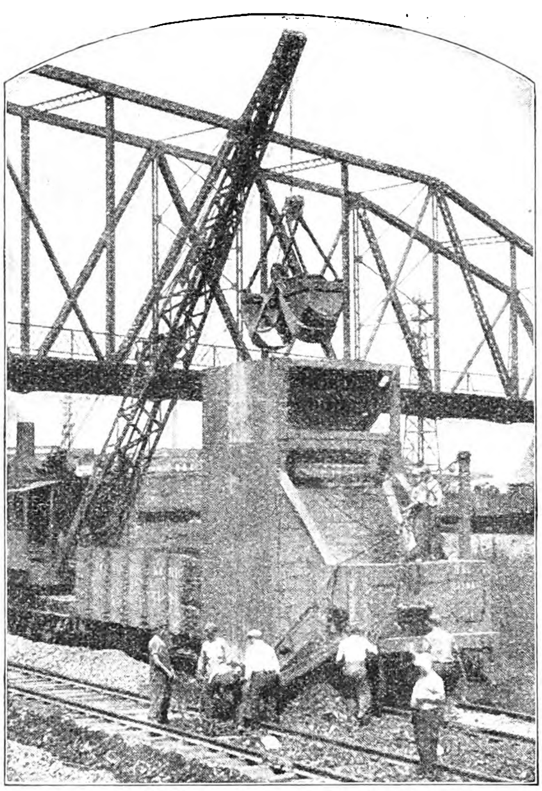
WITH the completion of construction, the work of the engineer is not finished. Wear and tear, increased by the constant demand for greater speed and heavier train loads, needs to be constantly remedied by replacements and repairs, which have to be made without interruption to traffic. This is the maintenance problem.

A slight insight into the magnitude of this important work may be gained from the following statistics covering the seven-year period of 1922–1928, inclusive, for the railroads of the United States:

Roadway and Structures

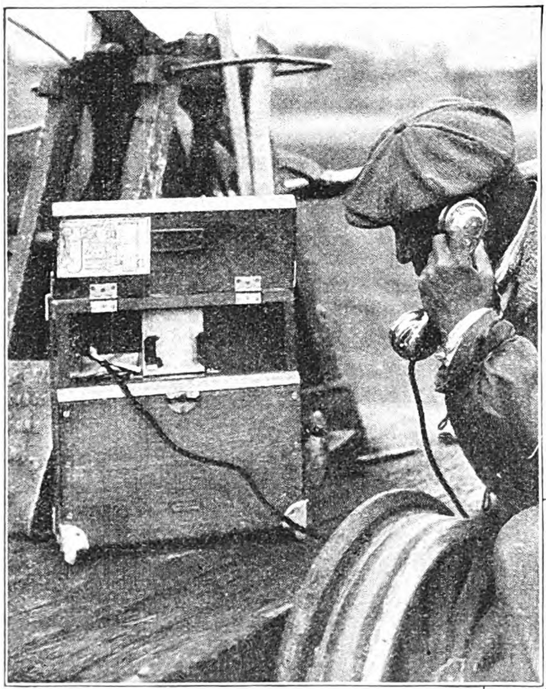
Additional track and track material	$ 843,981,000
Heavier rail	242,848,000
Additional ballast	85,879,000
Shops and engine houses	242,470,000
All other improvements	1,385,603,000
Total	$2,800,781,000

The annual program of maintaining a railroad calls first for the renewal or replacement of rails that have become worn. New rail is generally laid out of face—that is, uninterruptedly, without patchwork—in stretches of from one to five miles on main-line high-speed tracks. Local conditions and the amount of rail to be laid determine the methods to be used.



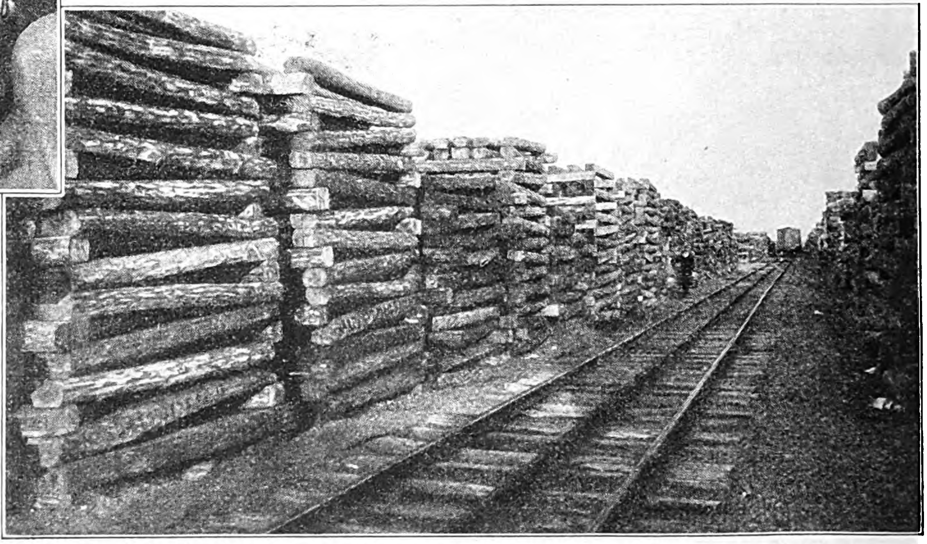
Fouled ballast must be cleaned in a special machine, after which it is replaced

Let us consider, as an example, the events of one day's work where a large amount of 130-pound rail was laid, replacing 100-pound rail. To organize this work thoroughly the supervisory forces determine from experience just how many men will be needed for each operation of work and how best to get the men to the point of work. Foremen are notified just what their men will be expected to do that day and come prepared with their tools. Further arrangements are made with the transportation department whereby the trackmen can have the uninterrupted use of this track for as long as possible.



Crews have telephones which are used to learn of train movements

Sufficient men are gathered so that each man can be assigned to a particular duty and to enable him to utilize the full work period. This eliminates the changing of tools and doubling men back and forth on the work. The operations are carried through in the following sequence: 1. Distributing new materials; 2. Pulling spikes; 3. Throwing old rail in about 12 inches from former position; 4. Removing old tie plates; 5. Plugging old spike holes in ties; 6. Adzing surface of ties to give a sound and level bearing for the new tie plates; 7. Placing new tie plates; 8. Setting new rail into place with a rail-laying machine. (This operation is frequently done with various types of cranes, some designed particularly for this work); 9. Placing joint fastenings and tightening two bolts per joint; 10. Spiking every 4th or 5th tie to proper gage; 11. Full bolting the joints; 12. Full spiking all ties; 13. Placing rail anchors to prevent change in the expansion space between rail ends from shifting the rails; 14. Installing bond wires connecting rails in automatic signal territory; 15. Throwing old rail out of track; 16. Disconnecting the old rail; 17. Assembling and classifying old material removed from track.



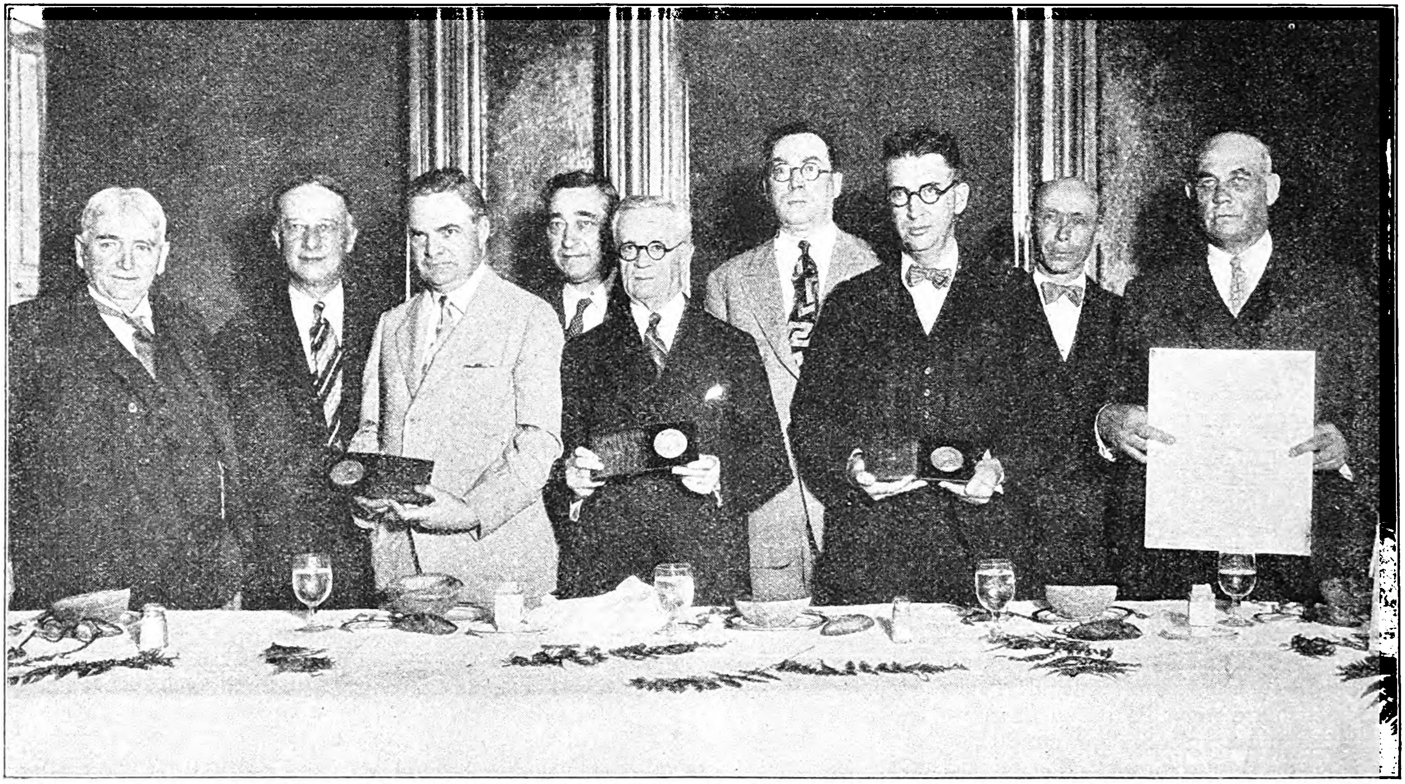
Railroad ties by the thousands are stored in piles ready for use in the laying of new track or replacing old ties. Most of the ties are chemically treated

In this manner it was possible to lay 20,000 feet of rail in one working day with a force of 120 men. With equipment now available, this force could be reduced, since in addition to the machine for setting in rails, there are power-driven adzing machines, power bolt-tighteners, and pneumatic spike-drivers.

Following the laying of the new rails comes the renewal of the cross ties and general rehabilitation of the track. Untreated ties decay rapidly and the average life is but from eight to nine years. With the general use of preservatives injected into the wood to check decay, the life of cross ties has been more than doubled. Ballast becomes fouled and blocks the proper drainage. To restore the drainage and re-establish the uniform grade line or surface of the rail, the ballast is cleaned and the track raised slightly so that fresh ballast may be impacted under the ties.

The rails themselves are subject to heavy wear at the joints because of the hammer blow delivered in the passage of the wheels from one rail to the next, battering out the metal at the joint and also the ballast under the ties. This causes a dip in the rail, referred to as a "low joint," which must be resurfaced and raised periodically. It is this condition that frequently limits the life of rail in main tracks.

More work is required on the maintenance of curves than on straight track, as the centrifugal force of trains passing over the tracks tends to force the weaker points out from the true circular curve, resulting in a bad riding condition. Such curves must frequently be remeasured, calculated,

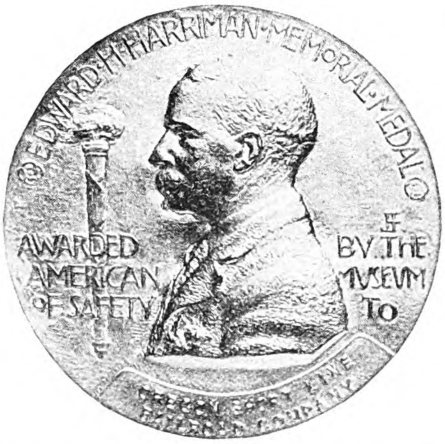


Winners of the safety blue ribbon of the rail. From left to right, front: Mr. Arthur Williams, President of the American Museum of Safety; Ex-Governor Alfred E. Smith, Trustee; Mr. H. J. Plumhof, Oregon Short Line Railroad Co., winner of the Harriman Gold Medal; Mr. J. P. O'Brien, Oregon-Washington Railroad and Navigation Co., winner of the Harriman silver medal; Mr. Earl V. Develer, Nevada Northern Railroad, winner of the Harriman bronze medal; Mr. R. H. Allison, Cleveland, Cincinnati, Chicago & St. Louis Railway Co., Honorable Mention, Group C; Mr. H. E. Trout, Conemaugh & Black Lick Railroad Co., Honorable Mention, Switching and Terminal Roads. Rear (left), Mr. J. F. Patterson, representing the Long Island Railroad, Honorable Mention, Group A; Mr. W. G. Curren, Staten Island Rapid Transit Railway Co., Honorable Mention in Group B

The Harriman Medals for Rail Safety

THE late Edward H. Harriman was a pioneer in railroad safety and the good work he started on his own railroad system is now, by reason of the Harriman Memorial Medals, carried on long after his death, Mrs. Harriman giving annually a gold, a silver, and a bronze medal for the railroad making the best records in their respective classes. The gold medal (group A) is given to the winning railroad in the "over 10,000,000 locomotive mile class"; the silver medal (group B) to the winning railroad in the "1,000,000 to 10,000,000 locomotive mile class"; while the bronze medal (group C) goes to the winning railroad in the "less than 1,000,000 locomotive mile class." The railroad in each group having the second best record receives an honorable mention. A fourth group "D" has been added this year to take care of switching and terminal railroads, by means of a proper certificate.

THE growth of safety on our railroads is most gratifying and the Harriman Memorial Medals furnish a great stimulus to renewed endeavor. The award is based on the records of the Interstate Commerce Commission, interpreted by the aid of carefully worked out formulae. In 1929, 157 Class I railroads carried 148,379,000 passengers a total of over eight billion passenger-miles, without a single passenger fatality. Deducing an analogy from these figures, one passenger, traveling continuously at a speed of 50 miles an hour for 183 years, could travel 32,000 times around the earth without accidental death.


EDWARD·H·HARRIMAN·MEMORIAL·MEDAL
AWARDED BY THE AMERICAN MUSEUM OF SAFETY TO

The medals were awarded at a luncheon on June 24th given by Mr. Arthur Williams, President of the American Museum of Safety, that makes the awards. A very distinguished company of railway men attended. Ex-Governor Alfred E. Smith, a trustee of the Museum, made the presentations. The Committee of Award is as follows: Arthur Williams, Chairman; Samuel O. Dunn, Editor, *Railway Age;* Charles M. Schwab; Hon. Frank McManamy, Chairman Interstate Commerce Commission; Lew R. Palmer, Secretary; F. D. Underwood; and A. A. Hopkins, member of the staff of the SCIENTIFIC AMERICAN and Director of the Museum.

The Harriman Memorial Medals are awarded for safety on railroads

FOR THE UTMOST
IN SAFETY AND ACCIDENT PREVENTION

OUR POINT OF VIEW

Machinery and Unemployment

THE blame for unemployment has always been placed, more or less, upon machinery and, in times past, labor has fought its introduction into industries where handwork had been the rule. Even at the present time, there are numbers of pessimists who deprecate the increasing use of machinery and lugubriously point out that it is a Frankenstein monster. Their memory is short; they have been told time and again of the wage earner's gain through machinery, but they seem never to learn. Thus it is necessary to repeat.

Machinery made it possible for one man to do, in 1925, what 3.1 men did in 1914. Thirty years ago, 200 unskilled workers were required to do the work now performed by one steam shovel. In the glass industry, one machine takes the place of 600 skilled glass blowers of a few years ago. In 1920, there was perfected an automatic machine for producing electric light bulbs, that displaced 994 men; and recently this machine has been so improved that it now displaces something like 2000 men. Many other cases are as strikingly significant.

From these figures, it would seem that the pessimists' assumptions are correct. They're not. The number of wage-earners increased 3 percent during the eight years between 1919 and 1927, but—and this is far more important—our production increased 50 percent! With increased industrial prosperity, better wages have been possible and at the same time the worker has been freed from the bondage of labor. Working hours have been cut down: first from a 12-hour day to a 10-hour day, then down to eight hours, and now proposals have been made to make a further cut to six hours. The workingman's week was cut down from six to five and a half days, and it is now proposed to cut it to five.

Better pay and more leisure in which to enjoy the fruits of his work—these are the dividends of the American wage-earner. There is bound to be some temporary unemployment caused by machinery, but this is in an unimportant proportion to the benefits accruing. Nevertheless, certain adjustments are necessary, and it is up to the workingman himself, as well as to industry, to study the question thoroughly so that, as more and more machinery is put into operation, these adjustments may be made with the least loss and an economic balance may be reached.

Sir Arthur Conan Doyle

AFTER an illness of two months, Sir Arthur Conan Doyle died of heart trouble at his home in Sussex, England, on July 7. Famous throughout the world as the creator of that super-detective of fiction, Sherlock Holmes, he was in late years a diligent student and an ardent believer in spiritism. Considering this as a sort of religion, as "infinitely more important than literature, art, politics, or, in fact, anything else in the world," he was annoyed that he was known chiefly for his creation of Sherlock Holmes, and grieved because his friends did not share his unfaltering belief in the spirit world.

Sir Arthur was interested in writing from earliest childhood, having written his first book at the age of six and achieved fame as a story-teller among his early school-mates. His later education was in medicine and he was a practicing physician for several years. His first recognition as an author came when he wrote "Micah Clarke," in 1888, a year after his first volume of Sherlock Holmes; and he won his knighthood with his apologia for the Boer War. The loss of his eldest son in the World War was largely responsible for his devotion to spiritism during his later years.

Sir Arthur was for many years a reader of SCIENTIFIC AMERICAN; and while our opinion relative to psychic, or spiritistic, phenomena, differed from his, we always counted him one of our firmest friends. It may be supposed that the untrammeled imagination which created the greatest detective of fiction "created" much of the spirit world of which he has been called a sort of "Bishop," but that may be countered with the argument that perhaps the practical, analytical mind that worked out Sherlock's crime solutions discovered truths still unknown to many of us. As yet we are not ready to admit either; we are open-minded.

All But the Rattle

EARLY this year it was announced that certain automobile manufacturers would, during 1930, junk old cars up to a value of around 15,000,000 dollars. It was explained that this procedure would have several benefits. First of all the removal of derelicts, still on wheels and a menace to other cars on the road, would prove a blessing to motorists. Manufacturers also said that these rattle-traps undermined their replacement market and their removal would measurably increase sales—a mere matter of 15,000,000 dollars being small compared to the expected sales of 4,000,000 cars at around 3,500,000,000 dollars. Then, too, junking by the manufacturers would decrease the number of old cars that are yearly abandoned along roads to become eye-sores. The plan was heralded as one of the shrewdest moves the automobile industry had ever undertaken.

In the SCIENTIFIC AMERICAN Digest of this issue, our readers are given the first story of how this junking is done. In the Ford plant, the process turns out to be a salvage job in which, with characteristic thoroughness, Henry Ford saves all but the rattle of derelict cars. And although it is said that the salvage per car is 14 dollars, our opinion is that it is more, that the Ford company actually makes money on the proposition.

Other manufacturers no doubt are junking many cars also, but so far we have no details. Those who are not would do well to follow their lead for, aside from all other considerations, the job of salvaging metal in this wasteful country is well worth while and may in time be a vital necessity.

International Affairs

THE INTERNATIONAL BANK

THE beginning of the Bank of England during the reign of William III was modest indeed, and the most far-seeing financial genius of that era could not have predicted its future or imagined the tremendous effect it would have on England's and the world's commerce. And today as we listen to the advocates and opponents of the International Bank established to facilitate the settlement of war reparations, we suspect that even the brilliant financial leaders that conceived and boldly sponsored this world bank, and the more conservative bankers who sincerely oppose this new venture, could not gather together and jointly form a reasonably adequate conception of its future effects on world trade and world relations.

That it will be a success, granting reasonably proper management, is a foregone conclusion; that it will become a ponderous financial fly-wheel, steadying world trade and stabilizing foreign exchange, seems probable even to financial laymen; that it will become such a prize that its control will gradually become another bone of

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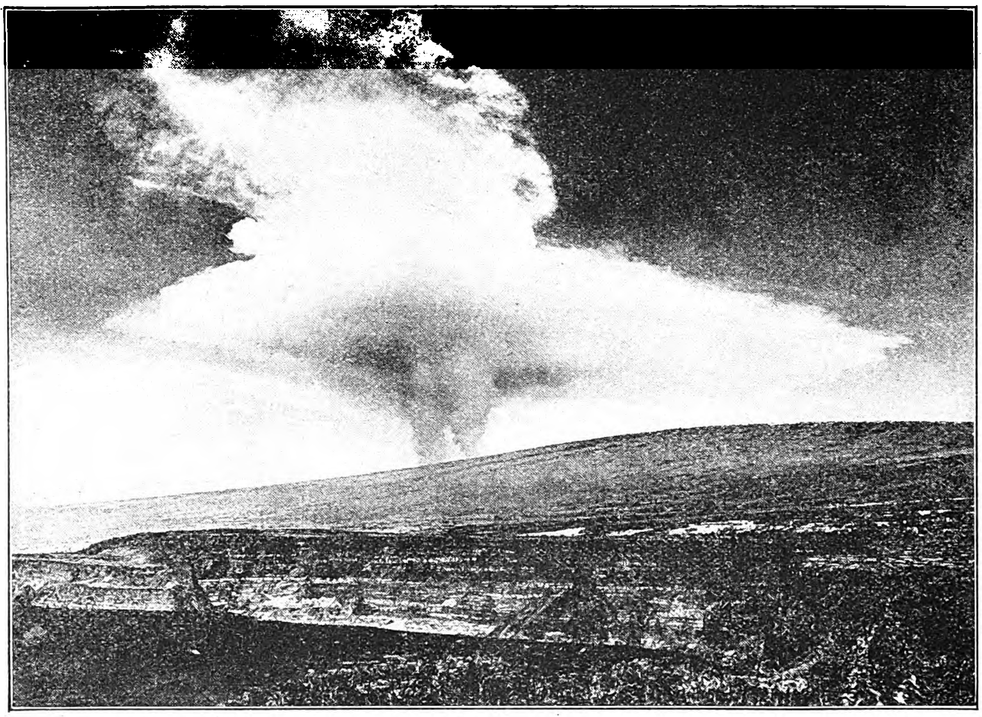


Outburst of Mauna Loa as seen from Kilauea Observatory at 8:30 A.M., May 19, 1916, photographed by Dr. H. O. Wood. This was referred to at the time as the "ballet girl" stage of the eruption. The two legs of the fume column were about two miles apart where the gas rushed up from different places along the southwestern rift of the volcano. A few minutes later they merged into one and the action became stronger. Later the rift opened and gave vent to a lava flow. The distance from the observer is about 25 miles. Kilauea crater in the foreground

Volcanology

What Is Being Done to Make the Observation of the Earth's Internal Fluids an Experimental Science

By T. A. JAGGAR
Volcanologist U. S. Geological Survey

IT may seem strange to many people to learn that the recent campaign suggested by the SCIENTIFIC AMERICAN for interesting amateurs in seismology promises to be of great assistance to volcanology. What is volcanology? A tourist, who recently visited Kilauea Volcano in Hawaii while it was sleeping, expressed the popular viewpoint. He saw the observatory and learned of the existence of a volcanologist. "What a cinch," he remarked, "nothing to do but wait for an eruption!"

It had never occurred to him that some of the fundamental processes of volcanology are happening under Iowa at his home town. It had never occurred to him that possibly the recent Mississippi flood with its losses of three hundred millions of dollars is not unrelated to the forces that made the New Madrid earthquake in 1812. The science of the earth is all one thing whereby the continents rise, erosion carves out the valleys, sedimentation fills the mediterranean seas (of which the Gulf of Mexico is one), and the sea bottoms lower. There is a shift of matter under or within the crust of the earth from the heavier regions to the lighter. There is every reason to suppose that this matter is magma, which makes the intrusive rocks at the core of our mountain ranges, or the lavas which pour out at volcanoes.

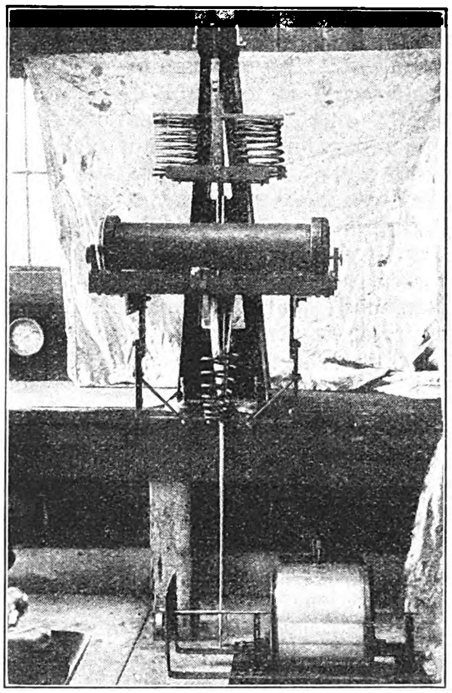
VOLCANOLOGY is concerned with the movement of magma. This movement is going on all the time somewhere, rapidly in some places, slowly in other places. It is probably much more important to mankind in its buried movements underground than in its visible movements at volcanoes. These buried movements and shifts of magma lift the mountain ranges at the sources of the Mississippi, lift shore lines in California and Japan, are somehow concerned with the scorching heat under the steam power plant at Geyserville north of San Francisco, and the high temperatures of our deep oil wells, and play their part in the stresses that make big earthquakes.

Science is gradually learning that what is happening under your home town in Montana or Pennsylvania or Louisiana, at a depth of about 35 miles, is equally important with what is happening in the air 30 miles above you. The aviators and the radio people need all possible knowledge of the air. The geologists need all possible knowledge of the earth and the relations of its gases, pastes, and solids. We explore the air with balloons and radiation. The oil people are beginning to explore the earth with echoes, conductivities, magnetic needles, and torsion balances. Volcanology needs the assistance of amateurs to microscope the tiltings and tremblings of vast continents, because without them the job appears to be too big, even for the government.

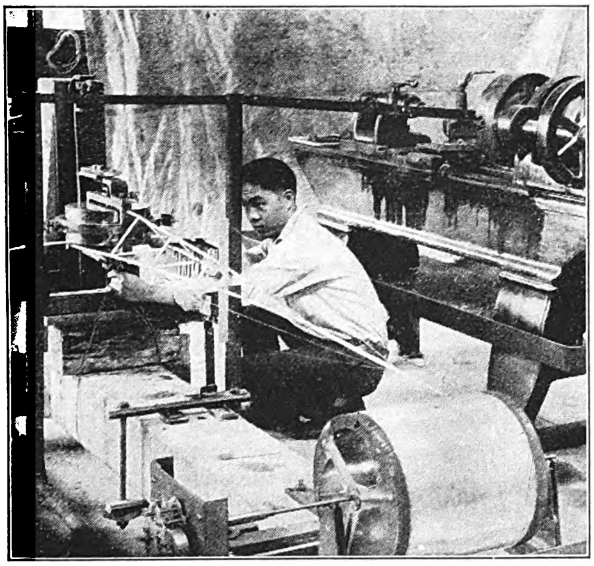
This makes volcanology something very different from what you thought. Nevertheless, the study of volcanoes and volcanic eruptions is a part of the game. For volcanoes have the advantage that they lie over places where the earth crust is thin, where the ground is hot close to the surface, and where the lava may sometimes actually be seen emerging. In a general way all the active volcanoes of the present day lie at places where there was much greater volcanic activity in

Tertiary time. That is, there are more extinct volcanoes at the volcanic districts of the world than there are live ones. Volcanism today is decadent. In the economy of the earth there have been geologic ages representing big cycles when the crust heated up and cracked, and volcanic magma poured out. The Miocene Tertiary was the last of these.

Decadent volcanism, however, in a volcano belt does not necessarily imply decadent magma underground. The magma underneath a chain of volcanoes may be engaged in processes of intrusion at the present age in a fashion much more lively than that which underlies Iowa and Pennsylvania. If we can make our instruments sensitive enough to show the same kind of motion under both Hawaii and Pennsylvania, but quantitatively greater in Hawaii, we are creating a science of volcanology wherein nobody has to wait for "eruptions." The popular conception of an eruption as something violent, steamy, and explosive is based on a very occasional happening at volcanoes, not at all characteristic of that flow of magma which has done most of the building of the great volcanic lands of the world. Volcanoes show us magma flowing out as lava, and a sensitive pendulum set up on a volcano shows us the ground tilting and trembling as a result of the magma spreading underground as an intrusive, or escaping elsewhere as an outflow. This is what makes a volcano so valuable as a natural laboratory. If we may correlate the physics of the ground with visible flow of magma, we may then go elsewhere and interpret underground flow of magma from measurements of the physics of the ground.



An experimental seismograph built in the shop of the Hawaiian Volcano Observatory, on designs by the author, for registration of the vertical motion of local earthquakes. The heavy mass weighs 160 pounds and is supported by spiral springs designed for compensation of temperature effects. The registration apparatus is the long, aluminum arm protruding downward, here not shown in its proper relation to the writing pen on the chronograph drum. In operation, the drum is coated with smoked paper and makes one revolution in 30 minutes. When properly placed, the tip of the boom connects with the short arm of the stylus, the pier is mounted on a concrete table in a quiet cellar, and a time-marking apparatus lifts the pen tip once a minute, while the chronograph drum moves along on its spindle. The action of the earth lifts the pier at a horizontal hinge line around the heavy mass acting as a center of percussion



Shaking table with horizontal pendulum seismograph mounted on it, at the Hawaiian Volcano Observatory. This machine is to make artificial horizontal earthquakes with the aid of a lathe chuck. The connecting rod at the lathe has its motion reduced at the two upright levers which rotate on the floor, two steel rollers under the table containing the seismograph. Any quick period required may be given to the apparatus by means of the lathe gears, and the amplitude is made to imitate local earthquakes. A series of tests compares the actual and theoretical magnification of the seismograph as recorded by the pen writing on smoked paper on the drum. Both drum and pendulum are attached to the shaking table. In this way seismographs made in the shop may be calibrated artificially in order to learn how they will behave under earthquake impulses. The shaking table was designed by the geodesist R. M. Wilson

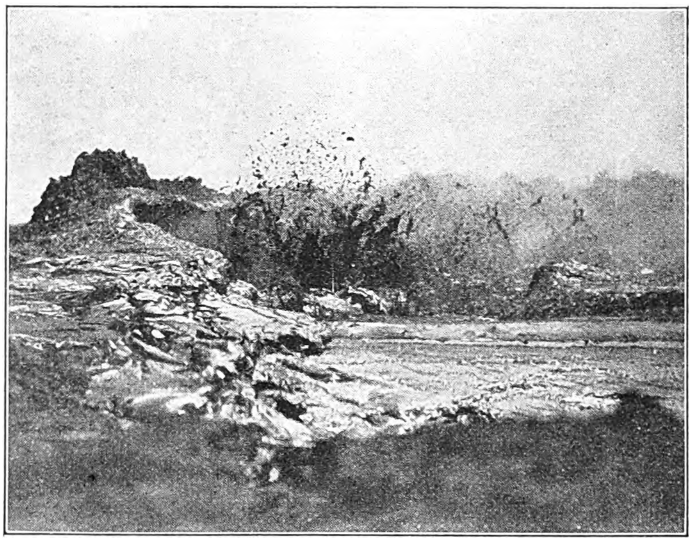
THE original study of volcanoes began with human necessities. Bad eruptions happened at Vesuvius, and the meteorological observatory there turned its scientific work in the direction of keeping a journal of what the volcano was doing. A bad earthquake happened at Naples, and Mallet made some interesting studies of how the buildings were thrown down in relation to a supposed center of bumping underground. The buildings were cracked at right angles to lines extended out in all directions from the center of the shock. If this theory worked, then a building right over the earthquake center, or at the epicenter, ought to be jolted straight up and down, and cracked horizontally. A building far away to the east of a shallow center should be broken vertically along north and south cracks.

If earth movements were as simple as this, the study of earthquake sources would soon become an open book. It was originally thought that steam explosions and collapses underground accounted for earthquakes near volcanoes. Then it was argued that these things are very small, and that volcanic earthquakes are very small. When a very big earthquake happened, like that at Messina, near Mount Etna, it was argued that this could have nothing to do with the volcano, because the volcano did not erupt at the same time. Geological text books have rung the changes on this argument, distinguishing between tectonic and volcanic earthqakes. Tectonic earthquakes are supposed to be crustal movements that have nothing to do with magma, but are occasioned by expansion or contraction or pressure such as are involved in the world forces which build mountain folds and faults in strata. The modern volcanologic viewpoint is that earthquakes occurring at an active volcano may be large or small, shallow or deep, usually occur at faults and not at craters, and represent forces which may be either tectonic or magmatic, according to the way in which those terms are defined. As we have magmatic movements of intrusion and continental balance under the mountains, and as we have crustal movements of pressure, expansion, and contraction under the volcanoes, and as nobody knows what makes an earthquake anyway, the guess of every amateur seismologist is just as good as the next man's.

Between 1891 and 1923 there grew up in Japan a science of field seismology led by Dr. F. Omori. Japan is a land of earthquakes and volcanoes mixed together. Dr. Omori devoted himself at first to devising seismographs and spreading them among the meteorological stations of Japan. He measured thousands of earthquakes. Very exceptional earthquakes were accompanied by big fault cracks, the sides of which moved up or down or sideways. Geologists have the habit of pouncing joyfully on these exceptional ones and concluding that the accumulated stress in the rock at the side of the fault crack was released when the fault gave way and that this yielding to accumulated stress is the usual cause of great earthquakes. Oldham, a distinguished geologist of India, has combated this notion with the argument that the stress is developed very suddenly in the deep region. Omari found out that earthquakes are far from simple, that big ones may occur in the midst of a big volcanic eruption, or near a big volcano not in eruption, or in a district not recently volcanic at all, and that some of these earthquakes have obvious fault movements and that some show no obvious faults at all.

THIS last fact had been observed by Oldham in India, by the Americans at the New Madrid earthquake of 1812, and by Major Dutton at the Charleston earthquake of 1886. Omori came more and more during the last fifteen years of his life to devote himself to the study of volcanoes, for he saw that there is an infinite series of earthquakes, small to great, somehow related to magma. He and his successors have learned in Japan that both volcanic eruptions and strong earthquakes are accompanied by topographic changes of elevation of the land. In using the expression "volcanic eruption," in this sense, the reader should remember that flow of magma is meant. A big gush of explosion with ash and steam is not essential to a volcanic eruption, and a retirement of lava straight downward under a volcano crater might be accompanied by a very important "eruption" or flow of magma. In this case the eruption would be a flow of lava from a rift under the sea which nobody would notice, unless the volcanologists were using their wits. And seven tenths of the geology of the earth is under the sea.

In 1911 an observatory was started at Kilauea Volcano in Hawaii, which the writer has had the honor to operate. This also was influenced by the humane viewpoint, for the terrible disasters at St. Pierre, Vesuvius, Jamaica, Messina, Etna, and Costa Rica had induced donors to create an endowment in the Massachusetts Institute of Technology for geophysical study that might lead to amelioration of conditions in earthquake lands. The observatory was started by the Massachusetts Institute and carried on thereafter by the Hawaiian Volcano Research Association assisted by the government. The Hawaiian Volcano Observatory kept a diary of everything that happened at the Hawaiian volcanoes and measured everything that was measurable within the limit of funds at its command. The volcanoes were mapped, the Kilauea lava pit was mapped again and again as its lava topography changed, leveling circuits were occupied repeatedly, a seismograph station was set up at the crater and afterwards supplemented with other stations about the island, and experiments were inaugurated.



Southeastern corner of the lava lake of Kilauea, March 19, 1921, at 2 P.M. A cauldron sink-hole against the pressure ridge at the edge of the pit had formed, and the lava was rushing toward this place and being sucked down in the convectional circulation. Single jets of lava shot up by the escaping gas were 40 feet high. The torrent on the right is rushing into the cauldron, and a rampart is being built up in the background. This was a crisis of high rising when the fire-pit overflowed and the gas pressure was enormous. Photo by the author

THE experiments proved, by the use of different kinds of thermometers and pyrometers, that the liquid lava grows hotter from below upward, just as it grows more foamy from below upward, as the bubbling gases are released from solution in the melt beneath. This melt is very dense under pressure down deep, and as the gases escape to the bubble form under release of pressure, they react with each other and with air to produce combustion of hydrogen, carbon monoxide, and sulfur gases along with rise of temperature. A lava eruption is thus a heating expansion of slag foam. This was a new idea. When this basaltic foam spreads out in the crater or beyond, in contact with atmospheric temperatures, it freezes, and in the crater pits it is engaged in an incessant struggle with congealing cold.

The topography of the top of the live lava column in Kilauea Crater becomes diversified into crags, floors, and lakes of lava. A series of experiments with steel pipes was initiated whereby it appeared that the liquid lakes are only 40 or 50 feet deep, with wells and tunnels feeding them. These wells and tunnels are not in the solid rock of the mountain, but form a honeycomb in the partially hardened lava that underlies the crags and floors. This hardened lava column is red hot and pasty, with tubes leading up through it to the shallow saucers of foamy lava on its top, while somewhere down deep both the pasty lava and the liquid merge into the very stiff primitive rising lava, under great pressure, and with the gases in complete solution.

THIS primitive stuff nobody has ever seen. When it is released from pressure to froth into the region of man's ken, it changes, heats, gassifies, and oxidizes to a glassy foam mixed with burning gas which may be very unlike the mother magma. The partially congealed refuse of this makes the lake bottoms, crags, and floors, and this paste rises and falls majestically as the main lava column in the pit, with the liquid lakes rising and falling at about the same rate on top of it, but with small differences between the two from day to day. The discovery of the difference between bench lava and liquid lava was another new idea.

With all this rising and falling, measurable with reference to the bench marks on the edge of the crater, it became of interest after 15 years of work to see how the curve of up and down compares with past curves. It was well known from the work of the devoted missionary Coan in the middle of the 19th Century, that Mauna Loa had more than a dozen outpourings of lava in great streams sometimes 60 miles long, and that Kilauea had lava in its pit most of the time. There had been some hint of a cycle about nine years long. The Hawaiian Volcano Observatory uncovered a cycle between 1913 and 1924, eleven years long, with the pit very deep and inactive at both ends of this time. Moreover, the lava rose from 1913 to 1919, sank from 1919 to 1924, and crashed down with a great engulfment of the walls of the pit in the last named year. Along with this culmination of 1919, Mauna Loa showed increasing eruptions in sympathy with the Kilauea cycle. The 11-year period was compared with what is known of the 19th Century, and it was discovered that the high levels agree very well with years of maximum sunspots, and that 12 cycles of 11.1 years each from 1790 to 1924 agree better with the facts than the older conception of a nine-year cycle. It happens, too, that this is just the sunspot average.

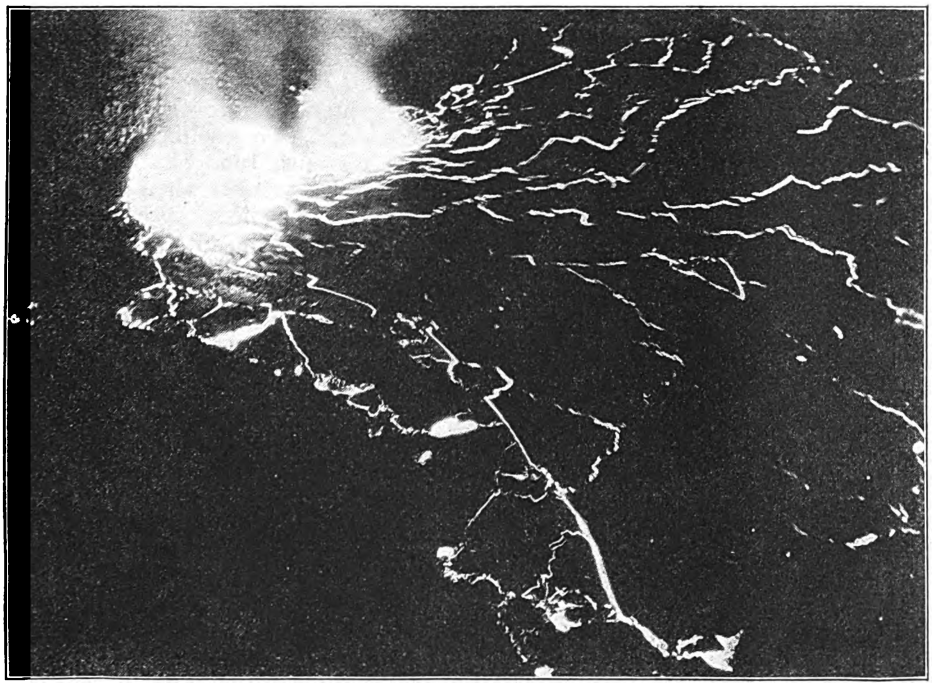
THE facts indicate that Mauna Loa and Kilauea alternate somewhat, and that there is a greater cycle 134 years long during which the lava of the entire Hawaiian system rose to a culmination of outpouring about 1855, declining thereafter until 1924, when there was an explosive eruption at Kilauea, and very probably a submarine lava flow under the deep sea off to the east. The supercycle had followed an explosive eruption at Kilauea in 1790, and this larger in-interval of something like 130 years corresponds to similar periods in Japan and Italy elapsing between great earthquakes or great volcanic eruptions at the same place. It is reasonable that magma should move in waves of accumulated gas pressure and release, and also there may be astronomical controls in these cycles.

The volcano seismographs at Kilauea have indicated thousands of earthquakes, and by comparing the records with those of the secondary stations and with the reports of felt earthquakes at habitations, it has been possible to locate groups of earthquake centers. These have often corresponded fairly well with known volcanic fissures or faults, sometimes when the fissures in question broke into eruption and gave vent to lava flows. The earthquake centers rarely correspond with summit craters. Often the earthquakes, registered by a pendulum and a pen writing on smoked paper, are accompanied by a swinging off of the pendulum to a new position after the earthquake. This means that the ground has tilted during the earthquake. These tilting movements have been compared with changes of level of the country as proved by geodetic levelings. It has been discovered that Kilauea Mountain rose more than two feet while the lava was rising in the seven years following 1913, and sank by a similar amount during the explosive engulfment of 1924. And the pendulums indicated the actual months of maximum tilting, as corresponding with times of maximum lava pressure and lava withdrawal.

All of this means that land underlaid by magma is subject to swelling and shrinking forces, and it will prove increasingly fascinating to harness these forces with simple instruments and volunteer observers until the centers of motion, and the relative motions of different places, have been discovered. To anyone who has worked where these motions are rapid and strong, as on Hawaii, it appears that the geographical facts of distribution of motion, in relation to volcanic centers, are much more needed than precision work at one place. That is where the amateur and volunteer will come in, and consequently the simplification of instruments appears to the writer to be the most important need of seismology.

What is the use of volcanology? On the answer to this depends in part how we ought to attack the science. If we are interested in theories of the earth's internal elasticity, of its heat, of its gases and radioactivity, and care nothing for the effects of volcanic eruptions and earthquakes on mankind and his cities, we should devote ourselves wholly to precision laboratories with only minor attention to geography. But there comes into the argument the Mississippi flood, the devastating tidal waves, the failure of gigantic engineering works at times of great earthquakes, and destruction of cities such as St. Pierre. If a great insurance company were to create a research laboratory of volcanology to solve company problems, what would they demand? They would certainly demand, first, attention to engineering and to geography. In other words, the human need for a science of eruption, of deformation, of sedimentation, and of erosion calls for field laboratories eternally measuring by observatory methods the quantitative aspects of those processes. All the processes are tied together as affecting the pipe lines, dams, railways, farms, cities, roads, bridges, wharves, levees, aqueducts, wires, harbors, and fills on which human beings have spent billions of dollars.

AS it is, the science of volcanology, quite apart from volcanoes, is the forerunner of a new science of the earth, which at this moment in America is being greatly assisted by the new flood-relief measures carried out by the government on a gigantic scale on all the rivers of the United States. Probably few people realize that this study of earth process is the pioneer of a science of geonomy, the workers of which will be geonomers living at observatories and actuated by the same spirit as astronomers. Erosion science has hardly been touched, yet mountain canyons are falling down all the time and their wreckage is being swept to the ocean. It is a marvelous opportunity for new measurements and new instruments. Mountains are heaving up, continents are tilting, flood plains are shifting, waters are muddying and clearing, bays and lakes are filling, the bedrock is shaking and, under all, the magma is welling under the crust of the earth, warming the hot springs, heaving the hills, and accounting for a hundred unmeasured phenomena up and down the Pacific Coast and Alaska, as well as in Arkansas, Virginia, and the Adirondacks. With simplified instruments and hundreds of amateurs, we may expect the natural history of the earth to take a new lease on life.



Night photograph of a live lava lake in the bottom of Halemaumau pit at Kilauea Volcano, July 25, 1929, at 9 P.M. It shows the bright lines on the surface of a crusted pool of lava, and the great luminosity of fountains flaming during an eruption in which a fountaining lava grotto similar to the one on the front cover furnished the molten matter which sweeps over the pool

Why Stars Twinkle

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

PROBABLY the first thing that many of us learned about the stars was that they twinkle, and the fact is obvious enough to deserve its place in the nursery classic. But does any grown-up, except perhaps an occasional minor poet, notice the phenomenon—and in particular what have the astronomers to say about it?

As a matter of fact the professional observer habitually scans the twinkling lights of heaven as he walks toward his telescope and the more they twinkle the less is he pleased. Whenever the brightest stars, though low down in the sky, twinkle but lazily and those higher up shine steadily, he anticipates a good night's work. But on our clear snappy winter nights, when the wind roars overhead and the brilliant stars are dancing and flickering, he hopes for little or nothing; and after one glance through his telescope he may even shut up shop and go home to bed.

For the twinkling of the stars is the best test that the unaided eye can make of what is technically called the "seeing"—that is, of the state of the air through which we must look. The late Professor Young, translating literally and with his characteristic jocular humor from some French book, used to repeat to his students, "The earth's atmosphere is the astronomer's black beast" and a *bete noire* it surely is.

FORGET for a moment the clouds, fogs, smoke, and rain which so often blot out the heavens altogether and think of the limitations which even clear skies impose. Could we astronomers but live without breathing, and escape for our working time to an airless world, our lot as observers would be a happy one. With nothing above us to scatter the sunlight and veil the heavens with blue sky, we could see the stars as well by day as by night—and photograph them too. The solar corona could be observed at any time merely by hiding the sun's disk by a suitable screen placed in front of our telescope, instead of waiting years for a total eclipse. Best of all, our spectroscopes could get at the far ultraviolet parts of the spectrum of the sun and stars, which is utterly and hopelessly cut off by the absorption of light of this sort in the upper atmosphere and which probably contains more things of astrophysical interest than all the parts that we actually can observe.

But let all this pass again and write it off as hopeless, even to dream of. Even so, the cloudless sky still is too often our worst enemy. The atmosphere is lamentably far from being optically satisfactory to look through. It refracts light, which would not be a serious matter if it were only homogeneous—but this it never is. The air is full of streaks and patches of different temperature and unequal densities, which are carried along by the wind and churned into a still more turbulent complexity wherever the wind is puffy or where winds blow in different directions at different levels. Large scale disturbances of this sort are often directly visible as dust whirls near the ground, or as the long parallel streaks of cloud in the "mackerel sky." They are all too familiar to the airman, too, as the "bumps" which make flying uncomfortable and occasionally even dangerous.

THESE larger irregularities are not always present, fortunately for the astronomer, but the smaller ones are always there and make trouble enough. Looking through them is, on a smaller scale, like looking up through running water or the rippled surface of a pool. Every streak of denser or thinner air, like the crest or trough of a ripple, acts as a lens would do to concentrate or spread out two originally parallel rays of a star's light. If only the starlight was strong enough, said Young many years ago, we should see on a white surface illuminated by it a moving pattern of lighter and darker patches resembling that formed on the sandy bottom of a pond when the sun shines on its rippled surface.

This prediction can be verified by anyone with keen eyesight who takes the trouble to find a dark room with a window free from all disturbance from artificial lights and let the light of Sirius come through the window (stopped down to a couple of feet square) and fall on a white sheet a dozen or more feet away. Until his eyes are fully adapted to the pitchy darkness, which will take 15 minutes or more, he will see very little. But then he will find that the patch of starlight on the screen is distinctly visible, even for considerably fainter stars, while for Sirius it is bright enough to exhibit the shifting lights and darker patches which Young predicted. Now imagine an observer looking through a hole in this screen. As the brighter or fainter patches pass over it he will see the star increase or diminish in brightness. In other words it will *twinkle* and of course it will do so just the same if the screen is not there.

We see now, not only why the stars twinkle, but why their twinkling gives really valuable information to the astronomer regarding the state of the air—much better, indeed, than could be obtained by looking, even with the sharpest eyes, at a screen illuminated only by the feeble light of Sirius. It is clear, too, why stars high in the sky twinkle less than those lower down, for the rays of the first traverse a smaller thickness of air and so pick up less trouble.

Why bright stars seem to twinkle more than faint ones is not so obvious, the explanation being that rapid changes in the fainter object are less conspicuous to the eye than in the brighter one.

NO explanation is needed why the stars twinkle more on a windy night than on a calm one. Indeed, when they twinkle violently on a night when there is a calm or a light breeze at the ground it is very probable that it is blowing half a gale higher up.

It is obvious, too, why terrestrial lights usually twinkle when seen at a distance of some miles, especially when seen through a wind or across ground from which heated air is rising, or from the deck of a moving steamer—as the writer has this moment seen the lights of a Greek seaport, twinkling furiously.

The planets do not twinkle, at least under any ordinary circumstances—which affords one of the simplest rough-and-ready tests by which the novice may distinguish them from the stars. The reason again is simple. The planets, unlike the stars, show disks of considerable angular diameter. The lines along which light enters our eye from different parts of the planet diverge when followed backward. The rays from opposite sides of Jupiter, for example, which enter the same eye were more than a foot apart a mile farther back on their course. If we could isolate the light from any one small portion of the planet it doubtless would twinkle, but the different parts do not keep step in their twinkling and so the whole amount of light received by the eye does not change perceptibly. That this is the true explanation is shown by certain exceptions which prove the rule. Mercury, which shows a small disk, often twinkles, and so may the larger planets when seen near the horizon through turbulent air.

A star, when it twinkles, changes not merely its brightness but its color, especially if it is at a low altitude. How great these changes are is not generally realized because they usually happen too fast for the eye to follow. A simple device reveals them. Look at the star with an ordinary field glass and swing the glass rapidly with a sort of conical motion (a thing easier to do than to describe in a few words) so that the star appears to follow a rough circle within the field of view. If the motion is fast enough the luminous point will appear to be drawn out by the persistence of vision into a curving line of light. A star which is not twinkling gives a uniform line but one which is, shows a surprising variation both in the intensity and color of the light. On a night of bad seeing the luminous line is beaded with patches of brilliant color, almost like the flashes from a diamond. When the glass is held still the successive changes, which may follow one another 20 times a second or more, become partially though not wholly fused into the familiar flickering image.

THIS remarkable and beautiful phenomenon was first explained by the Belgian, Montigny, more than 70 years ago, but it still is not as widely understood as it ought to be, and the writer owes the account which follows to the excellent Italian treatise of Professor Armelline of the University of Rome.

Owing to the refraction of light in the atmosphere the rays of starlight which traverse it are not quite straight, but are curved slightly downward as they go deeper. Blue and violet light are refracted more than red and yellow, so that the corresponding rays are more curved. If, then, we have a streak of air high up which, for example, acts as a convex lens, the red and blue rays, though both concentrated into bright patches of starlight on the earth's surface, will pursue paths of slightly different curvature and will not reach the earth in the same spot. If, then, we could see the patterns cast on the surface by the red and blue light separately, we would find them very similar in design but shifted laterally with respect to one another.

FOR a star in the zenith, indeed, the rays would come down straight and there would be no shift, but in all the cases the red and blue patterns would be out of register by an amount increasing as the star's altitude diminished; and also of course the higher in the air were the regions which produced the pattern. The actual light pattern would be very complex, composed of patterns of all colors, some more out of register than others. But it is evident that, from point to point in it, any given color might happen to be intensified, and any other (not too nearly like the first) might be weakened. The resulting pattern would therefore be irregularly and sometimes strongly colored and as it drifted past an observer's eye the star would appear to change in color as well as in brightness. There can be no doubt that this is the true explanation. It is confirmed by the fact that conspicuous changes of color appear only in stars at a low altitude, for which the curvature of the rays is greatest.

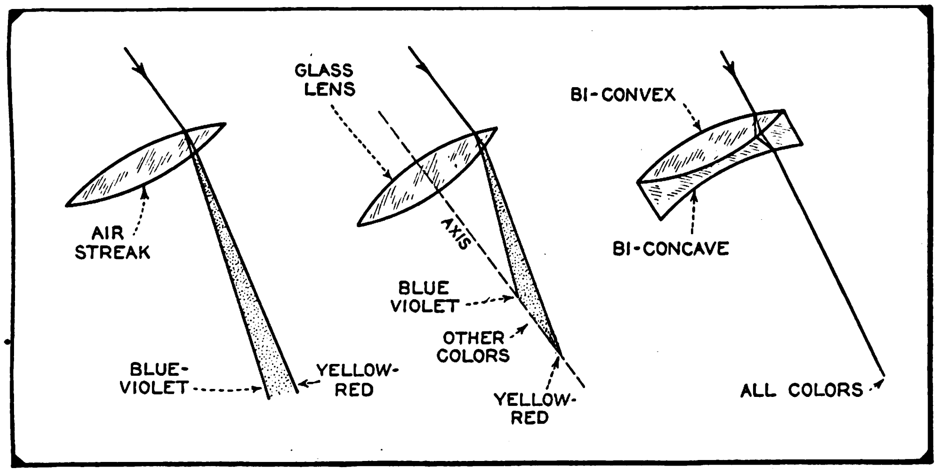
When viewed with a telescope, especially a large one, the appearance of a twinkling star differs greatly from that which it presents to the eye. The changes in brightness and color are far less conspicuous, but the star images at times of modest disturbance appear to shift and dance irregularly about. When the seeing is really bad the image is distorted and refuses to come to any sharp focus, but is continually "boiling" and shifting; and sometimes it "explodes" into a diffused mass of considerable size.

All these effects again are readily intelligible. The rays which strike different parts of the objective of the telescope and are brought by it to one focus have traversed different paths within the atmosphere, so that some of them may be weakened at any given moment and others strengthened. The changes in brightness of the integrated image are therefore pretty well ironed out, and the same is true of the color.

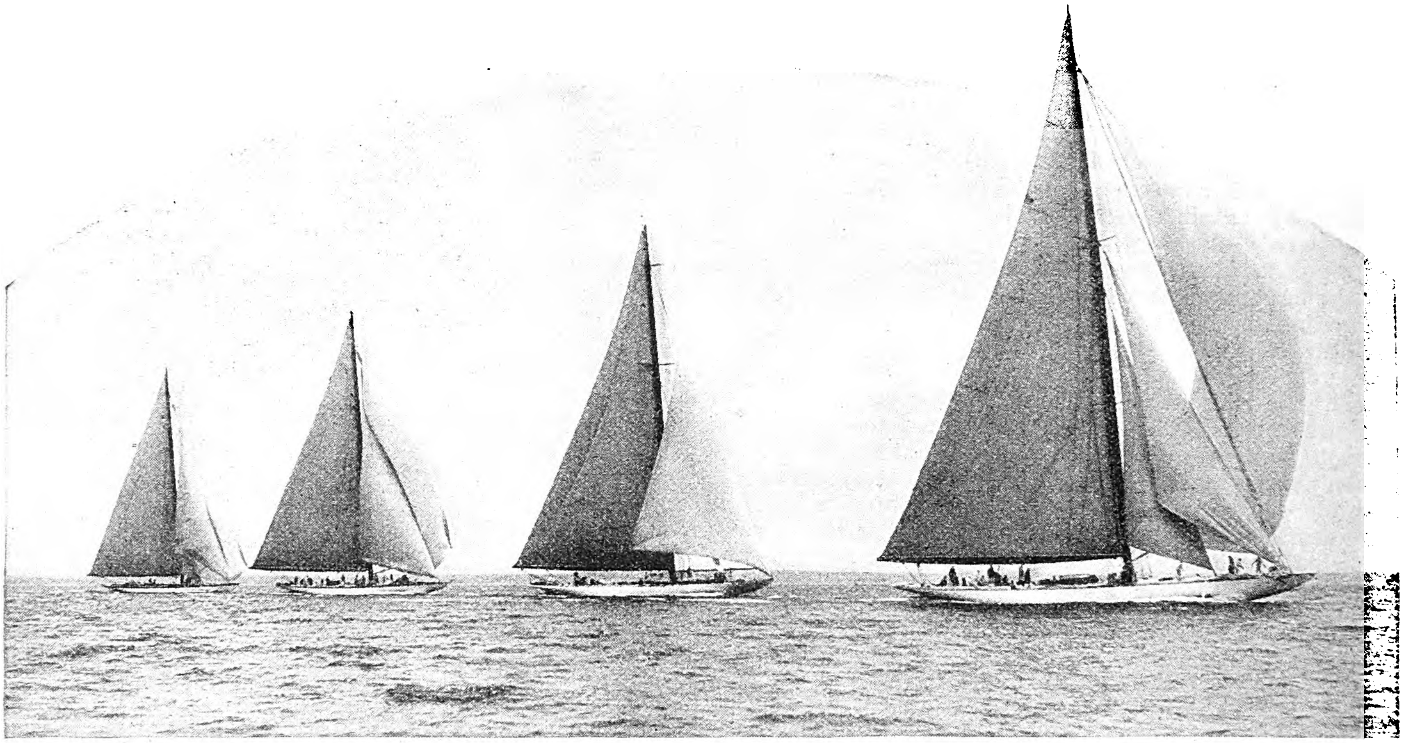
On the other hand the small lateral deflections of the direction of the ray as a whole, which are usually quite imperceptible through the unaided eye, become visible and often conspicuous when magnified. When the disturbance pattern in the air is on a large scale all the rays which enter the objective of the telescope may be deviated in the same general direction, and as this changes from moment to moment the image dances. When the pattern is small the rays entering different parts of the objective are deviated in different ways and the image refuses to come to any good focus but boils, and in particularly bad moments it explodes. This sort of trouble evidently should be most frequent with large telescopes, and so it actually is found to be.

ATMOSPHERIC disturbances of all these kinds are among the worst defects that can afflict an observing station. It is no wonder then that when a great observatory is being planned careful tests of seeing are made at many proposed sights and often enough to get a good average representative of conditions the year around. For work of this importance a telescope of several inches aperture in the hands of an experienced observer is necessary. But in the preliminary reconnaissance which selects the places for further testing the simple observation with the naked eye of the twinkling of the stars should suffice to exclude many hopeless situations and pick those which are more promising.

So the modern astronomer who sees the little stars twinkling—and the brighter ones still more—moves on, fearing that, should he set up his telescope in so ill-favored a spot, he might find it useless for the greater part of the time, and be left "wondering" what the stars "are," rather than finding out.—*In the Gulf of Corinth.*



A streak of denser air high aloft (see left hand sketch, which is of couse diagrammatic) affects the light rays arriving from space in the same way as a simple bi-convex, non-achromatic lens (middle sketch). In the case of the glass lens we can virtually balance out this "chromatic aberration" by adding a second lens (third sketch), but there is no convenient way of capping a dense air streak with a rarefied one, even from an airplane, and this is why the astronomer often must "go home to bed," as Dr. Russell says in the text



The candidates for the defence of the America's Cup. *Right to left:* *Weetamoe* (1); *Enterprise* (4); *Yankee* (2); and *Whirlwind* (3). The defender will be selected in the latter part of August after a series of official trial races

The America's Cup Defenders

By HERBERT L. STONE

Editor, *Yachting*

WHEN the little schooner yacht *America* fared forth across the Atlantic 79 years ago this summer to fling down the gage of defiance to British yachtsmen it is safe to say that not one of the adventurous spirits who backed that valiant effort ever foresaw that the insignificant cup which now bears the name of the vessel that won it would one day stand for the supremacy of speed upon the waters; or that many millions of dollars would be spent in any single attempt to retain it in this country.

For 79 years, during which 13 hard-fought races, or matches, have been sailed for this particular bit of silverware, the cup has never left our shores; and to meet Sir Thomas Lipton's fifth challenge this year we have made, perhaps, the most elaborate preparations for its defence in September that have ever been seen in any yacht race. For we have built no less than four candidates for the defence, the cost of which, together with the expenses of campaigning them throughout the season, will total between three and four million dollars. And this for a cup the intrinsic value of which was originally 100 guineas, or about 500 dollars

The schooner *America*, which was built in New York at the foot of East 12th Street, after a model by George Steers, for a syndicate of New York Yacht Club members headed by Commodore John C. Stevens, was, as far as the records show, the first American yacht to cross the Atlantic for the purpose of racing in a foreign country. It had been suggested that, in connection with a great international exhibition to be held in England in 1851, it would be "eminently fitting" if America send over a yacht to sail in the races to be held in English waters that year. It was also intimated that plenty of matches could be secured in the event of a yacht being sent. So the *America* was built and sailed across in the spring and early summer of that year. She was a schooner of moderate size, being 90 feet long on the water and 101 feet, 9 inches over all, her model following closely that of a smart pilot schooner turned out by George Steers a few years earlier. Her rig was distinctly American, with excessively raking masts, a single big jib, and a loose-footed foresail.

But when the *America* reached British waters she found it exceedingly difficult to arrange for the promised matches. Her crew made the mistake, as she sailed up the Solent towards the Royal Yacht Squadron on her arrival, of tackling the "crack" English cutter *Laverock* in an impromptu brush, during which she beat this boat so handily in a beat to windward that other British yachtsmen seemed loath to sail a race with the stranger. English yachtsmen were most hospitable, but they showed a strong disinclination to arrange a special match with the *America.* Finally, Commodore Stevens, despairing of getting a race, posted a challenge to sail the *America* in a match against any British vessel whatsoever for any sum up to 50,000 dollars. This had no effect in bringing about the desired meeting, but the officers of the Royal Yacht Squadron informed Commodore Stevens that the *America* could race in the regular open regatta of the Squadron on August 22nd, for which all of their yachts were eligible, the race to be sailed without time allowance. The prize was to be a trophy, put up by the Club, valued at one hundred guineas.

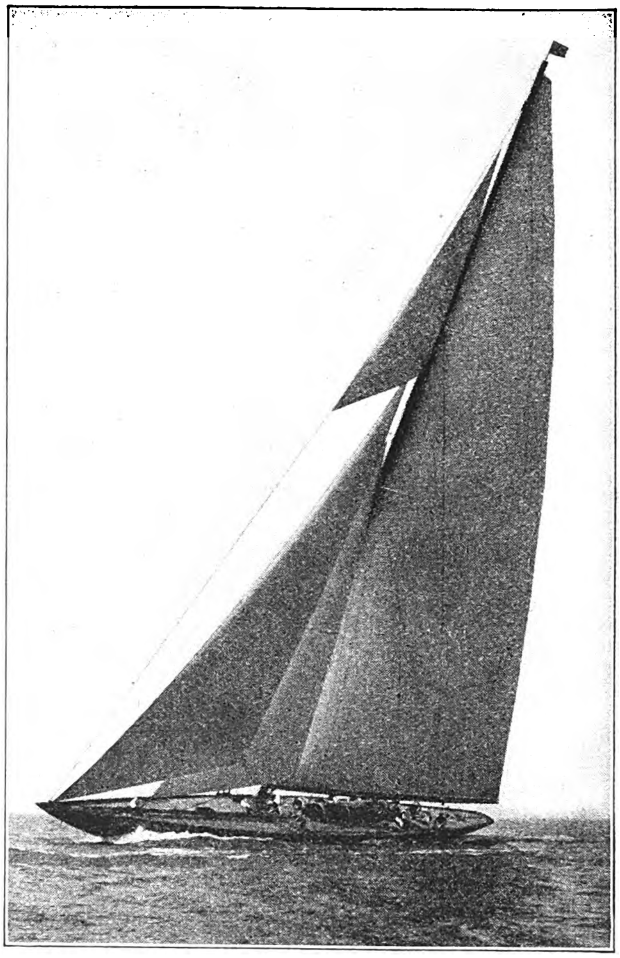
This was hardly what the crew of the *America* wanted, but they decided to start, the course being around the Isle of Wight, a distance of about 53 miles. There were 15 starters in this race, all British except the *America*, and ranging in size from 47 tons to 392 tons, the latter being the big three-masted schooner *Brilliant*. The race was sailed in a variety of light, fluky winds, and with strong tides to contend with, but the *America* won rather handsomely. The original records of that race are not clear as to the time by which *America* finished ahead of the second boat, but the New York Yacht Club records give it as 18 minutes.

The Cup thus represented almost the sole proceeds of that summer adventure, and some six years later, or in 1857, it was turned over to the New York Yacht Club by the syndicate which built the *America*, to be put up for international competition, and has been held by that organization ever since. The race this year marks the 14th attempt to capture it, all the challenges coming from Great Britain, with the exception of two from Canada. Also, this last challenge by Sir Thomas Lipton makes the fifth attempt the Irish baronet has made to "lift the mug," as he expresses it, the first having been in 1899, just 31 years ago. All of his yachts have borne the name of the four-leafed clover so dear to Irish hearts.

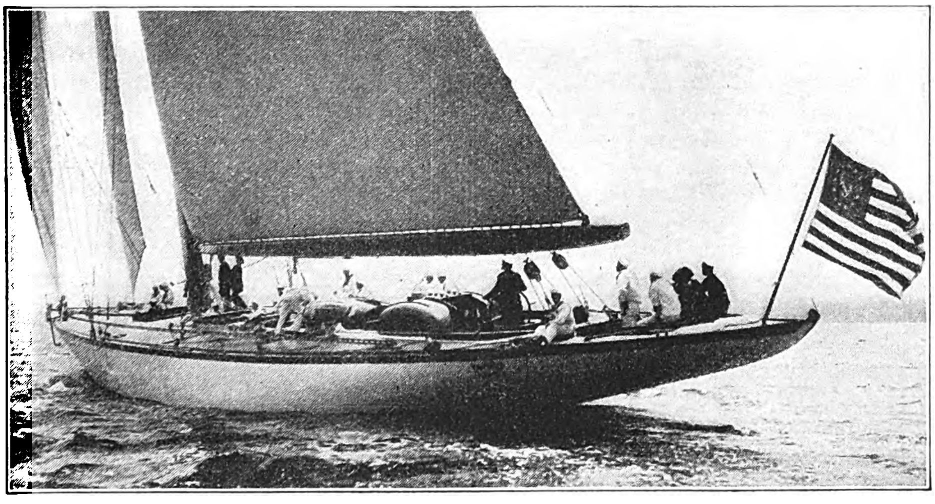
OF late years the cost of building and campaigning a yacht for Cup defence has become so great that it has become a matter for syndicates to handle, rather than individuals, as was the case with most of the Cup yachts up to the time of the *Vigilant*, in 1893. So when this last challenge was received, those interested in seeing a proper defence assured started to form syndicates for the building of candidates to meet the *Shamrock V*. In a short space of time no less than four such syndicates were formed, and work on the design and construction of the four yachts went merrily forward. It is estimated that to build and race a Cup yacht of this size costs between 700,000 and 800,000 dollars.

In the matter of design we found ourselves confronted with a situation which was somewhat unique, inasmuch as none of our active naval architects had ever designed an America's Cup yacht, and few of them had turned out a racing cutter of the size called for. "Nat" Herreshoff, of Bristol, and William Gardner, who created the two candidates for the race of 1920, had both retired and were out of the picture. So the four syndicates turned to three of our younger designers, and to Clinton H. Crane, who is no longer pursuing naval architecture as a profession, but who recently turned out several smaller successful yachts as an avocation.

Towards the race this year the New York Yacht Club displayed a very liberal attitude and suggested to Sir Thomas that instead of his building to a specified water-line length, as in the past, and their meeting him with a boat of the same water-line length, that he build to one of the regular classes of the New York Yacht Club, in which event we would build to the same class and race him boat for boat, without time allowance. Heretofore the yachts have raced with time allowance, so that sometimes the first boat to finish did not turn out to be the winner, which was often unsatisfactory and confusing to the general public.



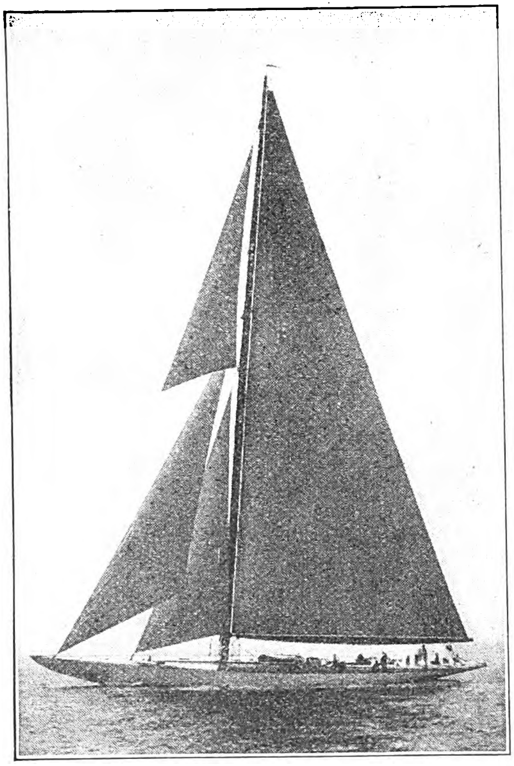
The Shamrock V, **Lipton's Cup challenger**



Deck view of the *Whirlwind*. She is a double ender with canoe stern. This is the first time this form of stern has been used in an America's Cup yacht

SIR THOMAS accepted and elected to build to Class J, or 76-feet rating. Therefore, all of our boats were built to this rating also. This 76-feet rating does not mean that the boats are of this length, but that the resulting measurement derived from a formula taking into consideration length, displacement, and sail area will be 76 feet. As a matter of fact, the various yachts built for this year's race vary in water-line length from about 80 to 86 feet, and in tonnage (displacement) from 128 to 158 tons, all with approximately the same sail area. This allows plenty of scope in design to assure that the boats would not be of exactly the same form and dimensions. The over-all length varies from 120 to 130 feet in our four candidates. With the modern Marconi, or jib-headed rigs that modern yachts carry, all of the boats have extremely long, hollow masts, varying in height from 162 feet to 168 feet. As these are made in one piece, with no fidded topmasts, as in the case of the older yachts, it means that particular attention must be given to proper staying of the masts in order to keep these long slender spars in the boat, and many fears are being expressed as to the possibility of the masts giving way in a hard breeze and jump of sea, such as are likely to be met off Newport in September.

Another forward step this year in these defenders is that the hulls are all built to Lloyd's scantling requirements, which means very substantial construction as compared to the defenders of recent years, in which every sacrifice



***Weetamoe*. Mechanical appliances are used for handling halliards and sheets**

was made to lightness. This practice went so far that it was considered unsafe to race in a wind which to the early Cup boats would have been only a whole-sail breeze, and resulted in one of the races of 1920 being called off in a wind of only some 25 miles-an-hour strength. Also, it means less of a handicap to the challenger, for as our boats are built to the same scantling (or frame) dimensions, they have to be as substantial as the *Shamrock V*, which, to race, must sail across the Atlantic on her own bottom.

ANOTHER feature of modern yachts built for the defence of the Cup that marks a great departure from previous practice is in the mechanical contrivances for handling gear. Below decks, on all the boats built for this race, no accommodations of any kind for the crew are to be found. The entire personnel of each yacht, from 22 to 24 men, is berthed and boarded on a large tender, which follows the yacht to which she is attached to the various ports where she may base. This leaves room below for the stowage of various light sails or "kites" which these boats must carry to make the most out of every vagary of the wind, and for the many winches and drum hoists for handling halliards and sheets. The halliards for all except the lightest sails lead to mechanical hoists below, while the main sheets and some of the headsail sheets also are led to winches below, where a gang of men takes in on them or slacks them off on signal from deck. This is a far cry from the traditional method of all-hands tailing on to sheet and halliard to hoist or trim sail, as in the days of the *America*, and all of those yachts which followed her in the quest for the Cup up to quite recent times

The four yachts built for this year's defence are the *Weetamoe*, *Enterprise*, *Yankee*, and *Whirlwind*. A comparative table showing the principal dimensions of these boats, and of the challenger, *Shamrock V*, is given, and the details of ownership and design follow.

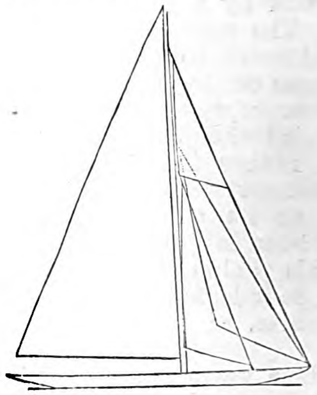
Weetamoe, Racing Number 1. Designed by Clinton H. Crane. Built by the Herreshoff Mfg. Co., Bristol, R. I. She is for a syndicate organized by J. P. Morgan and Junius S. Morgan, Jr., the other members being Henry Walters, Cornelius Vanderbilt, Arthur Curtiss James, Gerard B. Lambert, and George T. Bowdoin. Former Commodore George Nichols is managing owner and skipper and will sail the yacht throughout the season. With him on the quarter deck are John Parkinson, Robert N. Bavier, A. H. Eustis, and Junius S. Morgan

Yankee, Number 2. Designed by Frank C. Paine, a son of General Charles J. Paine, who owned or managed the Cup defenders *Puritan*, *Mayflower* and *Volunteer* in 1885-6-7. Built by George Lawley & Son, Boston, for a Boston syndicate composed of John T. Lawrence, Chandler Hovey, and Frank C. Paine. The first named is syndicate manager, and in the afterguard with him are Raymond Hunt, Frank Paine, Chandler Hovey, and, on occasion, Charles Francis Adams, Secretary of the Navy.

Whirlwind, Number 3. Designed by by L. Francis Herreshoff, son of the famous Nathaniel Herreshoff, the "Wizard of Bristol," who designed all our previous Cup defenders since 1893. Built by George Lawley & Son, Boston, for a syndicate organized by Paul Hammond and Landon K. Thorne, of New York, who will sail her in her races, with Adrian Iselin, II, assisting.

Enterprise, Number 4. Designed by W. Starling Burgess, son of Edward Burgess who turned out the successful defenders *Puritan*, *Mayflower*, and *Volunteer* mentioned above. Built by Herreshoff Mfg. Co., Bristol, R. I. She is owned by a syndicate headed by Harold S. Vanderbilt, and consisting, beside himself, of W. W. Aldrich, Commodore Vincent Astor, George F. Baker, Floyd L. Carlisle, Ogden L. Mills, E. Walter Clark, and George Whitney. Harold Vanderbilt is her skipper, and sailing with him are C. Sherman Hoyt, C. F. Havemeyer, W. W. Aldrich, and the designer, Starling Burgess.

All of these four yachts, excepting the *Whirlwind*, are built with bronze plating over steel frames. The decks are of wood. The *Whirlwind* is of composite construction, with a double planking of wood over steel frames. This latter boat is a double-ender, the ends of the others being of moderate length for a modern yacht and of conventional form. Each of the defenders is fitted with a small centerboard, excepting the *Whirlwind*.



Sail plan of a modern Cup defender

WHILE the four American Cup candidates have been racing since June, the actual defender will not be named until after a series of official trial races to be sailed off Newport, over the Cup course, between August 20th and 30th. After this selection is made, the following two weeks will be spent polishing up the successful candidate to get her in the pink of condition to meet *Shamrock V* in a series consisting of the best four races out of seven, starting September 13th, nine miles southeast of Brenton Reef Lightvessel. And, then, may the best boat win!

	Weetamoe	*Yankee*	*Whirlwind*	*Enterprise*	Challenger *Shamrock V*
Length water line	83–0	84–0	86–0	80–0	81–0
Length over-all	125–11	126–0	130–0	120–9	119–10
Extreme breadth	20–3	22–6	21–7	21–8	19–8
Draft	15–0	14–9	15–6	14–5	14–8
Displacement (tons)	143	145	158	128½	134
Sail Area (sq. ft.)	7568	7550	7550	7583	7540
Height of mast	164	162	166	168	163

Principal dimensions of the Cup yachts

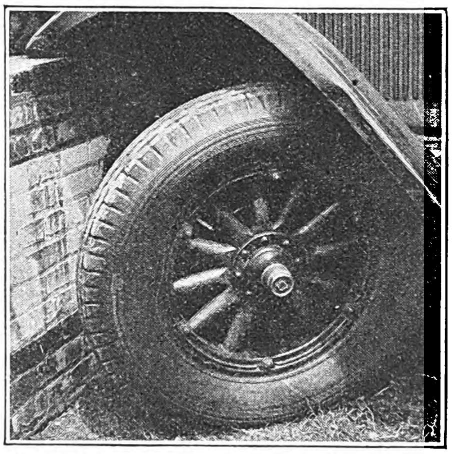
Crash-Testing Tires at High Speed

WHICH of these will best stand the force of tremendous impact: A 10-ton brick and concrete wall, reinforced with steel, and sunk deep in earth, a 3000-pound eight-cylinder automobile, or a few pounds of rubber and compressed air?

The answer to this question was given when Captain Dick Grace drove an eight-cylinder touring car under full power at 37 miles an hour into a solid wall over three feet thick. When the car crashed, the entire wall, 15 feet wide, was moved several inches from its base, the powerful car was wrecked and the front end was demolished, Captain Grace was hurled high in the air by the impact, falling beside the car, but the tires on the car were not damaged in any way despite the fact that they had received the full force of the impact.

Because of the daring exploits of Captain Grace who intentionally cracked up airplane after airplane to furnish thrills in "Wings," "Lilac Time," and other spectacular air movies, the General Tire and Rubber Company asked him to give its new blow-out proof tires the most severe test he could devise. On the company athletic field, engineers built a brick and concrete wall, 15 feet wide, over three feet thick, and six feet in height, half of it buried underground. A heavy steel I-beam was built into it to reinforce it.

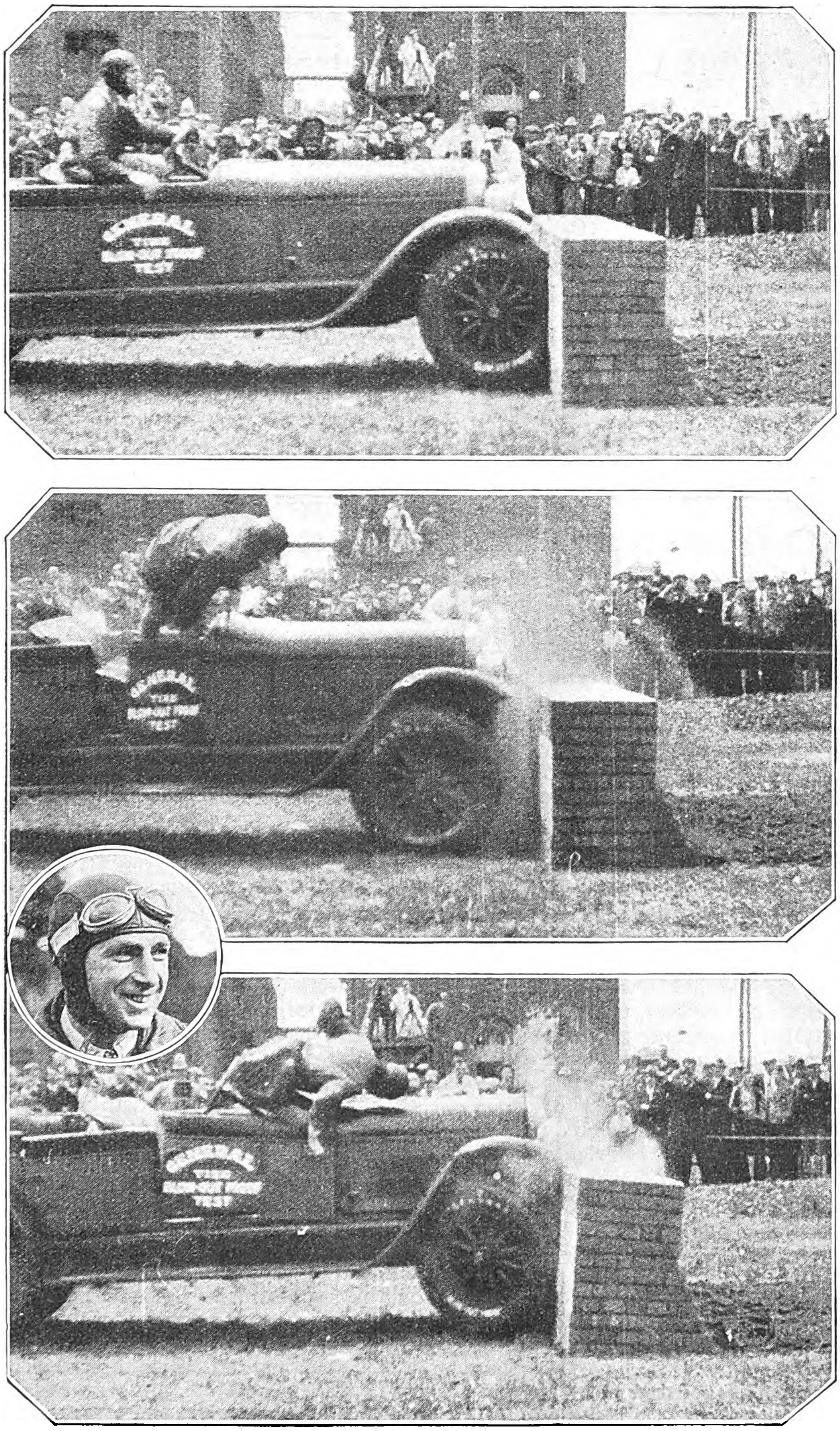
Captain Grace selected a powerful, eight-cylinder touring car with which to make the test. Before it was equipped with the new tires, the front wheels were moved forward so that they cleared the front springs and frame by six inches, making it certain that the tires would get the full impact of the crash. Then Captain Grace circled the field several times, gaining momentum for the final run.



The tires uninjured after the crash although the rim was badly bent

Just before the crash, he raised himself in his seat in a crouching position. With the throttle wide open, the car crashed into the wall, head-on. Slow-motion cameras revealed that the impact flattened the tires back against the rims, which were bent out of shape but the tires were uninjured.

"Such a test shows," said Captain Grace, "that tires will withstand the shock of driving over all kinds of roads at high speeds, even though they are driven unexpectedly into deep holes in the road."



Oomph! The car strikes the wall at 37 miles an hour. The upper left picture shows the flattened tires at the moment of impact; the center picture, the rebound; at bottom, the moved wall and the catapulting driver. In the inset, Captain Dick Grace

Our Patent System

By ORSON D. MUNN

Member New York Bar

THE Use and Abuse of Patent Rights: Just What Rights Our Patent Laws Grant to Patentees: The Government Cannot Give a Patentee the Right to Use the Invention of Any Prior, Existing Patent: Patents for Improvements Are Frequently More Valuable Than Pioneer Patents: Today, as Always, a Patentee Receives the Protection of the Government, in so Far as His Patent Rights Are Concerned, as Well as His Just Reward

THERE has been much unfavorable comment recently concerning our patent system. A western Senator has introduced a bill designed to prevent what is alleged to be the abuse of the rights secured by patents. The Government has instituted a suit against the so-called "Radio Trust," in which it charges that large and powerful corporations, holders of alleged "all-covering" patents, have by means of cross-licenses and agreements practically made it impossible for the independent manufacturer in the radio field to exist. We find others criticising our patent system because of the ineffectiveness of patents and the alleged lack of protection extended by the Government to inventors and patentees in general.

To determine whether or not the proposed legislation and the Government's action on the one hand, and the criticisms of the futility of patent protection on the other hand, are justified, we should first consider just what a patent is. It has been defined as a limited monopoly based on a contract between the patentee and the Government, wherein the Government, as an inducement to the patentee to make his invention known and useful to the people of the United States, promises to the patentee that for a limited period no one shall have the right to make, use, and sell his invention, without his consent. At the end of that period of time the patented invention becomes public property and may be employed by anyone. The rights secured by a patent are exclusive and the Constitutional provision under which inventions are protected provides only for the making of laws to secure "exclusive" rights to inventors. It is extremely doubtful whether Congress could pass any law, under this Constitutional provision, providing for the grant of anything less than an exclusive patent.

THERE are many who do not comprehend just what rights are given to a patentee by his patent. Many believe that a patent from the Government confers upon the patentee the absolute right to make, use, and sell his invention throughout the United States; but this is not the case. What he really gets is the right to exclude all others from making, using, and selling his invention. Obviously, this must be so, because many patents are granted for inventions which infringe prior patents; in other words, for improvements on the inventions of prior patents. Such improvements, everyone will agree, are patentable; but because they are patentable, the patentees get no right to use them if they embody the invention of a prior, existing patent. Our Government cannot take away from one citizen his property and permit its use by another—such monopolies were never granted by our Government—so that when the patentee of an improvement gets a patent from the Government which, in terms, gives him the exclusive right to make, use, and sell his invention, he must remember that he does not get the right, and the Government cannot give him the right, to use the invention of any prior, existing patent.

Patents for so-called improvements are in many instances more valuable than a so-called "pioneer" patent. A case in point is the Bell telephone patent of 1877, which may rightly be designated as a "pioneer" patent. During its life many valuable patents were granted for improvement in the telephone art, and it may be conceded, without detracting from Bell's great achievement, that the practical commercial telephone was developed by these subsequent inventors; but not one of those patented devices could have been used by the owners without the consent of the owners of the Bell patent. Each of them secured to the patentee exactly the same rights that were given to Bell; that is, the right to exclude everyone from using the patented invention without the consent of the owner of the patent.

A patentee having this right of exclusion may do with his patent what he pleases, within the law. He may never put the invention in use during the term of the patent, and yet, he does not lose the right to exclude all others from using it. Having this exclusive right he may sell his patent to whom he chooses, or he may refuse to sell it. He may grant a license to anyone whom he chooses to license or he may refuse to license anyone; also, it follows that he may license those whom he feels like licensing and refuse licenses to others. In all of this no one has the right to complain; not even the Government which granted the patent.

BUT the Government charges that in some instances, as in the so-called "Radio Trust," these patent rights are used in such a way as practically to control the particular art and to eliminate competition, thus monopolizing the business of a particular industry. That this can be done is true, and no doubt patents can be and are used unjustly to intimidate competitors and to drive them out of business. Naturally, the Government cannot and does not complain that the owners of patents have granted licenses and cross-licenses to each other, because that is within their right.

Whether a corporation owns one patent or a hundred, or whether it be licensed under one patent or a hundred is immaterial, because each patent must stand or fall absolutely independently of all other patents, and the monopoly created by a patent is not expanded in the slightest degree by the fact that numerous patents are combined. It is true that a number of patents may afford a more extended protection to a given manufacture than would a single patent; but no one can complain of that. It is another thing, however, to say that an agreement between licensees and owners of patents that they will never license any others than themselves, is within their patent rights. That is the thing to which the Government objects; such agreements are not justified by the patent grant and are clearly in violation of our laws aimed to prevent monopolies and restraints of trade.

Again, patents may be and are used to intimidate independent manufacturers by unjustified charges of infringement and threats of litigation made not only to the manufacturer of the device alleged to infringe, but to the trade, and as the user or retailer is liable for infringement as well as the manufacturer, it follows in many cases that as an alternative to expensive litigation the manufacturer ceases the manufacture of the device alleged to infringe and the retailer not only refuses to buy them for resale, but oftentimes returns to the manufacturer those which he has already bought.

It would be entirely proper for Congress by some appropriate legislation to penalize those who make an improper use of patents in this manner, even to the extent of providing that they shall be deprived of all relief in a suit instituted by them charging infringement, should such a misuse of their patents be pleaded and proved against them. Indeed, without the proposed legislation, courts of equity have frequently denied all relief to the owner of a patent who has maliciously sought to destroy the business of his competitor, by circulating among the trade warning notices of infringement prior to an adjudication of the question of the suit. This, on the ground that the owner of such a patent comes into court with unclean hands and is not entitled to ask a court of equity for any relief.

The criticism, however, that patents do not protect inventors and patentees, and the suggestion that the Government should in some manner enforce the patents which it issues, is without any foundation whatsoever. It has been stated that no patent is of any validity until it has been through the courts, and that when one gets a patent all he gets is the right to a law suit. In just what manner the critics would have the Government proceed is not suggested.

IT is clear to anyone, however, that a valid patent is a protection to the patentee or owner of a patent, and that the Government does in fact protect him in his rights secured by a patent. The courts are always open to him, and it must be known to everyone that the courts constitute a branch of our Government.

The courts, it is true, will only extend their protecting arm to those patents which they find to be good and valid; but this is true of all contracts. No contract is self-executing. When you enter into a contract all you have is a promise in writing, which, if evaded and avoided and disregarded you must go to the courts for enforcement; and like a patent, such contract will only be enforced if the terms thereof are clearly stated and it is not invalid. A patent is no different in this respect from a deed for a piece of real estate; in fact much land in the west is held under patents issued by the Government. You cannot eject a trespasser from your property by simply waving before his eyes your deed and you cannot complain to a policeman to put him off of what you say is your property, because the policeman does not know whether it is your property or not. He may rightly differ with you as to whether or not he is a trespasser, or whether or not your patent is a valid patent. So that in all cases of contracts, patents, deeds, and agreements of any nature, you must seek the assistance of the courts to enforce them.

On the other hand, unadjudicated patents in many cases have proved of great value and been the source of much profit to the owners. In fact, there are instances where an inventor has sold his invention and the right to a patent even before the patent has been applied for or issued, and there are also many instances where an alleged infringer has recognized not only the validity of the patent but the fact that he has actually infringed the patent, and has ceased his infringing acts, or, by treaty with the owner of the patent, secured the right to continue the use of the patented invention. The owners of patents do not always have to go into court to obtain recognition of their patent rights and to receive the benefits to which they may be entitled.

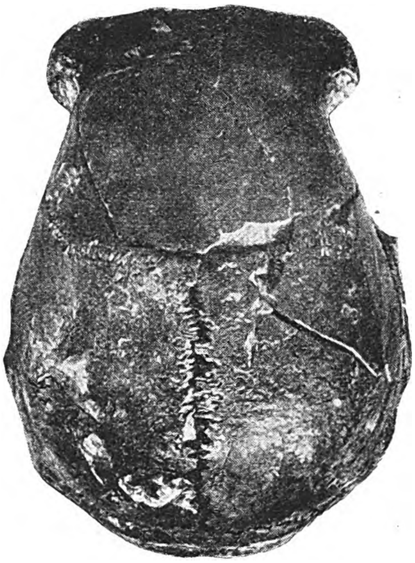
NO inventor, and no patent owner, should permit the present agitation, and the unjust criticisms of our patent system to deter them from creating new inventions and seeking patents therefor, nor should they be disappointed if the thing for which they have obtained a patent should not prove as valuable and useful as they anticipated. The Government is obliged to grant patents for new and useful inventions, but, obviously, there is no place in the arts for many of these patented inventions, either because they are impractical, or because there are things in existence for doing the same work, equally as efficient and economical, or because there is not sufficient capital available for commercial exploitation; under such circumstances no patentee should expect to profit by his invention. On the other hand, many cases can be cited where the inventors of simple things for which they have sought and procured patent protection have been amply rewarded and to an extent they never anticipated. It is true today, as it has been in the past, that the inventor or patentee of anything which materially benefits a given art or industry will not only receive the protection of the Government in so far as his patent rights are concerned, but also that reward, financial and otherwise, which the scope and value of his invention justifies.

More About the Peking Man*

By PROFESSOR G. ELLIOT SMITH, F.R.S.

Professor of Anatomy in the University of London
Author of "The Evolution of Man," and "Human History"

THE revelation of the nature of the brain-case in Early Pleistocene man displayed in the wonderful photographs reproduced in these pages affords ample corroboration of the claim made in *The Illustrated London News*† that the discoveries in China provide "a new basis for the study of human evolution." These photographs were made in Peking immediately after Professor Davidson Black had successfully accomplished his long and exacting task of clearing away the hard matrix of travertine in which the base and left side of the skull were embedded when it was found on December 2, 1929, by Mr. W. C. Pei.


The top of the skull of Peking Man, or *Sinanthropus pekinensis*

Now that the stony matrix has been removed from the surface—the cranial cavity is still occupied by a solid mass of travertine—there is revealed the most complete example of an Early Pleistocene skull so far discovered. It is a very impressive and illuminating specimen, not merely for the intrinsic evidence it provides, but also for the light the new data shed upon the other remains of early man. It is the skull of a young adult or adolescent. Mr. Davidson Black suggests the possibility that it is female.

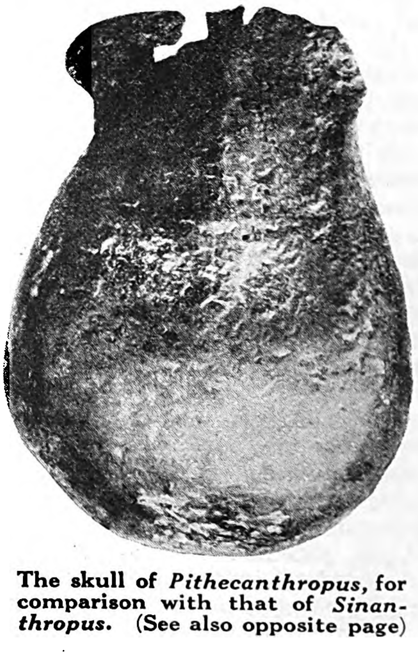
For the elucidation of its distinctive characters I have made two series of drawings in which the left profiles and the views from behind of the only three Early Pleistocene skulls so far known are shown superimposed upon one another. These drawings reveal the individuality of the new genus from China. While it has the prominent eyebrow-ridges of *Pithecanthropus* (which are lacking in the Piltdown skull), the brain-case is much fuller than the Java skull, especially in the frontal region, which approximates to the condition found in Piltdown man. But the latter is much better developed in the parietal and occipital regions than either of the Far Eastern skulls. The most striking contrast between the cranial forms of *Pithecanthropus* and *Sinanthropus* is revealed in the view from behind, in which the greater height and development of parietal eminences in the Chinese skull definitely differentiates it and justifies its generic distinction.

Sinanthropus Turns Out to be the Most Impressive and Significant Discovery in the Whole History of Human Paleontology

When Sir Arthur Smith-Woodward made his reconstruction of the Piltdown skull from the broken fragments found in 1912, he was vigorously criticised for making a model wider at the base (see the temporal bosses) than in the parietal region. The Peking skull reveals these peculiarities in a more extreme form. As it is an actual skull, and not a reconstruction, it provides welcome corroboration of the reliability of the reconstructed Piltdown skull. The outlines of the profile and posterior aspects of the Piltdown skull in the diagrams are taken from Figures 17 and 19 of my "Evolution of Man" (1927).

In his manuscript notes accompanying the photographs Professor Davidson Black claims that such a form (as is revealed in the posterior view of the Peking skull) is unknown in any other human skull. My drawings demonstrate the same peculiarity in the Piltdown skull. The collective testimony of these three fossils provides an impressive idea of the likenesses (as well as the generic differences) of these Lower Pleistocene men, and suggests the common denominator of the earliest man. The peculiarities already mentioned in the temporal part of the skulls (note, in particular, the temporal bosses in all three) do not exhaust its interest. The form of the mastoid processes (which seem not to have been fully extruded—as they are in other men—from the cranial wall) and the massive ring of rough bone (tympanic) surrounding the ear-hole, differ profoundly from the corresponding parts of all other human skulls. The peculiar modeling of the tympanic bone displays a startling resemblance to the condition found in the gorilla and chimpanzee. The mastoid and tympanic structures have distinctive characters in Piltdown Man, Rhodesian Man, and Neandertal Man, but none of these is so emphatically simian in type as the Peking skull.

WITH the photographs of the skull there has also come Volume VIII of the "Bulletin of the Geological Society of China," containing three important memoirs which throw a clearer light upon the history of the discovery of *Sinanthropus* and the geological and paleontological evidence for the antiquity of the human fossils and the animals associated with them. The Chinese geologist, Mr. W. C. Pei, gives an account of his discovery of what is probably the most important, and certainly the most illuminating, fragment of early man ever found. Father Teilhard de Chardin and Dr. C. C. Young have provided a preliminary report on the fossiliferous deposits at Chou Kou Tien, which not only establishes the fact that all the


The skull of *Pithecanthropus*, for comparison with that of *Sinanthropus*. (See also opposite page)

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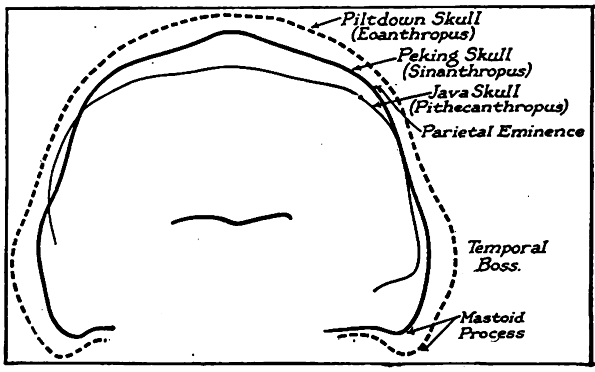
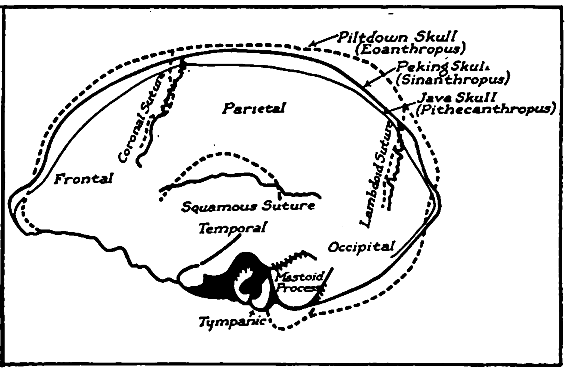
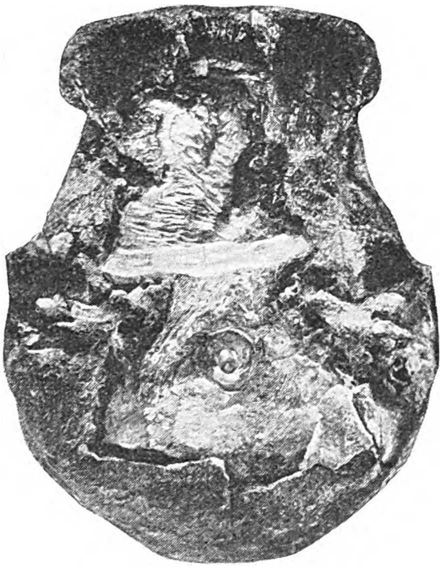
†The article in question, written by Professor Smith, was reprinted in SCIENTIFIC AMERICAN, June 1930, page 440.


Piltdown Skull (Eoanthropus)
Peking Skull (Sinanthropus)
Java Skull (Pithecanthropus)
Parietal Eminence
Temporal Boss.
Mastoid Process

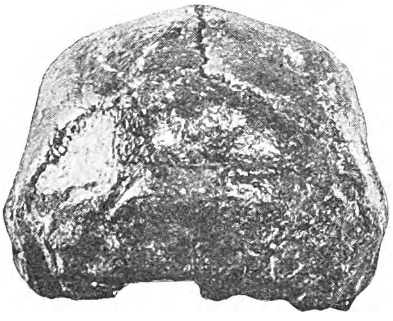
With posterior aspects superimposed, three famous skulls—Piltdown (*Eoanthropus*), Peking (*Sinanthropus*), Java (*Pithecanthropus*)


Piltdown Skull (Eoanthropus)
Peking Skull (Sinanthropus)
Java Skull (Pithecanthropus)
Coronal Suture
Parietal
Frontal
Squamous Suture
Lambdoid Suture
Temporal
Occipital
Mastoid Process
Tympanic

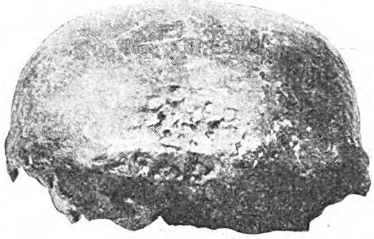
Left profiles superimposed. The same three skulls whose posterior profiles are superimposed at the left. Drawings by the author



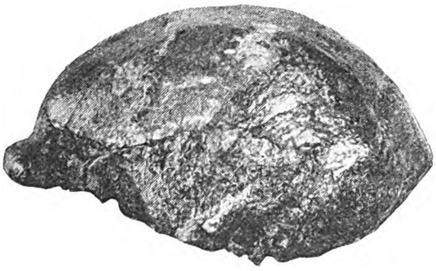
Base of the skull of *Sinanthropus* (the round central object is recent)



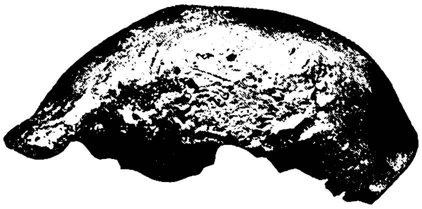
***Sinanthropus*, rear. The parietal eminences mentioned in the text are indicated in the drawing above**



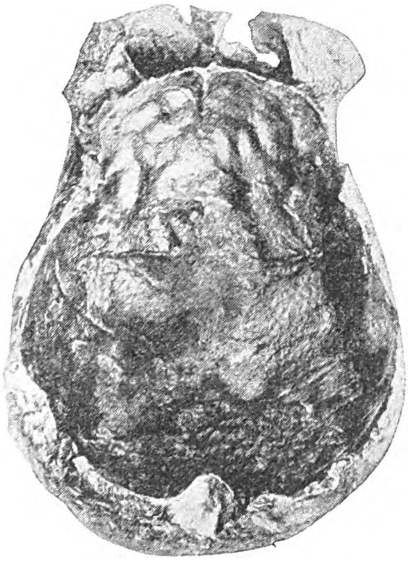
***Pithecanthropus*, rear. For position of "temporal boss" see the drawing**



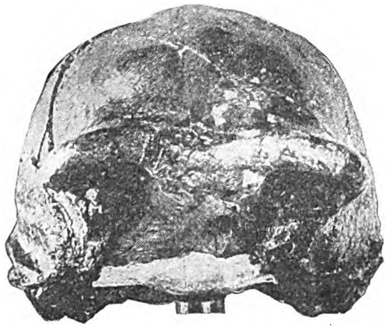
***Sinanthropus*, profile. It has a fuller brain case than *Pithecanthropus* (which is shown at right)**



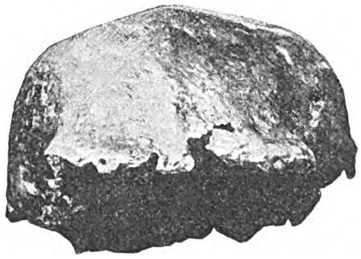
***Pithecanthropus*, profile. *Sinanthropus* (at left) has the same or more prominent eyebrow ridges**



Base of the skull of *Pithecanthropus*—smaller than *Sinanthropus*

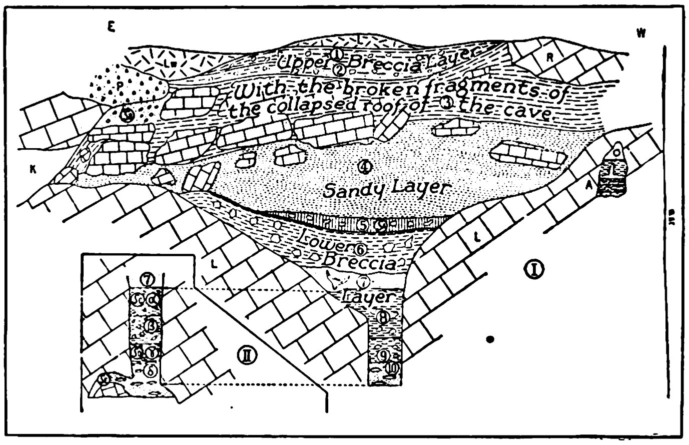


Sinanthropus*, front. Happily the eyebrow ridges are not even partially lost, as in *Pithecanthropus



Pithecanthropus*, front. *Sinanthropus* has the same frontal expansion as has *Pithecanthropus

remains are later than the Pliocene and earlier than the Loess—in other words, they are Lower Pleistocene—but also hints at the possibility that in the lower layers of the formation (the highly fossiliferous beds of Nihowon) they may find "some immediate ancestor of *Sinanthropus*." Professor Davidson Black has described (with many excellent photographs) the process of liberating the skull from its matrix.



Where "the most illuminating fragment of early man ever found" was discovered—at point marked "SE" (extreme lower left-hand corner). The jaw and skull fragments found a year earlier were at "SB," (top, left)

The evidence provided in these three memoirs makes it possible for us in Europe for the first time to visualise the circumstances of this epoch-making discovery. These facts are essential for the understanding of the significance of the new light on our remote ancestry. For several decades European paleontologists have been exploiting the druggists' shops of China for fossils — "dragon's bones" being an important item in the pharmacopœia of the Far East. But it was not until 1919 that a subsidiary bone deposit near Chou Kou Tien was visited by Dr. J. G. Anderson on behalf of the Geological Survey of China. Two years later (1921) he discovered the important main deposit and began excavating it. But its exceptional scientific importance was not realised, even when in 1926, Dr. O. Zdansky found two human teeth among the fossils that had been collected. The Rockefeller Foundation then gave a grant of money to help the Geological Survey of China and the Department of Anatomy of the Peking Union Medical College conjointly to carry on excavation for two years.

IN October 1927, Dr. Birger Bohlin found *in situ* in the Early Pleistocene beds a human tooth, on the evidence of which Professor Davidson Black and Dr. O. Zdansky created the new genus and species *Sinanthropus pekinensis*.

Dr. Zdansky was still sceptical of the justification for the creation of a new genus and species, and the credit of insisting upon the necessity for such action must be attributed to the insight and courage of Dr. Davidson Black, who naturally associated Dr. Zdansky's name with the discovery in view of the circumstances under which the two teeth were rescued in 1922 and described by him in 1926.

A year later (November 1928), Mr. W. C. Pei, working with Drs. Birger Bohlin and C. C. Young, found much additional material, including parts of two lower jaws and numerous skull-fragments of *Sinanthropus*. This induced the Rockefeller Foundation to make an additional grant for the work, and a special department (Cenozoic Research Laboratory) was set up by the Geological Survey of China and put under the honorary directorship of Professor Davidson Black.

The hope implied in the granting of this new appropriation was immediately realised by the most impressive and significant discovery in the whole history of human paleontology. Mr. Pei resumed work in May 1929, and in June and July found a number of human teeth. The summer rains then stopped work for seven weeks, so that it was not until September 26 that excavation could be resumed. Another collection of *Sinanthropus* teeth was then found.

At the end of November, when the weather was becoming bitterly cold, Mr. Pei was so "curious to know what were the lower layers of the deposit" that he prolonged the work for two more days. He found two caves, in one of which, at 4 o'clock on December 2, he found, "partly embedded in loose sand and partly in a hard matrix," the almost complete skull of *Sinanthropus*. He sent special messengers to inform Drs. W. H. Wong and C. C. Young, and telegraphed to Dr. Davidson Black.

THE circumstances under which the remains of *Sinanthropus* were found are totally different from those of *Pithecanthropus* and *Eoanthropus*. The latter were both scattered and deposited in gravels by running water. The Peking Man lived in caves, and left his remains there. According to Father Teilhard de Chardin and Dr. Young, it is probable that not only the rodents, hyenas, bears, and other carnivora roamed the site, but also *Sinanthropus* himself may once have sheltered within the Chou Kou Tien cave. Vast quantities of fossil bones have been found. The most interesting types, apart from *Sinanthropus*, are the big beaver (*Trogontherium*), the primitive water-buffalo (*Bubalus*), and the strange deer (*Euryceros*), whose extremely thickened jaws and facial bones and short, flattened antlers are perhaps the most characteristic of the fossils found at Chou Kou Tien. *Machairodus* is exceedingly rare.

The fossils are scattered in the layers filling the cave from top to bottom, and all belong to the same geological age. While a few of the bones may have been introduced into the deposit by a brief flood action (*Bubalus*, for example), most of the material was clearly left (or brought in) by animals living in the cave. The fossiliferous material was set by a slow process of weathering under humid conditions (water infiltrations and occasional brief flooding), but without any torrential action. Although a stream flowed near the cave, there are no true river-deposits. The characters of the breccia and of the fossilised bones indicate that the site was not an underground, water-drained fissure, but an ancient, gradually filled, open-air cave.

SUCH was the home of *Sinanthropus*. The conditions arouse more reasonable hopes than can be entertained in the cases of *Eoanthropus* and *Pithecanthropus*, not only of finding other parts of the skeleton, but also the objects used by Peking Man. It is surprising that no implements have yet been found in the cave. Mr. Pei recovered an angular piece of quartz—a type of stone not found naturally—within a mile of the cave. Similar quartz-fragments have been found from time to time during the course of the excavations, but in none of them has any recognizable trace of artificial breaking been found. It is inconceivable that any creature which had attained human rank could have failed to make some sort of tools of stone. Yet Peking Man occupied this cave for a long time, and does not seem to have left with his bones anything beyond some unworked quartz!

Alongside the skull of *Sinanthropus* was found the complete skull of a rhinoceros, with its lower jaw in position. Mr. Pei ends his reports with this passage, which excites the liveliest anticipations of what next summer may bring forth: "The layer below the one just described is exceedingly rich in fossils, which are so crowded together that but little matrix separates individual bones. Not only are the fossils rich in quantity, but their quality is extraordinarily good."

Arcs of Art

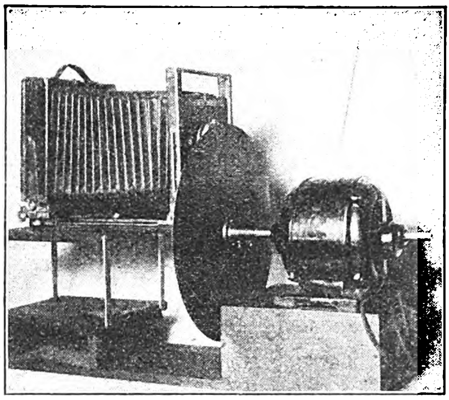
The Camera Analyzes the Electric Arc

By HENDLEY N. BLACKMON

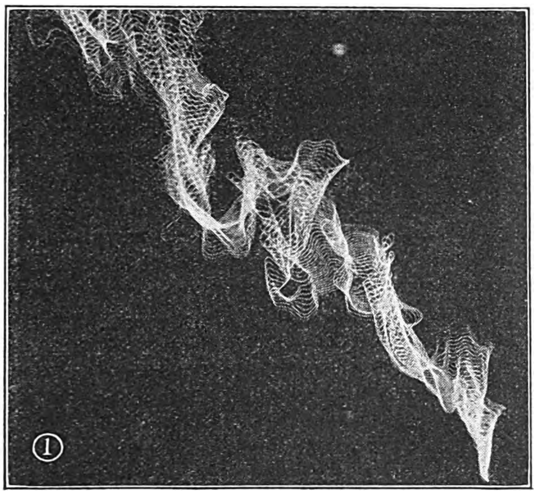
General Engineer, Westinghouse Electric and Manufacturing Company

SOME electric arcs form a most exquisite tracery—a weird gossamer picture of bright and dark bands of light emerging from a misty halo. These striated arcs are made by bringing one end of a 150,000-volt wire close enough to the other terminal for an arc to jump across. Once started, the arc hangs on until it is "stretched to death" when the terminals are pulled far apart.

In order to find out what happens at various points on the changing voltage wave, an electrically timed camera was used. This camera has a synchronous shutter consisting of a motor-driven disk with four radial slots, rotation of which times the camera to take pictures of the arc at any desired portion of the voltage wave. The pictures it makes show the physical characteristics of unleashed electricity and have helped scientists in solving the problem of the behavior of electric arcs.

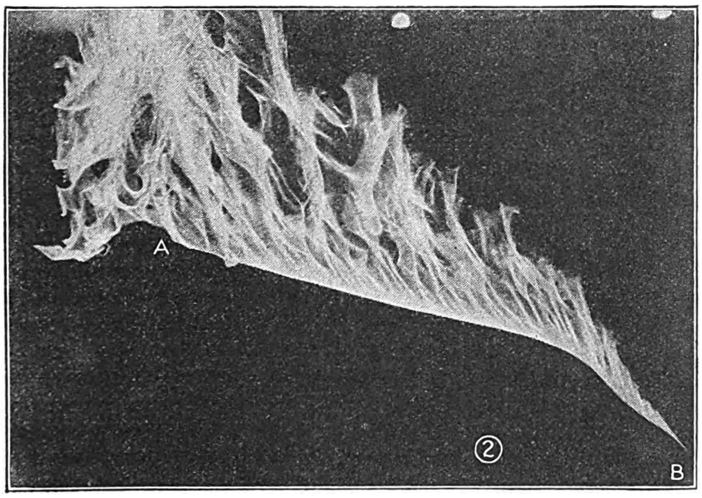


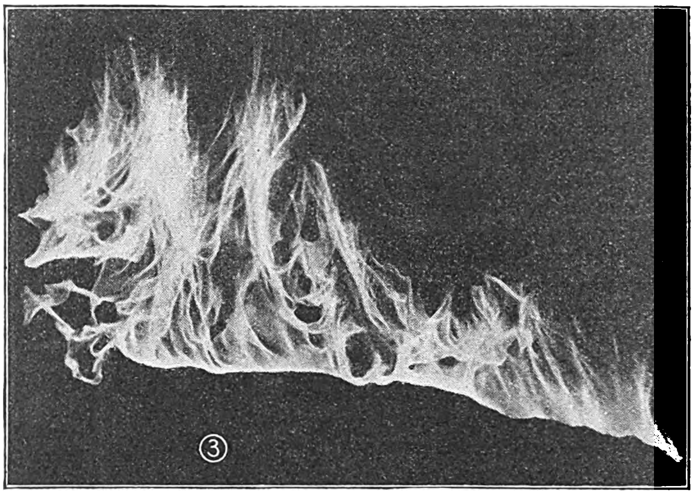
The arc-photographing camera with its motor-driven disk shutter

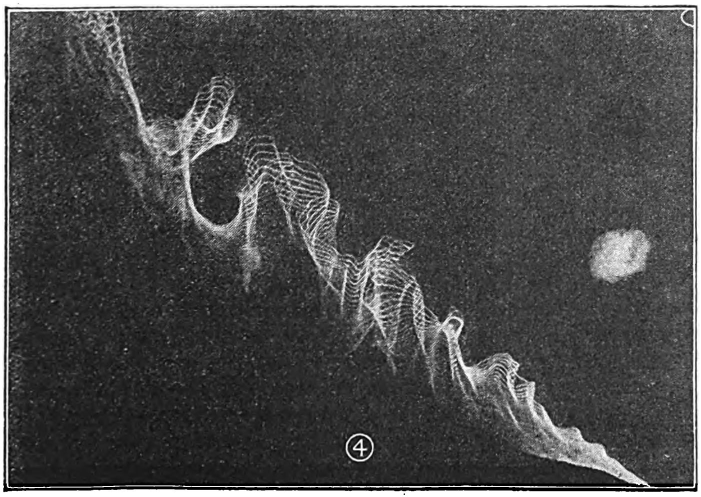


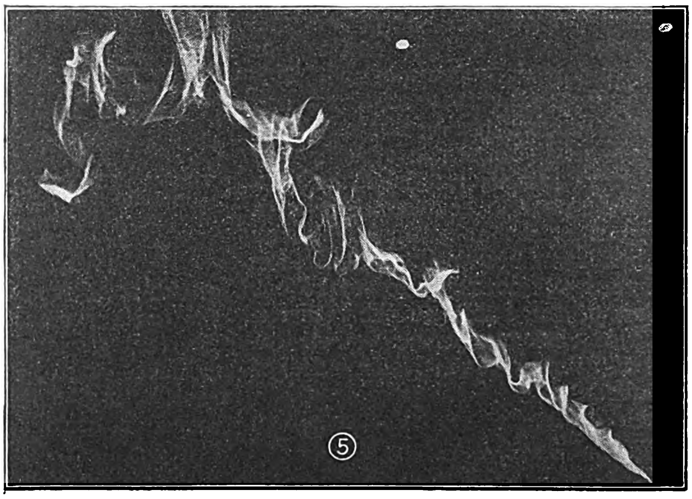
In the accompanying illustrations, Figure 1 shows how the halos are masked out by the synchronous shutter. Figure 2 shows what happens in the life of the arc: the arc began at "A" when the electrodes were 1½ feet apart, and was stretched 8 feet so that it finally went out at "B." The arc trailed off like a comet because at the left the electrodes were close together and more power was produced. As the arc was drawn out, the heated air carried the flame upward, the flame decreasing as the air gap was widened.

Figure 3 shows the sort of picture obtained by not opening the camera shutter until the arc has been drawn out quite a distance. Figure 4 was taken under the same physical conditions as Figure 1, but the halo is not masked out entirely; note the halo at the bottom and the sharply defined layers at the top of the arc. Figure 5 is a snaky specimen of the striated arc.









The Pattern of Evolution

By W. D. MATTHEW, Ph. D.

Professor of Paleontology, Chairman of the Department of Paleontology, and Director of the Museum at the University of California

A Criticism of Doctor Austin Clark's Thesis†

A GREAT many people are talking about evolution nowadays. Most of them do not know much about it and, generally speaking, the less they know about it the more it horrifies them. The theory of evolution, when you come to know it well, is not only of marvelous and inexhaustible beauty, but is an inspiration to a higher type of idealistic living than any orthodox religion.

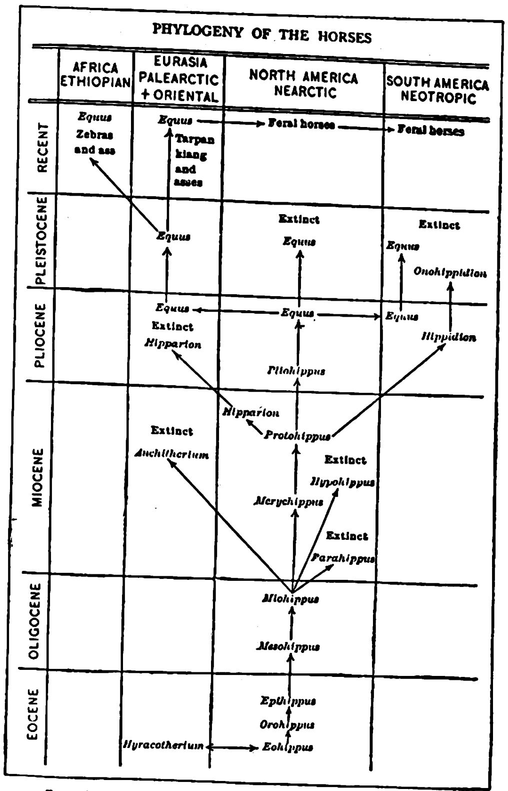
Doctor Clark, as a distinguished biologist and a specialist in certain groups of modern invertebrate animals, is very distinctly one who does know what he is talking about, and his views and conclusions about evolution are entitled to very careful and respectful consideration. If in the following pages I find it necessary to criticize and modify his statements of evidential fact, it should be understood that it is because they lie for the most part in a field that is my specialty but not his, the field of paleontology, and especially of vertebrate paleontology. In a scientific discussion the facts and the immediate interpretations that may legitimately be placed upon them are usually matters that must rest largely upon the authority of specialists. The soundness and validity of the conclusions drawn from these facts are matters of logic on which any reasonable man can and should judge for himself.

IN attempting to explain the principle of evolution (for it is a principle, not a theory, to the paleontologist) as it has actually worked out in the past history of life, certain aspects and effective illustrations have necessarily been selected from the record. These have been popularized and stated in some detail, while other parts of the evidence, often equally convincing but less readily explainable or of less general interest, have been omitted or briefly and casually summarized. This other evidence is quite necessary to any complete understanding of the nature of the record, but much of it is very difficult to get at, published only in technical papers scattered through numerous scientific journals. Much of it has never been printed at all; the specimens and records are stored out of view of the public in the research rooms of various museums, their existence known to the merest handful of specialists.

Such evidence, not yet assembled nor made available to the general student, yet serves to color the thought of specialists and control their interpretation of the better known data. Its existence, and, I may add, its controlling importance in the interpretation of our problems, is the reason why, in the free democracy of science, we may grant "authority" to individuals in their special line of research.

I do not agree with Doctor Clark's conclusions in this essay, because I think he has not fully understood the paleontological evidence, nor the geological and geographical background against which it must be viewed for correct interpretation. But he has quite properly pointed out certain neglected aspects of the evidence which make it less convincing as commonly presented than it really is when fully known.

These lie in two fields. First, that of the fossil record of the evolution of the various races of mammals in the Tertiary period—my own particular subject—and of the different orders of reptiles and classes of vertebrates in preceding periods. Second, the broader problem of the relationship and origin of the great phyla or branches of animal life, of which the vertebrates are one.



In the evolution of the horse there were several branch lines, none of which has survived, as shown in the cut

As concerns the first, I am obliged to take exception to his presentation of the evidence, as incomplete and in this connection misleading, and to his interpretation of it as failing to take into account the geologic and geographic background which controls its significance. He gives a brief and fairly correct summary of the record of the evolution of the horse, tracing it from the little four-toed *Eohippus*. But he does not mention that such diverse animals as the rhinoceros and the tapir are likewise traceable to small four-toed ancestors contemporary with the Eocene four-toed horses, and so like them that the most expert specialists have not always been able to distinguish the one group from the others.

Moreover, he speaks of the equid series as though it were a single line, and has elsewhere spoken of it as "an example of linear evolution." But it is not; there were several branch lines more or less clearly defined, running into parallel or partly diverse adaptations, none of which has survived to the present day. And in each stage of the main line of evolution of the modern horses there were several species, some more, some less in the direct line of descent. The record has, in fact, the familiar form of the phylogenetic tree, continually dividing up into branches and twigs of more or less importance, and the series customarily presented is merely the direct line leading up to the modern horse. From the same common ancestral stock are derived other lines of specialization, each one similarly branched, and two of them surviving today in the rhinoceroses and tapirs.

MOREOVER, the actual record of fossil perissodactyls [hoofed animals with odd number of toes. —ED.] as known to us to-day is obviously a very incomplete one if we view it in the light of geology and geography. The living members of the horse family consist of a number of related species—wild horses in Asia, wild asses in Asia and north Africa, zebras in Africa—scattered over considerable parts of the earth's surface, different species in different regions. The rhinoceroses are similarly distributed in southern Asia and Africa the tapirs in Malaysia, and Central and South America. Each family had a much wider distribution at the end of the Tertiary period, and during the Tertiary they were widespread, numerous, and varied through all the northern continents, the living members of the group being a few widely scattered, specialized survivors of a disappearing group, all probably on their way to extinction.

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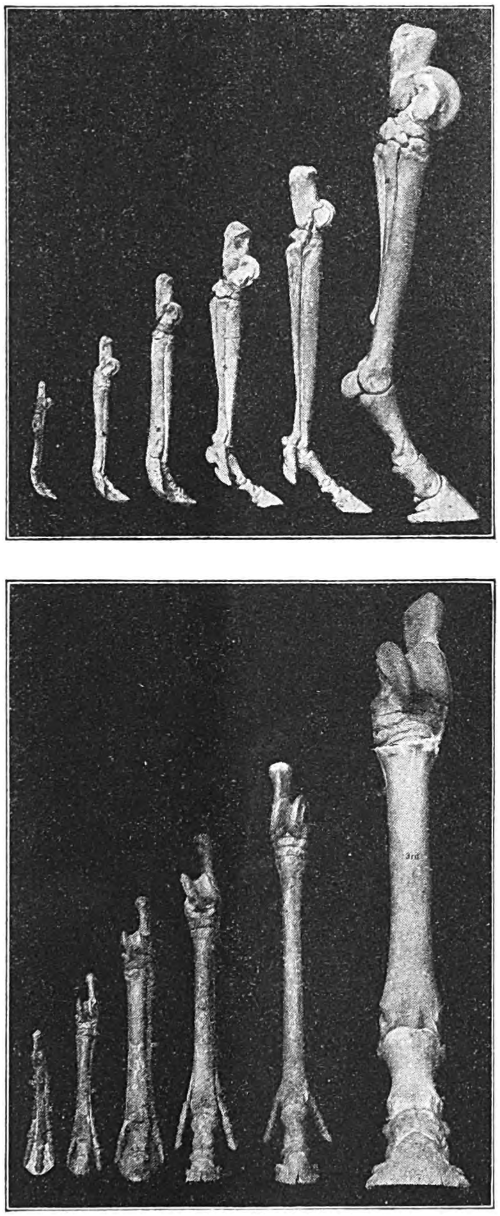
†SCIENTIFIC AMERICAN, August, 1930, Page 104

At each successive stage in their evolution, at each epoch of the Tertiary, there must have been numerous different species of "horses," as also of rhinoceroses and tapirs, living in various parts of the northern continents (Europe, Asia, and North America), some ranging over considerable parts of the continent, some confined to restricted areas, slowly shifting their range, becoming more abundant and widespread or less so, as similar animals do to-day.

OUR fossil record, though derived from many places, represents only the animals from small localities, scattered here and there over the continental regions, most of it from a few areas in the middle-western United States and certain parts of western Europe. Out of the dozens or hundreds of species of the family that were living in different parts of "Holarctica" (the aforesaid northern continents) at any one epoch or stage in the evolutionary history, we actually know only a few, and of these one appears to be more directly intermediate than others between the earlier and later stages. It is the closest known approximation to the direct line of evolution.

Our record, then, while it gives a correct picture in a broad way of the evolution of the race as a whole, reduces to a series of approximations more or less close to the detailed and exact phylogeny of any one line of descent. This is the explanation of the "gaps" of which Doctor Clark speaks, and which he thinks, as many other biologists have thought, must be due to some sudden great or considerable change in structure of the same nature as the "sports" with which Darwin and all breeders of plant or animal races were familiar in the last century, and which, under the name of mutations, have been so thoroughly and profitably studied by the geneticists of this century.

But it is not probable, in view of the nature of our fossil record, as outlined above, that the gaps in our evolutionary sequences are many, if any, of this nature. For they are very directly proportioned in numbers and in width to the scantiness and inadequacy of our record. Where the records are most abundant, and especially where we have reason on various grounds to believe that they come from points in or near the center of evolution and dispersal of the race, the habitat of the most progressive species, there these gaps almost or entirely disappear. In general it may be said that the more complete our record of any race the nearer it comes to being continuous, or separated by gaps which, although definite, are not beyond the limits of ordinary individual variation in a species.



Courtesy American Museum of Natural History

Side and front views of the evolution of hind feet of the horse. The smallest is *Eohippus*, then come *Mesohippus, Miohippus, Merychippus, Hipperion*, and *Equus*, the modern horse

The nature of these variations is much better understood than it was in Darwin's time, thanks especially to the researches of T. H. Morgan and his school. Some of them are inherited according to certain definite laws. They are "mutations" of the same nature as the larger, more conspicuous and more occasional mutations which the geneticists have studied in detail. Others are the non-heritable differences between individuals, due to slight or considerable differences in their environment and growth history.

Now it is to be observed that almost any major or conspicuous departure from the normal in an individual would have little or no chance of giving rise to a permanent change in the race. In almost all cases it would be immediately fatal or seriously detrimental to its chances for survival. For each animal is closely adjusted in habits and environment to a particular adaptation, a particular mode of life. With any important single change in its structure it would cease to be an efficient working mechanism. With any conspicuous change in appearance it would become a stranger to its fellows and as unpopular with them as strangers usually are. And even if it succeeded in leaving a few descendants, the chances that these would possess any superiority to their numerous normal competitors would be infinitesimal. Practically all cases in all combinations with the normal would result in an inferior mechanism, sooner or later to be eliminated by natural selection.

WITH the minute heritable differences these disadvantages would not exist. We are familiar with them in our own species and with all animal and plant races.[1] And moreover, the various correlated small differences in other parts of the organism necessary to make an efficient working mechanism can be and are adjusted by individual growth. This is a temporary adjustment, repeated generation after generation until it can be replaced by the appearance of the necessary inherited variations, thenceforward a permanent though small step forward in the evolution of the race.

We must think of each species as it is in nature, each race as it always has been in nature, as a complex of interbreeding strains, each having certain slight differences in inherited characters, intercrossing over and over again until some profitable combination of variations occurs, to be preserved, increased, and finally made universal by natural selection, and disadvantageous characters and combinations eliminated in the same manner. It is a process of almost inconceivable slowness. To change one species of horse into another seems to have required something like half a million or a million years—two or three hundred thousand generations. No appreciable change would occur in a few thousand years; but in the larger view of the geologic time scale it is seen to be cumulative, resulting in a slow progressive change in adaptation to equally slow changes in climate and environment.

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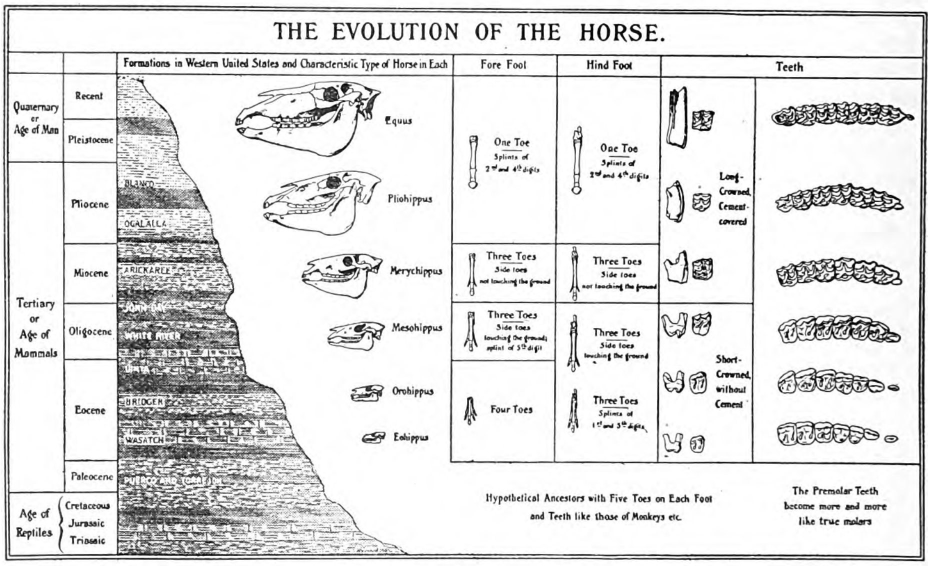
[1] Men slightly taller than the normal are common, and are apt to excel in many lines of athletics. Seven- or eight-foot giants are rare, and are always more or less crippled and handicapped by their abnormal height, its lack of adjustment to other proportions and to the world they live in. They seldom live to old age and find employment difficult except in the circus. So with any wide and conspicuous variation from the normal. It is of relatively rare occurrence, and *it is a handicap, not an aid to survival.*

Large changes, conspicuous mutations, can play little or no part in this slow process. A three-toed sport from a four-toed horse would be a cripple. He would not have the numerous correlated adaptations necessary to make of him a good working mechanism, all of which are present in the three-toed horses. No sport that I have ever seen or heard of is at all analogous to such a great series of differences as those that separate the four-toed from the three-toed horses. Very few of the sports and conspicuous mutations would have any chance of survival in competition with the normal members of their race. Still fewer would be those that would be at all likely to give rise to new races. Yet there are a few isolated and exceptional instances among modern animals where certain peculiarities can best be explained as due to such heritable variations of considerable amount. It is the rare exception, and there is no reason to suppose that it played any part in the recorded evolution of the horse.

THE entire history of the perissodactyl order resolves itself then into a branching out from a common ancestry very nearly represented by the *Eohippus* into such diverse specialized types as the horse, the tapir, and the rhinoceros, with various other specialized races that have not survived; and each branch in turn has its minor branches and twigs of which in the horse only one has survived and has itself begun to branch out into horses, asses, zebras, and so on. The record is fragmentary, but no other reasonable interpretation can be placed upon it than to see it as a slow, gradual change quite analogous to the growth and branching of a tree, and like it conditioned in direction, amount, and character of growth, by the circumstances and advantages of the environment, and by the continuity of life. And this is the general pattern of evolution, which we see illustrated in every race of animals and plants whenever our record is adequate to show its real character. The more complete the record, the more precisely it conforms to the pattern.

After a "bone-digger" has studied and compared all the known material, fossil and recent, old and new, in a group of animals, and found them all to fit into this pattern; after he has gone into the field and secured new fossils from new formations and previously unknown stages, and found them also fitting into the pattern and filling some of its gaps; when he has repeated the operation on group after group, and learned from reading and conversation that it is identical with the pattern determined by his confrères in various other fields of paleontological research; that it has stood the test of a century of criticism as to its theoretical as well as practical soundness—he gets to feel that the phylogenetic tree as the true pattern of the history and evolution of life is a pretty fundamental and certain matter, that it has taken this form because, short of miracles, it could take no other. In so far as the record goes it definitely does take this form. Where the record is absent, we should assume the same pattern unless there is convincing evidence for a different interpretation of existing life.


THE EVOLUTION OF THE HORSE.
Formations in Western United States and Characteristic Type of Horse in Each
Fore Foot
Hind Foot
Teeth
Quaternary or Age of Man
Recent
Pleistocene
Tertiary or Age of Mammals
Pliocene
Miocene
Oligocene
Eocene
Paleocene
Age of Reptiles
Cretaceous
Jurassic
Triassic
BLANCO
OGALALLA
ARICKAREE
JOHN DAY
WHITE RIVER
UINTA
BRIDGER
WASATCH
PUERCO AND TORREJON
Equus
Pliohippus
Merychippus
Mesohippus
Orohippus
Eohippus
One Toe
Splints of 2nd and 4th digits
One Toe
Splints of 2nd and 4th digits
Three Toes
Side toes not touching the ground
Three Toes
Side toes not touching the ground
Three Toes
Side toes touching the ground; splint of 5th digit
Three Toes
Side toes touching the ground
Four Toes
Three Toes
Splints of 1st and 5th digits
Long-Crowned, Cement-covered
Short-Crowned, without Cement
Hypothetical Ancestors with Five Toes on Each Foot and Teeth like those of Monkeys etc.
The Premolar Teeth become more and more like true molars

Doctor Clark states, however, that this is not the case with other groups whose fossil record is at least partially known, and instances the cats and dogs as an example. Cats were cats and dogs were dogs, he tells us, and as far back as their history can be traced there is no approach between them. I do not know where he got this information, but it is quite incorrect.

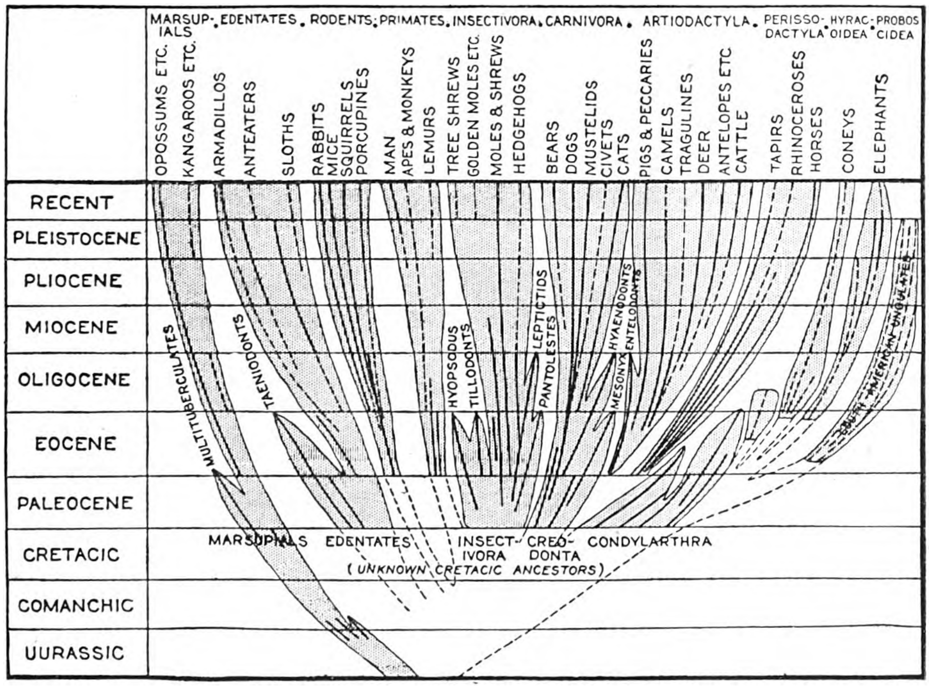
Let us look for a moment at the facts. Cats are among the most highly specialized of the Carnivora in the reduction and special adaptation of the teeth, but are very generalized and much like the older extinct and more primitive living Carnivora in the limbs and feet. Dogs, on the other hand, have retained a comparatively primitive dentition, but have specialized considerably in the limbs and feet for swift running. Both have a high type of brain among the Carnivora, and a variety of minor special characters are found in one or both.

Now we can trace back the cats and dogs through a fairly complete series of stages to the Oligocene epoch of the Tertiary, and the dog ancestry is a pretty close series beyond that to the beginning of the Eocene, but little is known of the earlier ancestry of the cats. The Oligocene dogs are but little different in the teeth from their modern descendants, but the limbs have much more nearly the cat proportions, the feet have five toes, like cats, and the claws are partially retractile. The Oligocene cats on the other hand are much like modern cats in limbs and feet, but have more numerous and less specialized teeth.

When first found, these Oligocene ancestors were not recognized as cats and dogs, as the names of the earliest discoveries testify. *Cynodictis* (i.e., dog-toothed weasel), *Daphœnus* (devourer, i.e., glutton or wolverene) are now recognized as ancestors of the dogs, *Aelurogale* (i.e., cat-marten) and *Dinictis* (i.e., terrible weasel) as ancestors of the cats; but these relationships were not at all clear to the experts who first described them. Not until the intermediate series were discovered could the real affinities be demonstrated.

IT appears, therefore, that Doctor Clark is wholly mistaken in supposing that cats and dogs make no approach as we trace their ancestry back. They are already distinct in the Oligocene, but most of the wide differences that separate them today have not yet appeared. Could we trace the cats back through the Eocene, we should presumably find them gradually merging into a common ancestry with the dogs, which we can so trace, and whose Eocene ancestry is merged in exactly this fashion with that of mustelids (otters, minks, skunks, and so on) and bears and raccoons and civets. It is identically the same pattern as we have seen in the horses, tapirs and rhinoceroses, and goes step by step along with it in time. (See cut.)

I fully agree with Doctor Clark—and with Darwin—that the selection and differentiation of the various domesticated breeds of animals affords the most important illustration of how natural selection has operated. But I can not at all agree with his statement that there are no intermediates between the principal breeds of dogs as he cites them, nor with his implication that they all appeared suddenly in their modern stage of specialization. Any dog-fancier or student of the history of the breeds of dogs could set him right on that better than I can, but I am sure from what I have read that the different breeds, while originating in part as sports, have been largely developed and modified through centuries of selection and inter-crossing. The whole subject of variation under domestication has been very thoroughly treated by Darwin and others, and its relationship to natural selection is largely affected by the fact that most of the breeds as at present developed, while useful to man for certain purposes, would have but little chance for survival in nature. Some of them are probably based upon wild species, and would doubtless revert to type in time if they ran wild; but there is no reason to suppose that these wild species were evolved in any but the normal manner.


MARSUPIALS
EDENTATES
RODENTS
PRIMATES
INSECTIVORA
CARNIVORA
ARTIODACTYLA
PERISSODACTYLA
HYRACOIDEA
PROBOSCIDEA
OPOSSUMS ETC.
KANGAROOS ETC.
ARMADILLOS
ANTEATERS
SLOTHS
RABBITS
MICE
SQUIRRELS
PORCUPINES
MAN
APES & MONKEYS
LEMURS
TREE SHREWS
GOLDEN MOLES ETC.
MOLES & SHREWS
HEDGEHOGS
BEARS
DOGS
MUSTELIDS
CIVETS
CATS
PIGS & PECCARIES
CAMELS
TRAGULINES
DEER
ANTELOPES ETC
CATTLE
TAPIRS
RHINOCEROSES
HORSES
CONEYS
ELEPHANTS
RECENT
PLEISTOCENE
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
CRETACIC
COMANCHIC
UURASSIC
MULTITUBERCULATES
TAENIODONTS
HYOPSODUS
TILLODONTS
LEPTICTIDS
PANTOLESTES
HYAENODONTS
ENTELODONTS
MESONYX
SOUTH AMERICAN UNGULATES
MARSUPIALS
EDENTATES
INSECTIVORA
CREODONTA
CONDYLARTHRA
(UNKNOWN CRETACIC ANCESTORS)

Redrawn from Matthew, in "Problems of American Geology," Yale University Press

How the mammals deployed during the Tertiary period. Despite the indicated gaps a careful study of the subject will point to a common ancestor of all the mammals. Note under "Carnivora" (at the top of the cut, just to the right of the center) the dog-cat ancestry mentioned by the author

Concerning the evolution of man, Doctor Clark does not say much, but again I must take exception to some of his statements. He emphasizes the distinctness between man and the great apes "in every bone of the skeleton," and assures us that "the differences seem too great to have ever been bridged by intermediate types," and that "of all the fossils that have been found not a single one represents indubitably a missing link."

I do not know how far he is acquainted with the demonstration made by Huxley and confirmed by many subsequent writers, that the anatomical gap between man and the anthropoids is less than between these and the monkeys, less than between monkeys and lemurs, and that the differences are very largely superficial adaptations. But if by a missing link he means any intermediate stage or stages, I can not see how he would explain away the characters of the Neandertal man, which differs from modern man in a dozen or more obvious distinctive characters of teeth, skull, jaws, and skeleton, every one of them except his "taurodonty" constituting a definite approach to the anthropoid apes. Or the characters of the recently discovered Peking man and of the Piltdown man, both early Pleistocene, older than the Neandertal man, and making a further approach in most, although not all, characters to the anthropoids—the Peking man having more human teeth but a very ape-like jaw, the Piltdown man so apelike both in teeth and jaw that some authorities have insisted that the jaw could not have belonged with the skull, which is still dominantly human. Or of the Taungs skull from South Africa, related to the chimpanzee, but making an unmistakably nearer approach towards the human type. Or the classic *Pithecanthropus* of Java, which has a skull-cap and brain construction about half-way between ape and man.

If these are not intermediate stages, what are they? If Doctor Clark means that they are not "missing links" because they are no longer missing, I quite agree, and only wish that more could be discovered, and that all of them were as fully known as the Neandertal man is today, thanks to Marcellin Boule.

Again Doctor Clark makes a great deal of family life and the dependence of women, of articulate speech and the use of tools and fire, as fundamental distinctions between man and all other animals. But there is a pretty wide difference between man and man in these and most other distinctions, physical or mental. It is not especially rare among primitive races of man, or civilized races under primitive conditions, for a woman to bear and rear offspring without the help of man; nor do I think it is wholly the custom among apes, as it certainly is not among various other animals. The great apes are not "promiscuous," nor indeed the monkeys, although they are not monogamous; and various degrees between polygamy and promiscuity are not particularly uncommon among the lower races of man. Is the difference between an animal that has a dozen or more sounds expressive of definite concepts or feelings and a savage who has at most a couple of hundred, so very much greater than between the latter and a man of science with a vocabulary that runs into the tens of thousands?

THESE are all matters of degree, as are all the distinctions seen by science between man and animals. If indeed Doctor Clark had declared for the presence of a soul, as do the orthodox, as the fundamental and impassable gulf between man and animals, I would have nothing to say. As a man of science I know nothing one way or the other about souls, and my religious convictions I do not think it necessary to express in the SCIENTIFIC AMERICAN. But so far as scientific evidence and the fossil record are concerned, it appears to me that it fits very clearly and convincingly into our pattern of evolution, and that the descent of man and the anthropoid apes from a common ancestry is far better proved than many things that we implicitly believe. There is, I am well aware, a divergence of opinion among eminent scientists as to how far back that common ancestry should be placed and just what relationship should be assigned to the apes.

Turning now to what Doctor Clark has called *eogenesis*, that is, the origin of the great branches or phyla of animal life, as he fully recognizes, the origin of these great branches must be carried back toward or beyond the beginnings of the geologic record, while our fossil record extends back only through the later half of that record. The rest is inference. If it were true, as he gives us to understand that it is, that each great branch appears in the Cambrian period as clearly distinct, as fully differentiated and specialized as it is today, then it would be a reasonable inference, although far from being necessarily or even probably true, that that degree of distinctness continued on back indefinitely. The alternate view would be that, having in the course of evolution attained the full degree of specialization that was of any net advantage to the organism, natural selection would cease to impel it any further and it would remain unchanged in the essentials of its machinery so long as it remained in the environment to which it was now completely adapted. If the environment changed, further changes might come about, not necessarily in the direction of progress. Otherwise it might well remain substantially unaltered from the Cambrian or a much earlier period, down to the present day.

I believe that that is pretty largely true of the lower groups of invertebrates, the groups with which Doctor Clark is especially familiar. Cambrian protozoa, Cambrian sponges and jellyfish, are much like their modern relatives, probably just about as much specialized *so far as the hard parts show.* The same is at least partly true of the echinoderms (star fishes, sea urchins, and so on). Whether it is true of worms nobody really knows. But when we get into the higher groups, the molluscs and arthropods (spiders, crabs, insects, and so on), and especially the vertebrates, it is very far from true. The Paleozoic era molluscs or arthropods do not have nearly the degree of diversity and specialization that can be found among the higher modern molluscs. The earliest insects have not taken on the important specializations that characterize the higher groups of the class; they compare only to the lower and more primitive groups. And the vertebrates, when they make their first appearance as ostracoderms in the Paleozoic era, have, as Stensio has shown, all of their essential organs in a more primitive stage of imperfect evolution as compared with even the most primitive of modern fishes, and are a long way behind the higher vertebrates in the perfection and specialization of their mechanism.

IT is quite true, then, that the great branches of animal life were already distinct in the Cambrian period, with the exception probably of the Vertebrata. It is by no means the case that they are as diverse from each other or as diversified within each group as they are today. On the contrary, the most advanced and specialized groups of the early Paleozoic era find their nearest relatives in the more primitive and generalized groups of today. Again taking our phylogenetic tree as an illustration, we may say that while most of the main boughs were already distinct when the tree was half-grown, and, while some of the twigs of different boughs today may be as near to each other as any in these branches were in the Cambrian period half-way stage of growth, yet the boughs as a whole have grown farther apart, are more fundamentally separate and distinct, as well as broader in scope. It is therefore altogether erroneous to conclude that the relationships between the branches have undergone no change at all since the Cambrian.

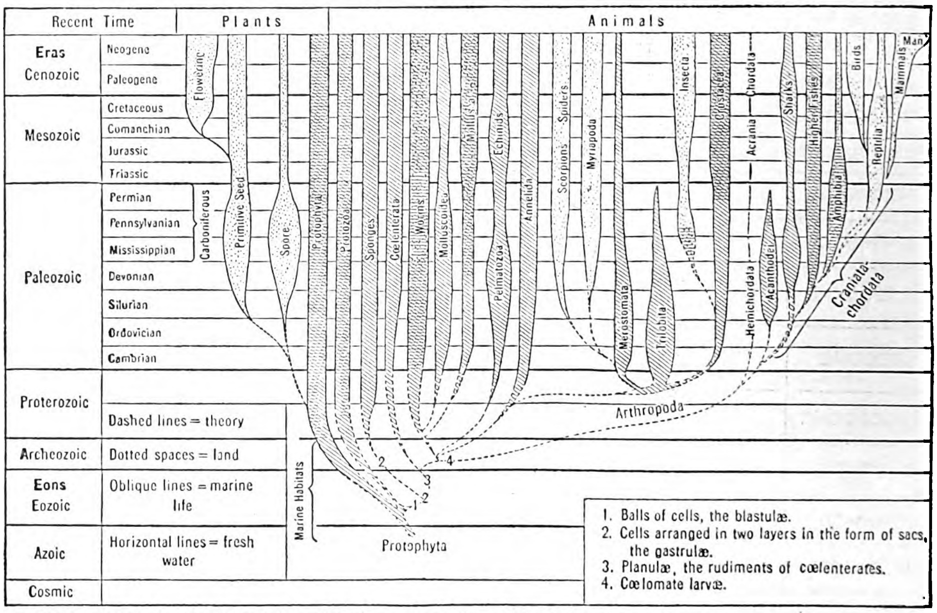
Our picture of the Cambrian tree of life is incomplete and sketchy, it is true. It is only the hard parts of these animals that are preserved to us (there are a few rare and partial exceptions), comparatively simple in structure in these lower types, and frequently of more or less doubtful position. They are identified chiefly through their likeness to corresponding hard parts of later and better known or surviving types. For the most part we do not know whether the far more important and complex soft parts were like those of modern forms. It is in this way that they are "at once recognized"—when they are—for the history of paleontology shows many decades of dispute over the real relationship of some of of the problematic fossils.

At all events, we can hardly question that the tree has grown enormously since the Cambrian, and in view of that fact I see no reason to adopt Doctor Clark's thesis that it came suddenly into existence at some moment in pre-Cambrian time. It is too much like the Indian juggler's mango tree trick, and, while the pre-Cambrian tree is hidden under a basket, under the cloak of our utter ignorance, I do not believe that such a miracle happened, or that its growth was otherwise than according to the natural processes seen in the subsequent record of the history of life.

Nevertheless there is, and will always remain, much obscurity as to the origin and early development of life on the earth, and a wide latitude for reasonable hypothesis as to its precise cause and course. I see no reason to adopt Clark's view that all the different branches originated at one time. Certainly the vertebrates must be excluded from any such hypothesis, for Stensio's studies have shown that the ostracoderms, although vertebrates, have the vertebrate organs and characters in a very rudimentary stage of development and make a very marked and significant approach to certain invertebrate groups.

IT is by no means clear that the other branches have a common origin. It is quite conceivable, and has been argued for half a century or more, that each branch may have evolved separately from inanimate matter at different times, passing through a similar but distinct one-celled stage, the identity of cell-structure in all modern animals being due to such fundamental laws of matter as make one quartz crystal like another in form and structure and composition and relationship of its component molecules. We pass here into the rarefied atmosphere of speculative hypothesis, far removed from the solid grounds of fact and record on which the paleontologist builds his lowly but tolerably permanent habitations.

And I confess that these higher flights, while interesting to watch, do not tempt me to emulation. My airminded friends may scale the heights of fancy as they will. Those of us whose temperament is more cautious and conservative will content ourselves with admiring their ingenuity and daring, and hope that they will not crash.


Recent Time
Plants
Animals
Eras
Cenozoic
Neogene
Paleogene
Mesozoic
Cretaceous
Comanchian
Jurassic
Triassic
Paleozoic
Permian
Pennsylvanian
Mississippian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Proterozoic
Archeozoic
Eons
Eozoic
Azoic
Cosmic
Dashed lines = theory
Dotted spaces = land
Oblique lines = marine life
Horizontal lines = fresh water
Marine Habitats
Flowering
Primitive Seed
Spore
Protophyta
Protozoa
Sponges
Cœlenterata
Worms
Molluscoidea
Mollusca
Echinids
Pelmatozoa
Annelida
Scorpions
Spiders
Myriopoda
Merostomata
Trilobita
Insecta
Crustacea
Arthropoda
Chordata
Acrania
Hemichordata
Acanthodei
Sharks
Higher Fishes
Amphibia
Reptilia
Birds
Mammals
Man
Craniata-chordata
Protophyta
1
2
3
4
1. Balls of cells, the blastulæ.
2. Cells arranged in two layers in the form of sacs, the gastrulæ.
3. Planulæ, the rudiments of cœlenterates.
4. Cœlomate larvæ.

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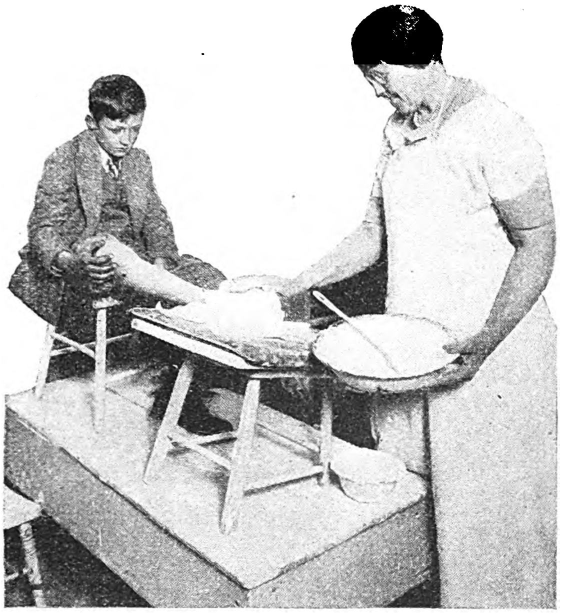
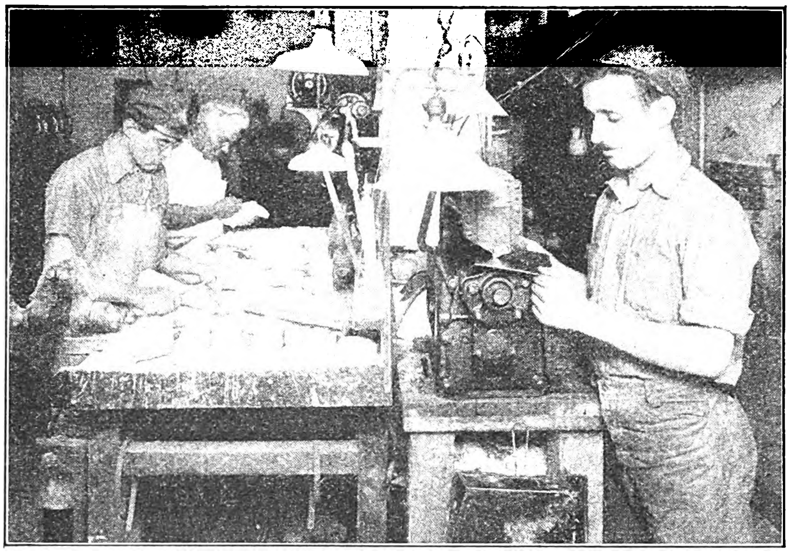
The phylogenetic tree, the true pattern of the history and evolution of life. The heavy horizontal line just below the center marks the "Cambrian period"

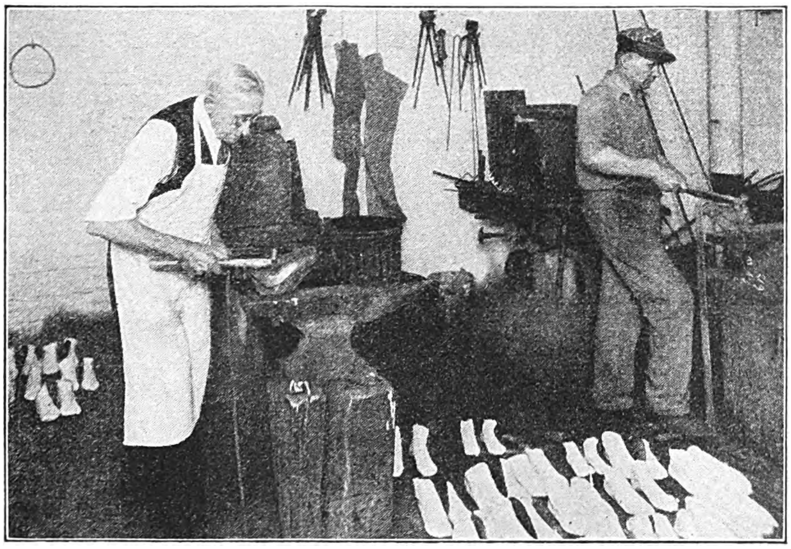


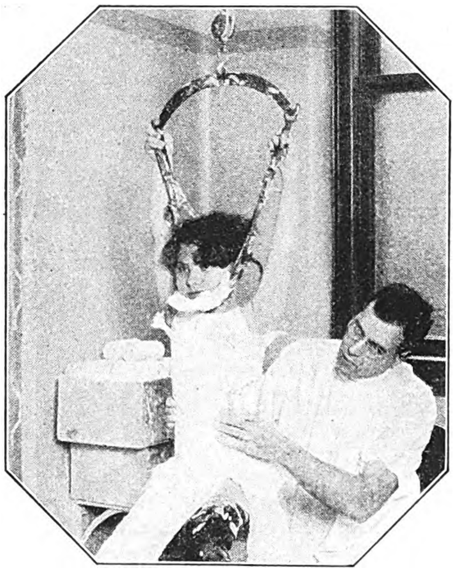
The first step in making a foot brace is a plaster impression, forming a mold for casting



A plaster duplicate of the crippled foot is cast in the mold, trimmed, and a piece of metal is cut to shape for forging

In this picturesque forge shop the iron plates are made to conform to the plaster replica of the foot made in the mold





Making a plaster jacket for the back. From this cast a mold is made which serves as a base on which to build a corrective corset

Modern Rehabilitation of the Cripple

By ALBERT A. HOPKINS

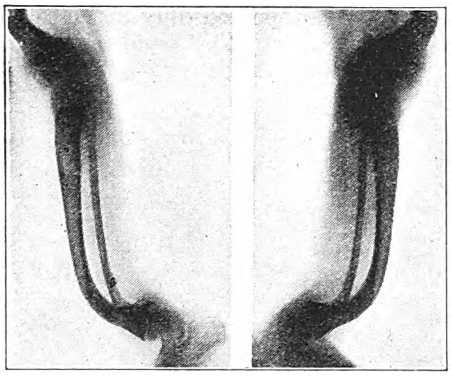
UNDER the shadow of one of New York's great home developments—Tudor City on 42nd Street—is the New York Society for the Relief of the Ruptured and Crippled, which devotes itself to orthopedic relief by surgery or otherwise. In the last quarter century great advances have been made in the treatment of cripples. There was a time when the patient was dismissed with a properly fitted truss or brace. Now the tendency is to try to relieve the sufferer by surgery, or by mechanical, electrical, or therapeutic treatments. We shall here consider only the non-surgical phases.

The hospital operates a vast clinic where treatment is free to the poor, and those who can pay are asked as little as 25 cents to one dollar. Those who are better off are generally glad to pay five dollars. The hospital originally occupied the plot on which the Commodore Hotel was built. The Grand Central Station improvements called for a new hotel and the hospital was moved a few blocks to the eastward into the heart of an extremely congested district.

Orthopedic surgery deals with the rectification of congenital and acquired deformities, particularly those of the

limbs and spine. It is a most interesting phase of surgery. Often as many as eight or ten operations are necessary before the patient is restored to society able to engage in life's struggle on a fairly equitable basis, handicapped perhaps, but vastly improved. This all takes time and it sometimes requires over a year to "make over" a child. A hospital of this kind is not a particularly cheerful place to visit, but on leaving you are filled with thankfulness that your limbs and your children's limbs are straight and that you have never been stricken by the dread infantile paralysis.

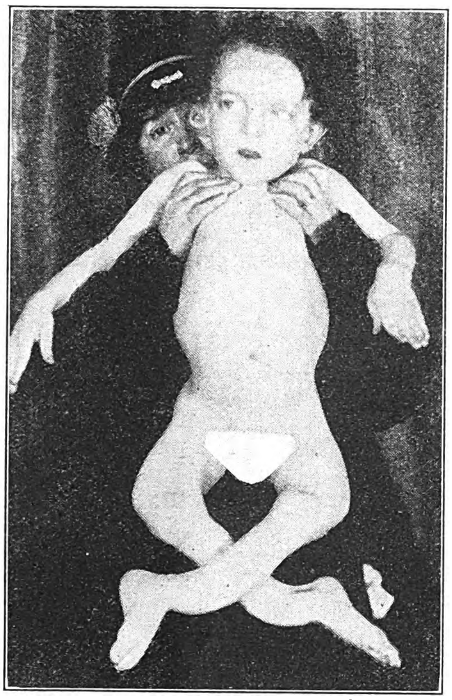
We cannot here go into the technique of orthopedic surgery with its power-driven bone tools, bone dowels, the reconstruction of bone ends and the introduction of transplanted or living tissue between the bone ends to secure movement, and dozens of other complicated and interesting operations. They can hardly be explained to the lay reader, so we will pass on to some of the other methods of treatment.



Correctional devices have always proved of great value with or without surgical relief. Foot correction occupies an important part of the work of this hospital. A cast is made of the foot and this serves as a mold in which to cast in plaster of Paris a replica of the deformed foot. This cast serves as a pattern to which a metal plate is conformed. This flat plate is cut out to form by a sheet metal working machine or nibbler. It is then contoured by blacksmiths who give a picturesque air to the shop with their time honored anvils.

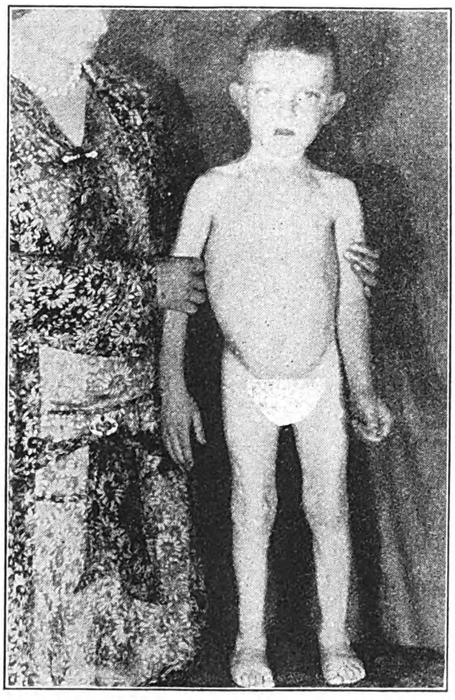
IN spinal deformities a cast is taken from the patient. A plaster jacket is made on the patient by winding wet crinoline bandages in which plaster of Paris is impregnated. This drys in a few minutes and becomes very hard. If a corset is desired this jacket is slit down the front, removed, and used as a pattern.

Various devices are employed for exercising the flabby and unused muscles and even used to help teach the patient to walk once more. Therapeutic lights of all types are employed and hydro-therapeutic treatments of all kinds are given. The therapeutic pool gives much relief from the effects of infantile paralysis, arthritis, congenital hip disease, and other diseases paralyzing the muscles. In effect, the treatment in the pool is similar to that given at Warm Springs, Georgia, which has been so strongly advocated by Governor Franklin D. Roosevelt of New York State, also a sufferer.



***Above:* A victim of rickets so deformed that he has never walked and his legs could not be untwisted. *Left:* X rays before operation**

The pool might be termed an underwater gymnasium but this would not be strictly correct. The principle is one of the most elemental in physics. Since a body submerged in water loses weight in direct proportion to that of the displaced water, patients assisted by this buoyancy are able to perform exercises while in the water, which they could not possibly do when not submerged. Dr. K. G. Hansson, of the hospital staff, conceived the idea in 1914 of indoor pools of heated water for therapeutic purposes and such pools now exist in New York City, Port Jefferson, Long Island, and in Los Angeles.

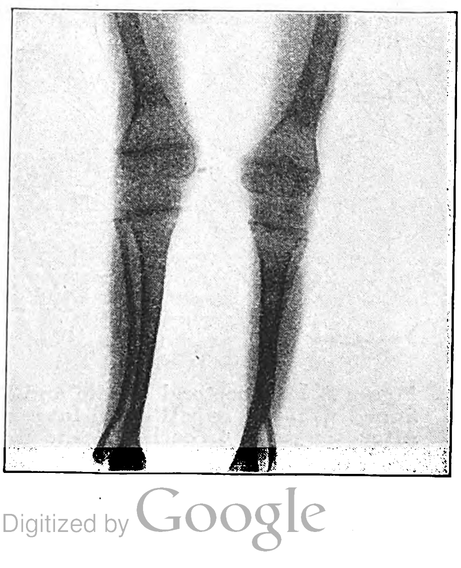


***Above:* The patient after operations had restored health. He can play, and his mentality has improved. *Right:* X rays after operation**

The patient is given a shower and then climbs up into the pool, which is waist-high and not sunk as is usual. The water is filtered and sterilized with ultra-violet rays. The pool is 26 feet long, 12 feet wide, and the depth varies from two to four feet. The tiles are of the "non-skid" variety to protect those who, at best, have difficulty in walking.

TWO of our illustrations show the "principle of Archimedes" worked out in actual practice. We also show a table submerged in the pool so that the patient may rest the torso on it and exercise the limbs.

Through the courtesy of Dr. Armitage Whitman of the hospital staff, we are enabled to present pictures of a boy whose whole life was changed by surgery. A social worker connected with another hospital visited a recently discharged patient who was a janitress in a tenement. There were no windows in the apartment and here the social worker found a child sitting with his legs crossed—tailor fashion, as in one of the pictures. He was a victim of rickets caused by lack of sunshine, proper food, and fresh air. His legs were consequently so deformed that they could not be untwisted. He had never walked and his feet had never touched the gound. The boy was removed to the Hospital for the Ruptured and Crippled and after four operations at proper intervals his deformities were corrected and he now walks normally and his mentality is improved.



Basic Patents in Evolution—II

By WILLIAM K. GREGORY

Professor of Vertebrate Paleontology, Columbia University. Curator, Departments of Anatomy and Ichthyology, American Museum of Natural History. Member of the National Academy of Sciences

IN Part I of this article we saw that the striped muscle fiber, a living elastic thread that contracts when stimulated by its minute nerve fiber, was the first "basic patent" or primary invention of the complex locomotor apparatus of vertebrates. The second step was the grouping of these muscle fibers into zigzag muscle segments arranged in tandem along either side of the body. Whatever may have been the still earlier stages, it is certain that at a very early period the vertebrate body as a whole had been modeled into some kind of "stream-line" form, with a blunt, rounded head and flowing contours dwindling to the rudder-like tail. This discovery of the advantages of the stream-line body-form, both for forward locomotion and for heading up stream, may well be reckoned as the third "basic patent," although of course the reader will understand that in nature such changes are more or less continuous and more or less simultaneous, so that it is arbitrary to assign a numerical order to certain changes which may more properly be considered as details in a drift or movement whose general direction is known.

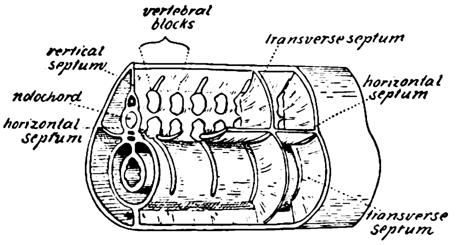


***Figure 6.* The basic patent of the vertebrate skeleton. The skeletal pieces (either cartilage or bone) arise as strengthening rods and blocks at the intersections of the longitudinal transverse and horizontal septa. After Goodrich, from "A Treatise on Zoology" (Ed., E. Ray Lankester), Part IX**

IN this connection it may be regarded as a well-established fact that the general course of evolution in the vertebrates from fish to man has been as follows: (1) a primitive chordate stage, typified broadly by the fossil ostracoderms of the Silurian age; (2) an early shark-like stage, with a relatively simple skeleton; (3) a lobe-finned stage of the Devonian age, provided with both lungs and gills and with paired paddles corresponding to our arms and legs; (4) an early land-living stage, typified by the earliest known amphibians of the Coal Measures; (5) an early lizard-like stage, known in the oldest fossil reptiles; (6) the stage of the mammal-like reptiles of the Permian and Triassic ages; (7) the early shrew-like mammals of the Triassic and Jurassic periods; (8) the first of the tree-living primates at the beginning of the Eocene epoch; thence (9) to the remotely prehuman stock that also gave rise to the Old World monkeys, perhaps at the close of Eocene times; (10) the predecessors of the anthropoid apes, some of the earliest of this lot giving rise to (11) the human line, perhaps in Miocene times.

Among other basic patents which were essential for the forward propulsion of an undulating stream-line body was the possession of a more or less elastic axial or functional backbone (Figure 6). In the first stage of its development this axis was unjointed and continuous and appeared in the form of the notochord. Later the notochord became surrounded by small blocks, clustering around the connective tissue partitions between the muscle segments, and still later these blocks combined in various ways to compose the different kinds of vertebræ that are found in amphibians, on the one hand, and in reptiles, birds and mammals, on the other.

At an early period steering was effected, as we have seen, by keel-like outgrowths from the body-wall, some of which eventually gave rise to the pectoral and pelvic paddles, which correspond to our arms and legs. At first these were supported only by rod-like pieces of cartilage that were laid down between the connective tissue mem-

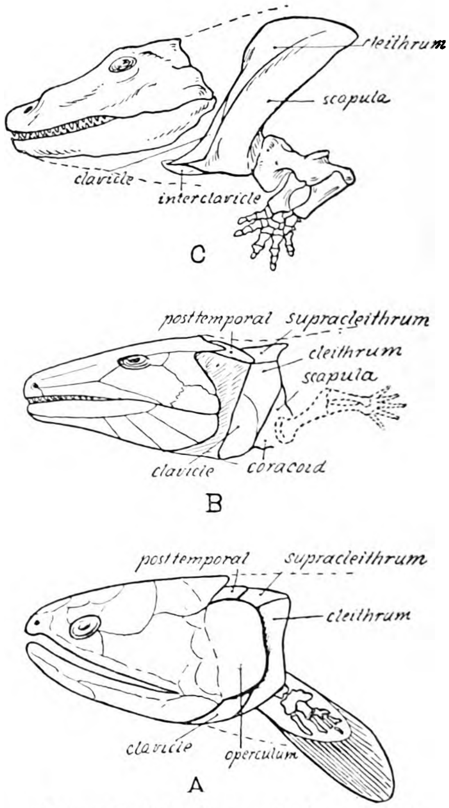


***Figure 8.* Relations of the shoulder-girdle to the skull in lobe-finned fishes and early tetrapods. (A) Lobe-finned ganoid (*Eusthenopteron*) from the Devonian period, with the pectoral girdle immediately behind the gill cover (operculum) and fastened to the skull by the post-temporal. (B) Most primitive known amphibian (*Eogyrinus*) from the Lower Carboniferous of England with the pectoral girdle still fastened to the skull by means of the post-temporal. (C) Typical primitive tetrapod (*Eryops*) from the Permian period of Texas, showing shoulder-girdle free from skull, although in life it was tied to it by muscles. Data for A from Bryant 1919; B from Watson 1924; C from Miner 1925**

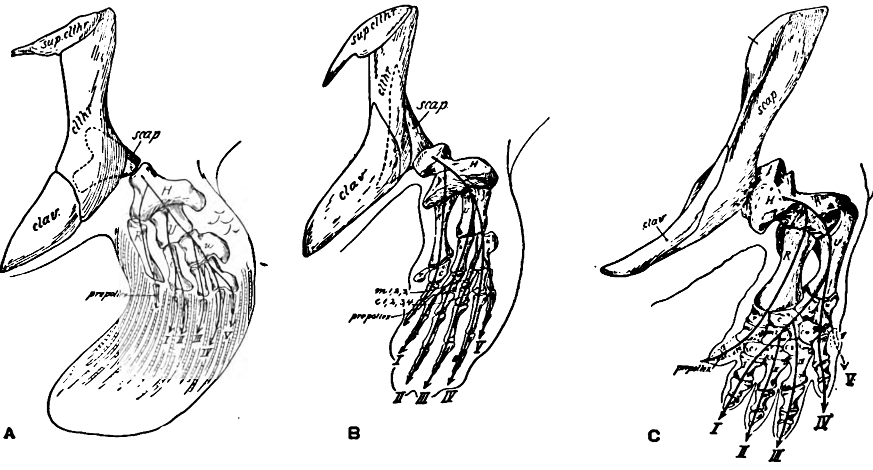
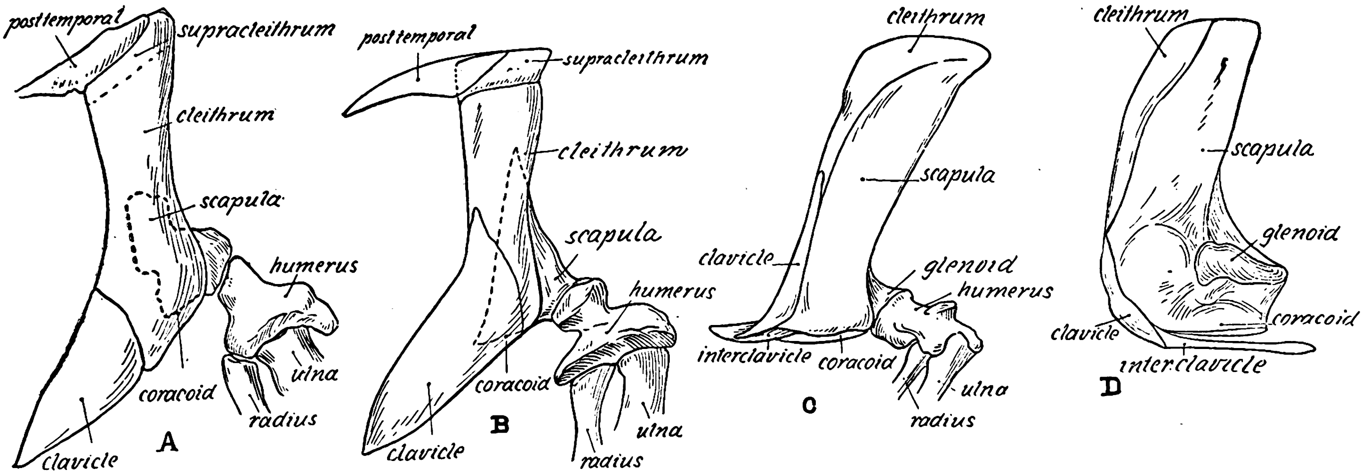


***Figure 7.* Left pectoral paddle and left half of shoulder-girdle in (A) lobe-finned fish, (B) hypothetical intermediate form and (C) early amphibian. After Gregory. In each view the limb is shown supporting the body weight**


posttemporal
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humerus
coracoid
ulna
radius
clavicle
B
cleithrum
scapula
clavicle
glenoid
humerus
interclavicle
coracoid
ulna
radius
C
cleithrum
scapula
glenoid
coracoid
clavicle
interclavicle
D

Figure 9. **Four stages in the evolution of the shoulder-girdle. (A) Left half of shoulder-girdle of lobe-finned fish (*Eusthenopteron*) showing the primary shoulder-girdle (scapulo-coracoid) behind and mostly on the inner side of the secondary, outer or dermal girdle (clavicle, cleithrum, etc.). (B) Left half of shoulder-girdle of very primitive amphibian (*Eogyrinus*), showing initial enlargement of the inner girdle, (scapulo-coracoid), but with the entire outer girdle still functional. Data from D. M. S. Watson. (C) Typical early amphibian (*Eryops*), showing great enlargement of the inner girdle (especially the scapula), reduction of the clavicle and cleithrum, and disappearance of the supraclavicle and post-temporal plates. (D) Early primitive reptile (*Diadectes*), showing enlarged primary girdle (scapulo-coracoid) and reduced outer or secondary girdle (cleithrum, clavicle, interclavicle). The coracoid plate is undivided. Details chiefly from Gregory, 1928**

branes that surrounded adjacent muscle segments. In the sharks the pectoral paddles are supported by a fan-like system of cartilaginous rods and basal blocks, which as a whole correspond to the skeleton of our hands and arms. By the time of the lobe-finned fishes of the Devonian period (Figure 7, A,) the skeleton of these pectoral paddles had begun to foreshadow the "tetrapod" or four-footed, land-living type, but they were still unable to support the full weight of the body on land. When at last certain of these air-breathing, lobe-finned fishes ventured to crawl out of the foul pools, in which in the dry season they were liable to suffocation, their pectoral paddles were drastically remodelled into the five-fingered tetrapod type (Figure 7, C) which even man retains in a somewhat modified form.

In a crawling amphibian or crocodile or in a running mammal, after the body is lifted up by the straightening of the limbs it falls forward, passing over an arc the radius of which is measured by the distance from the shoulder-joint to the base of the fingers. The pectoral and pelvic girdles are essential structures not only in transmitting the thrusts caused by the straightening of the limbs, but also in acting as slings for the support of the body. The pectoral girdle in front view is a U-shaped sling, consisting on each side of an inner core, the scapulo-coracoid arch, and an outer layer of bony sheathing plates, found in all fishes above the shark grade as well as in the earliest land-living animals up to the mammal-like reptiles.

In the air-breathing, lobe-finned fishes of the Devonian period the shoulder-girdle was a crescent-shaped structure that separated the gill-chamber in front from the muscular flanks of the body behind it (Figure 8, A). It consisted of two layers, an inner or primary shoulder-girdle, which

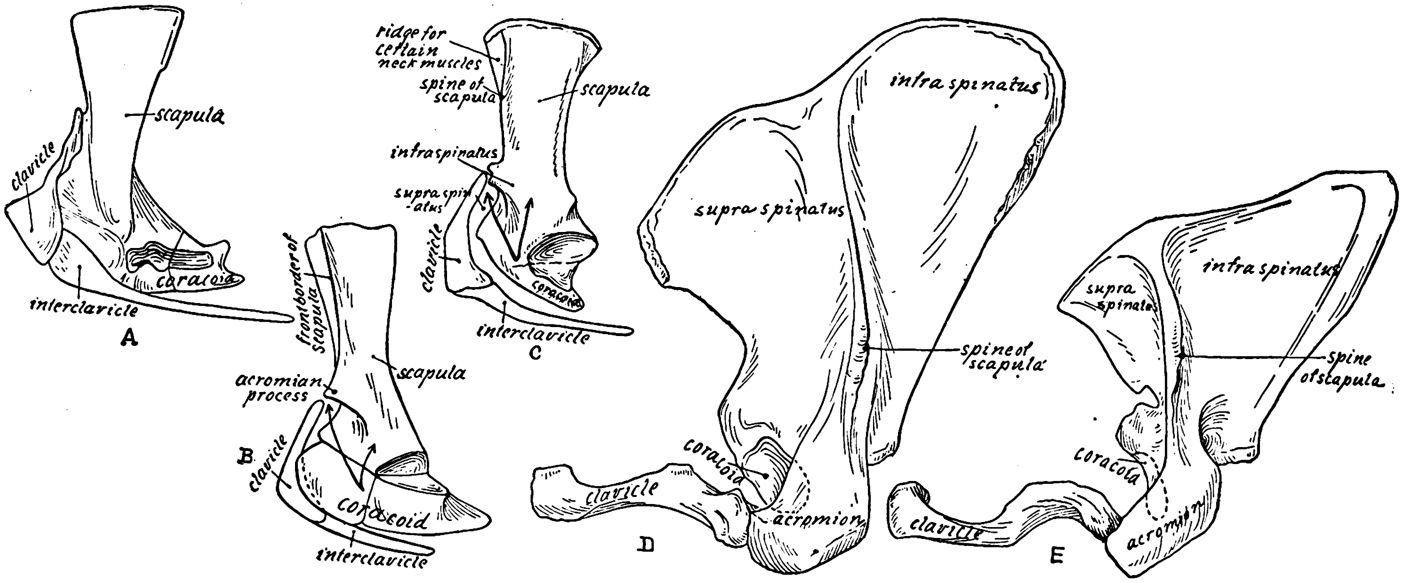

scapula
clavicle
coracoid
interclavicle
A
ridge for certain neck muscles
spine of scapula
scapula
infraspinatus
supraspinatus
clavicle
coracoid
interclavicle
C
front border of scapula
acromian process
scapula
B
clavicle
coracoid
interclavicle
infraspinatus
supraspinatus
spine of scapula
coracoid
clavicle
acromion
D
supraspinatus
infraspinatus
spine of scapula
coracoid
clavicle
acromion
E

Figure 10. **Further history of the shoulder-girdle. (A) Typical early reptilian type, after the loss of the cleithrum. The coracoid plate is now subdivided by a vertical suture into two parts, of which the posterior one later gives rise to the coracoid process of mammals. (B) First phase of the mammal-like reptile stage, in which the front border of the scapula is reflected outward to form the "spine of the scapula." The arrows show the directions of the two upwardly-growing divisions of the supracoracoid muscle, which give rise to the supraspinatus and infraspinatus muscles of mammals. (C) Second phase of the mammal-like reptile stage, showing further progress toward the mammalian condition, in which the "acromion" projects from the spine of the scapula and the coracoid plate is reduced in size. (D) Shoulder-girdle of the gorilla (left half), showing complete agreement with that of man except for minor differences in the proportional size of certain parts. (E) Shoulder-girdle of man (left half). Of the original two-layered girdle the clavicle represents the outer or dermal girdle, while the scapula represents the primary girdle. The coracoid is reduced to a hook. After Gregory, 1928**

was more or less crescent-shaped, with the concave side directed forward, and a surface layer of bony plates following the same general direction and fastened above to the hinder outer corner of the skull. At first the outer or sheathing plates of the pectoral girdle predominated but when the weight of the body came to rest on the bent pectoral paddle, the stresses on the inner or primary shoulder-girdle increased, so that the scapular blade (Figure 9) grew upward and finally (Figure 10) became the dominant member of the series.

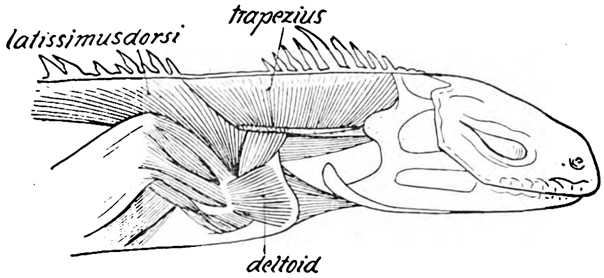


***Figure 11.* Musculature of the shoulder-girdle of a primitive reptile (*Sphenodon*). From Gregory and Camp, 1918, after Fürbringer, 1900**

In the course of many millions of years the outer dermal girdle as a whole gradually lost its functional importance, so that in the higher mammals several of its plates, namely the interclavicle and the cleithra of either side, have disappeared entirely. In the primates, including man (Figure 10, D, E) only the clavicles or collar bones remain as souvenirs of the outer or dermal shoulder-girdle; this was because the ancestors of man were tree-living forms in which the clavicles were important in suspending the weight of the body from the arms.

Meanwhile the inner or primary shoulder-girdle has likewise undergone many important changes (Figure 9). In the lobe-finned fishes (Figure 9, A) its lower prong, the coracoid, was not large. In the early amphibians it has broadened out into a large semicircular plate. In the mammal-like reptiles (Figure 10, C) it finally diminishes in size, while the scapular blade above it meanwhile becomes dominant; in the mammals (Figure 10, D) the coracoid undergoes progressive reduction and finally (Figure 10, E) dwindles into the coracoid process of the human scapula.

THE scapular blade has also been greatly modified and its history furnishes a beautiful example of the fact that during the course both of individual growth and of evolution, bone is not a rigid substance but responds to the changing forces around it by laying down "trabeculæ," or tracts of bone cells, in directions that stiffen the bone against the stresses developed within it. Thus the form of the bone changes from within in adjustment to external stimuli. In the lobe-finned fishes (Figure 9, A) the scapula is relatively small, but when the pectoral paddle had to support the weight of the body on the ground the stresses that were developed in it increased and it enlarged accordingly (Figure 9, B, C). At first its function was chiefly for the anchorage of the muscles that suspend the body, including those that run either downward and backward to the ribs or downward and forward to the sides of the neck vertebræ. The inner side of the scapula also serves as the anchor for a part of the subscapular muscle which tended to draw the humerus inward; its outer surface (Figure 11) was partly covered by the great deltoid muscle running downward to the outer side of the humerus, while its upper border served for the origin of muscles that passed inward to the top of the backbone. Thus the scapula or upper part of the primary shoulder-girdle becomes the platform for many important muscles that transmit the thrust of the backwardly extended humerus upward and forward, or prevent the collapse of the scapula upon the humerus, or hold up the body when the opposite limb is lifted from the ground.

THE subsequent changes in the scapula were dependent upon the change from crawling, with the elbows sprawling outward, to running, with the hands under the body and the elbows drawn in to the sides (Figure 12). When this happened, certain muscles on the outer side of the coracoid plate found themselves in a disadvantageous position and they accordingly gradually shifted upward (Figure 10, B, C), invading the outer face of the scapula from below and giving rise to the supra- and infraspinatus muscles of mammals. These muscles assist in moving the humerus back and forth but they are even more essential in cooperating with the subscapular muscles in preventing the collapse of the scapula upon the humerus. However, the original front border of the scapula had already been curled outward (Figure 10, B, C) by the stress of surrounding muscle and had given rise to the so-called "spine of the scapula" of mammals. Thus when the invading muscle from the supracoracoid mass grew upward, the rear fork passed behind the spine of the scapula and occupied the post-spinous fossa, while the front fork passed in front of this spine.

It has frequently been observed by all students of the skeleton of mammals that the presence of muscles and their tendinous sheaths frequently cause the upgrowth of ridges and crests from the bone that supports them. Consequently when the front fork of the upgrowing supracoracoid muscle found itself pressing against the scapula, it was soon able to evoke a supporting crest, which finally gave rise to all that part of the mammalian scapula which lies in front of the scapular spine. Hence we, in common with other mammals, owe the front part of our shoulder-blade to our remote ancestors, the immediate successors of the mammal-like reptiles, who first developed a ridge or crest in front of the spine of the scapula for the support of an upwardly prolonged slip of the old supracoracoid muscles.

When the limbs were drawn in at the sides (Figure 12, B) the joint between the humerus and the scapula was pulled outward and the coracoids were drawn out into narrow rods; then these lost their attachment to the breastbone or sternum and dwindled away into the hook-like coracoid process. This was retained only because it gave anchorage to the powerful biceps and coraco-brachialis muscles which flex the forearm.

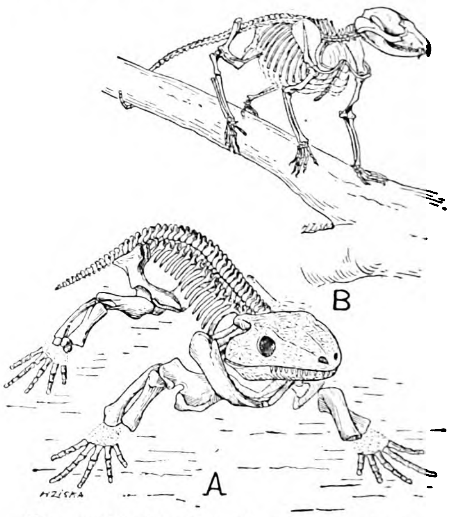


***Figure 12.* Contrast between primitive reptile (A), with sprawling limbs and typical mammal (B), with limbs drawn in at the sides**

In brief, the pectoral girdle of the ancestral fish served as the rear wall of the gill-chamber and as the anchorage for the pectoral paddles and body muscles. It consisted of an inner and an outer series of plates. Under the changed conditions of locomotion on land the inner or deep parts of the pectoral girdle gained the ascendancy and the outer plates finally became greatly reduced. Man inherits his shoulder-blade, or scapula, together with his now vestigial coracoid, from the inner series of the pectoral girdle of the fish; his clavicle, or collar-bones, represents its dermal plates.

Thus new advances require the sacrifice of old devices and the working out of new basic patents.

(*To be concluded*)

A Fish Factory At Sea*

THE outfitting of a ship, formerly in operation in the Orient, as a floating fish factory, has just been completed in England and she has left for a cruise in the waters off southwest Africa. The *Seapro*, as she was renamed, is provided for dealing with the many classes of fish in that locality and a fleet of motor boats for doing the actual fishing. These boats, it is anticipated, will bring to the parent ship from 60 to 100 tons of fish every day. Some of the fish that will be utilized are fit only for conversion into cattle, pig, and poultry feed; some are valuable for their oil content; others have livers that provide a valuable medicinal oil; and some are worth putting in cold storage for sale at a convenient market.

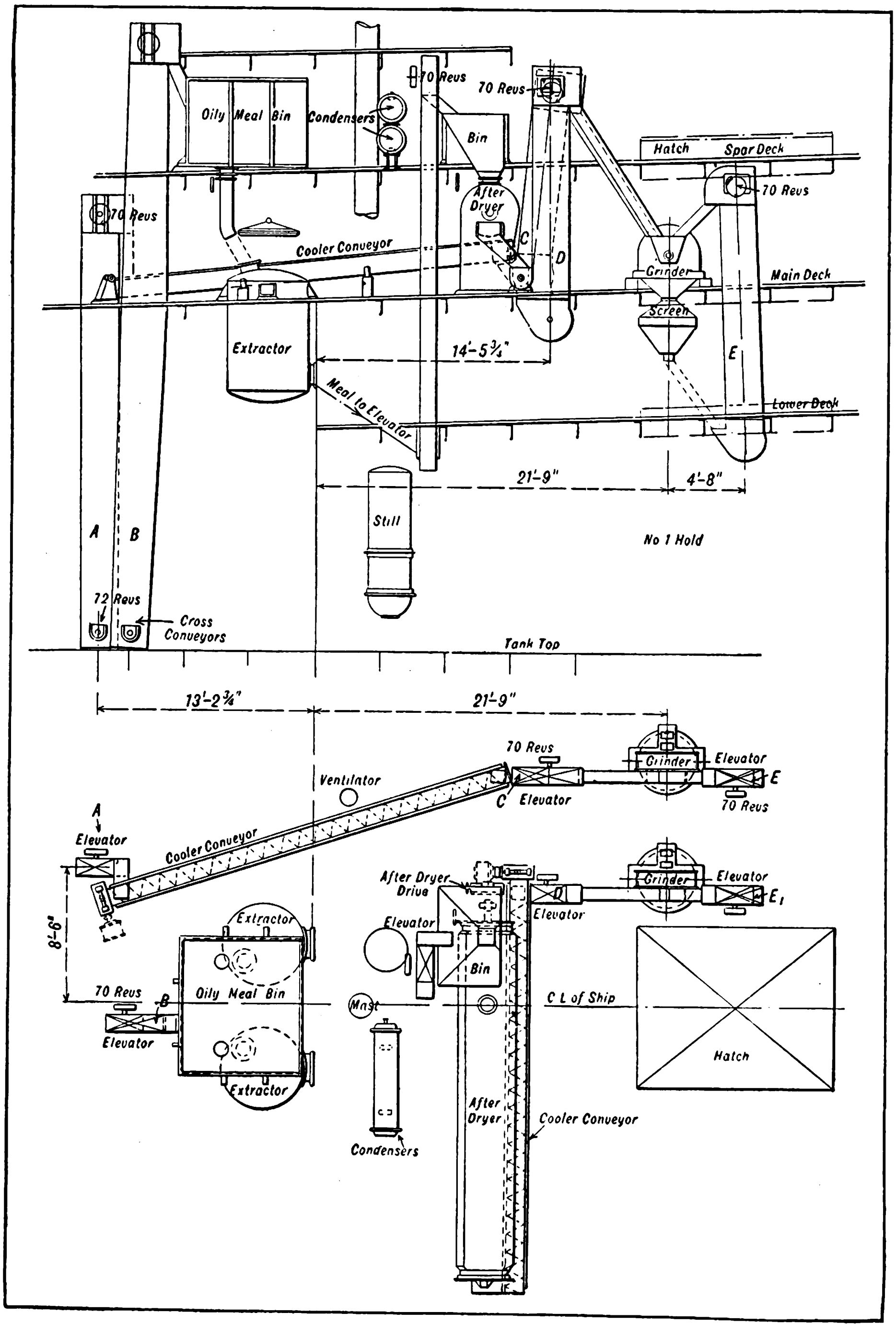
In such an enterprise as that of the *Seapro*, one of the first matters to be borne in mind is that the average content of water in fish is from 70 to 75 percent and that the ship must not be encumbered with so much valueless material. As a consequence, the greater part of the catch must be passed through dryers to drive off this moisture.

The coarser kinds of fish will be hoisted on deck from the fishing boats and dumped into hacking machines, one on each side of the vessel 'tween decks. These machines comprise two pairs of rolls made up of a series of toothed plates. The rolls rotate at different speeds and tear the fish into small pieces. The hacked material is then passed through a sterilizing chamber where the albumen is coagulated and any noxious bacteria killed by being subjected to steam. Then it goes into the drying machines, one of which is on each side of the ship.

THE drying is done in four parallel cylinders which are steam-jacketed. In the drying process, large quantities of steam are driven off and this contains a certain proportion of vapor of an offensive nature. This steam is, therefore, collected and passed through a series of three condensers which are cooled by circulated sea water. The condensate is discharged overboard. There remains a small amount of uncondensable gas which must be done away with, so this is sent up the boiler funnel for complete burning.

From the dryers, the meal is discharged into elevators, one of which is for "white" fish and one for oily fish. The white fish meal goes up elevator A—see diagram—to a cooler, then through a magnetic separator for taking out any scrap metal, into a grinder, and finally into bags ready for the market. The oily fish meal goes up elevator B into a large bin on the spar deck, from which it drops into one of two oil extractors, or digesters, on the deck below. Trichlorethylene, which is non-inflammable and recoverable in its entirety, is used for dissolving the oil. After the first wash of solvent has become saturated with oil, it is drained off and distilled. The condensers shown in the diagram condense the vaporized solvent. When all the oil has been recovered from the meal, steam is introduced into the extractors to recover any remaining solvent. The oil-free meal is then passed through the same process of grinding and separation as the white fish meal. The fish oil that has been extracted is pumped from the evaporator into tanks or barrels. The operations are all automatic, the machinery and conveyors being driven by electric motors.

In the after part of the ship there is a complete plant for making tins, boiling and canning such sea foods as crayfish; and another plant for boiling out the oil of fish livers. The refrigerating plant for carrying fine food fish to market is of normal design.


Oily Meal Bin
Condensers
70 Revs
70 Revs
Bin
Hatch
Spar Deck
70 Revs
70 Revs
After Dryer
Cooler Conveyor
C
D
Grinder
Main Deck
Screen
Extractor
14'-5¾"
E
Meal to Elevator
Lower Deck
21'-9"
4'-8"
Still
A
B
No 1 Hold
72 Revs
Cross Conveyors
Tank Top
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Grinder
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Side and top views of the principal equipment on the *Seapro*

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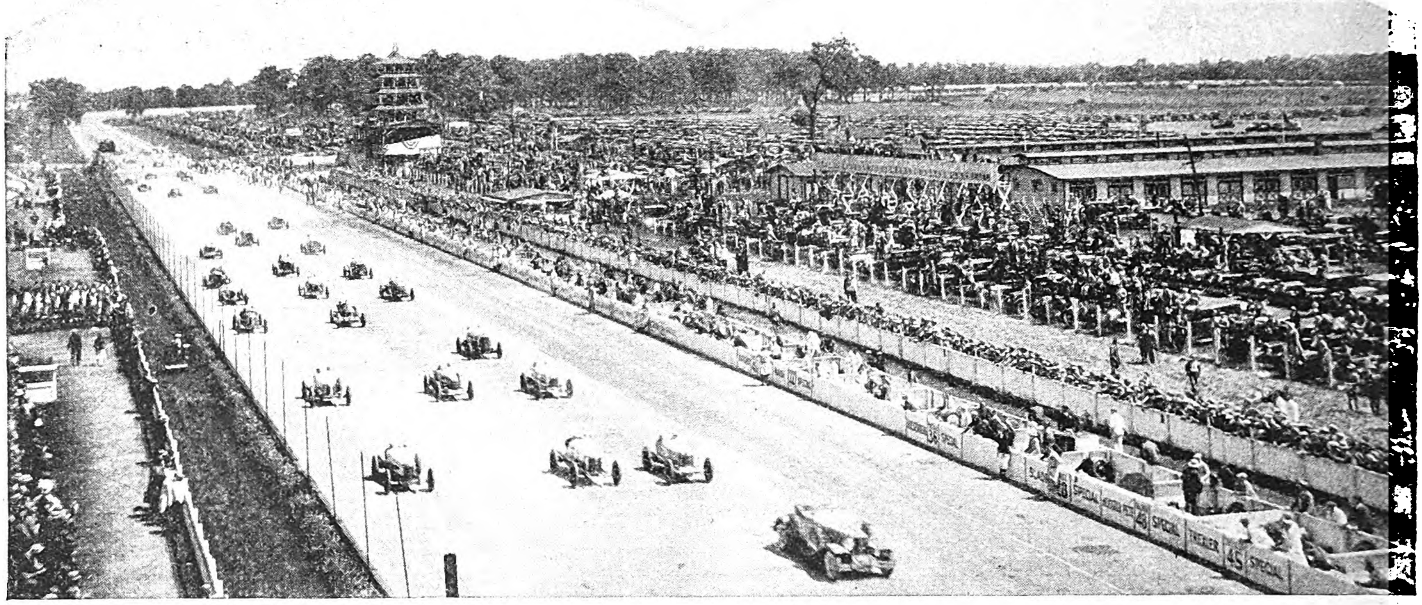
*Abstracted, by permission, from *The Engineer*, London. Illustration courtesy *The Engineer*



The start of the 1930 Indianapolis race. The cars in this, the first lap, are being paced by a stock Cord front-drive car. This lap is not a part of the race but is run only to bring the cars across the starting line at 75 miles an hour

Racing Cars of 1930

By WILLIAM F. STURM

A STUDY of the 1930 Indianapolis race is especially interesting in view of the greatly changed conditions under which the race was run. The race is run on a four-cornered track, 2½ miles around, and paved with vitrified brick. The four corners were built for a speed of only 90 miles an hour average for the lap. They are banked only 16.66 degrees for the first 50 feet from the lower edge of the track, and 36.66 degrees for the outer 10 feet—the rim—where cars never run except in case of a near smash with another car.

One thing that made for a good race this year—one easy on tires especially—was that the temperature at noon was 58 degrees, with a good breeze blowing, against the 87 degrees last year.

A resumé of the first five places in the race, with last year's average for each, follows:

First—Billy Arnold, Miller-Hartz, front drive, eight cylinders, 150.5 cubic inches displacement; 100.448 miles an hour (last year's average, 97.585).

Second—William Cantlon, Miller-Schofield, rear drive, four cylinders, 183 cubic inches displacement, 98.054 miles an hour (last year, 95.596).

Third—Louis Schneider, Seal Fast, rear drive, eight cylinders, 121 cubic inches displacement, 97.241 miles an hour (last year, 93.699).

Fourth—Louie Meyer, Sampson, rear drive, sixteen cylinders, 203 cubic inches displacement, 95.253 miles an hour (last year, 93.541).

Fifth—Bill Cummings, Duesenberg, rear drive, eight cylinders, 243.5 cubic inches displacement, 93.579 miles an hour (last year, 88.792).

SEVERAL matters rather definitely decided by the race were:

That the rules banning the supercharger and other so-called speed adjuncts were not destructive to the speed average of the race.

That stock cars, or modified stock cars, did not enter the race in as large numbers as expected.

That the highly specialized racing car is still supreme, winning, as it did, the first four positions; or, if we include the changed stock motor in fifth place, winning the first seven places.

That while these highly-specialized cars will continue to be built, the modified stock-car engine made a showing that warrants the belief that it will appear in next year's race in greater numbers.

A year ago the Indianapolis Motor Speedway Corporation issued a radically new set of rules for the 1930 race. For four years the drivers had been piloting 91½ cubic-inch racing cars equipped with centrifugal type superchargers and having one-man bodies. (See SCIENTIFIC AMERICAN, January, 1930.—*Editor.*)

The rules for this year's race provided for the abolition of the supercharger; limited carbureters to two; limited poppet valves to two per cylinder; raised the piston displacement limit to 366 cubic inches; and made mandatory the two-man body and a minimum weight limit of 1750 pounds, with the further provision that cars must weigh 7½ pounds per cubic inch of displacement.

The drivers naturally made a great outcry. Racing had not been especially good for several years and the new rules compelled the drivers to spend from 2000 dollars, which was the minimum price a new body with gas tanks could be built, to 10,000 dollars, or 15,000 dollars for a completely new car. The rules meant even more than that to the driver—they meant that the little 91½ cubic-inch cars were practically obsolete, since other tracks would, in the main, follow the Indianapolis rules.

A study of the entry list of the race shows that there were 10 four-cylinder, 2 six-cylinder, 23 eight-cylinder, and 2 sixteen-cylinder cars. It is an interesting note that the winning car was an eight-cylinder, built up and owned by Harry Hartz, but not driven by him. Hartz is recognized as one of the cleverest men in the business when it comes to getting cars ready for an Indianapolis race. He himself has won three second places and two fourth places in years past, but he is now definitely out of the driver's seat.

A further note of interest is that the race was won for the first time in its history by a front-drive racing car, with a front-drive mechanism that is practically a duplicate of that in the most popnlar front-drive car in America. Another front-drive won sixth place, while still another won seventh.

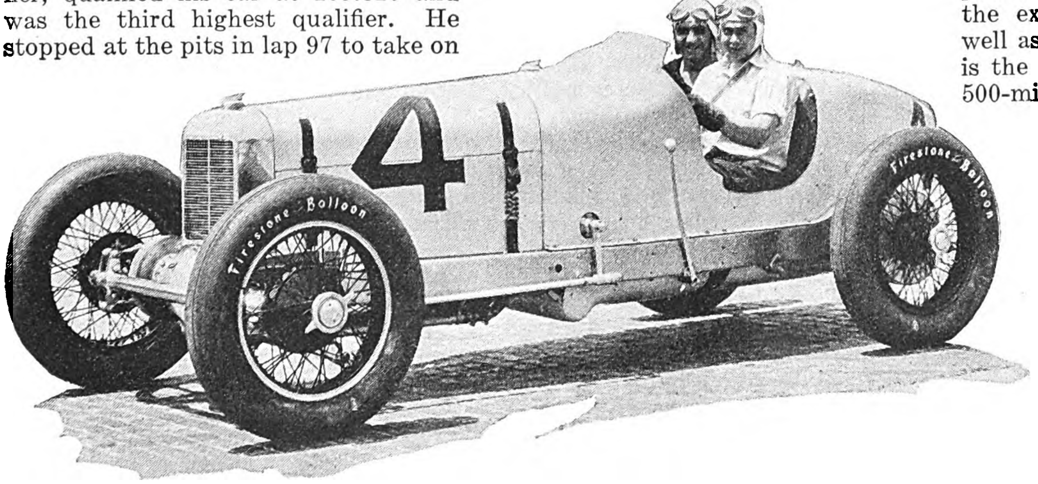
The average of the race—100.448 miles an hour—was the highest of any 500-mile race except one: that won by Peter DePaolo in a Duesenberg Special in 1925, when the average was 101.13 miles an hour.

THE race brought back into racing the four-cylinder car, and evidently it will stay because of its good showing. Ten of the drivers went to the four-cylinder because these motors could be obtained with large piston displacement from a west coast maker who knew engines thoroughly. The fact that the limit of two carbureters might make carburetion difficult for multi-cylinder cars no doubt was another factor, as the drivers of the fours were certain of good carburetion with two carbureters to four cylinders.

Louie Meyer's carburetion on the sixteen-cylinder Sampson Special, however, with two downdraft carbureters, was very good; so good, in fact, that he had the greatest acceleration on the track and qualified his car at 111.290 miles an hour for four laps of the two and a half mile track, next to the fastest qualification made. The racing drivers handled their carburetion well on the eights.

In qualification, Arnold, the race winner, averaged 113.268 miles an hour. He took the lead after Louie Meyer and his Samspon Special had held it for two laps and after that was never headed. Arnold stopped in the 111th lap for right and left front tires, oil, and gas, taking three minutes. He made no more stops until the finish of the race, and had no mechanical trouble.

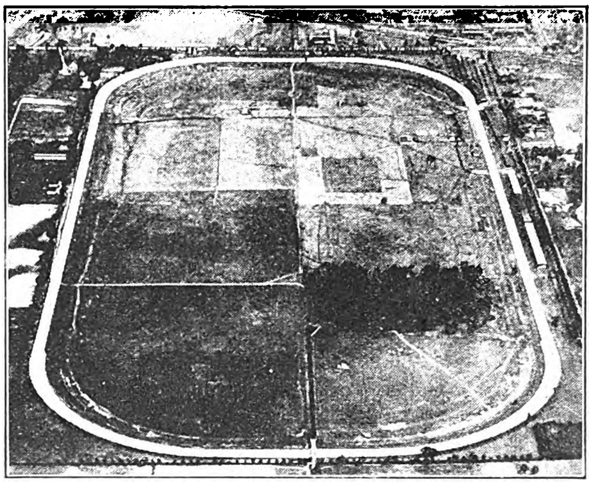
William Cantlon, second place winner, qualified his car at 109.810 and was the third highest qualifier. He stopped at the pits in lap 97 to take on a right front and right rear tire, water, gas, and oil, and gave up his wheel to Herman Schurch, relief driver. The time at the pits was 2 minutes 15 seconds. Schurch stopped in lap 151 for 25 seconds and Cantlon took the wheel.



Billy Arnold, the youthful winner of the 1930 Indianapolis Speedway classic. His Miller-Hartz two-man racing car is the first front-drive to have won this annual race

Louis Schneider, in his Jones-Maley Special, had no mechanical trouble. He stopped at his pit in lap 102 for 1 minute 20 seconds for a right rear tire, gas, and oil. In lap 184 he stopped for 40 seconds for gas and to tighten up a shock absorber.

Arnold's car develops approximately 150 horsepower; while Cantlon's develops approximately the same. For those interested in gear ratios and engine compression, Cantlon's four-cylinder car pulled a 3.9 to 1 gear and its compression ratio was 10 to 1. This is the highest compression ratio used in the race, the average being between 6 and 7 to 1. The gear and compression ratio of the winning car could not be ascertained.



The round-cornered, brick track on which the races are run, as it appears from an airplane

ARNOLD wound his engine up to a peak of about 6200 revolutions per minute. Cantlon's peak was about 5000, while Schneider, the third man wound his to between 5600 and 5800. Louie Meyer wound his sixteen-cylinder car to a top of 6100.

The Sampson Special of Louie Meyer is unique in construction. Its two banks of eight cylinders are placed vertically and each has its own crankshaft, cooling system, and oiling system, only the gasoline system being a common one. Even the radiator is separated in the center, there being no connection between the two sections. Each water cooling system holds approximately four gallons. Each of the two crankshafts has a gear on its front end and these two are connected at the front of the motor to a like gear on a shaft which runs between the two banks back to the transmission. The motor was reversed, to obviate the necessity for a change in the transmission and rear-drive assembly. It had a total displacement of 203 cubic inches and was the highest priced car in the race, representing an investment of approximately 16,500 dollars.

The outstanding performance in the race was that of a Jones-Stutz Special. This car was entered by Milton Jones, a private owner, of Cleveland, Ohio, and was driven to tenth place by L. L. Corum. It was stock in every particular except that its oil and gas tanks were made larger for the sake of fewer pit stops for fuel and oil, and the fenders and running boards were removed.

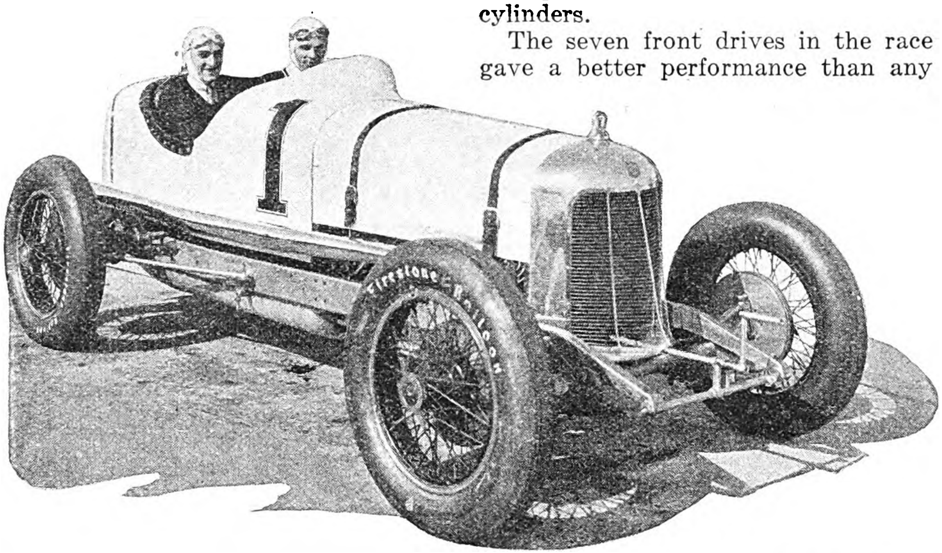
THIS car weighed 4600 pounds at the starting line. It ran the entire race without the hood being lifted except to add two quarts of oil. In spite of its great weight it made no tire changes, the four original ones going through in perfect shape and with so little wear that they evidently were good for thousands of miles more of ordinary usage. The tire wear and performance of the car is a tribute to the excellent balance of the car as well as its mechanical perfection. This is the best stock car performance the 500-mile race has ever seen, even in the days when modified stock car racing was the vogue.

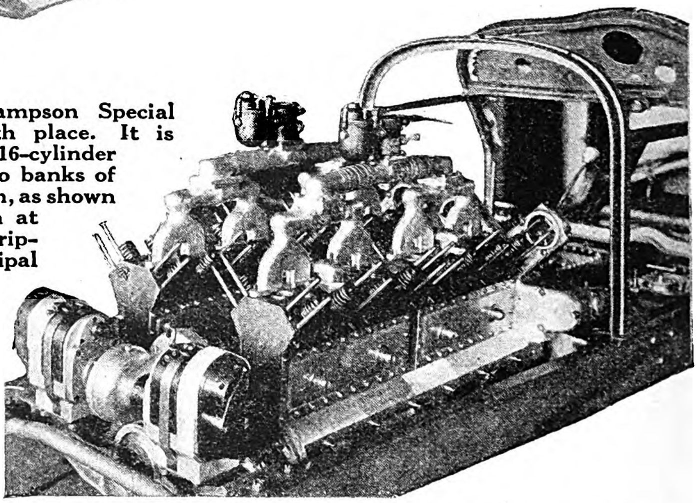
It was unfortunate that the duPont Special, the only factory-entered car in the race, had a smash-up and was put out of the race. This car's performance would have been watched with interest because of its near-stock set-up.

Bill Cummings' Duesenberg Special had a motor that formerly was in a Duesenberg stock car. A new head, not stock, was made for the race.

Dave Evans' Jones-Maley

front-drive was, in part, the second front-drive of modern times, it being one of the two cars built by Harry Miller for the 1925 race at Indianapolis. It is a peculiar commentary that it sat in its garage throughout the race in 1925 because DePalma, Duray, Bennie Hill, and other big drivers of that time decided they did not wish to handle it through a race.





Louie Meyer's Sampson Special which took fourth place. It is powered with a 16-cylinder motor built in two banks of eight cylinders each, as shown in the illustration at the right. A description of its principal features is given in the text. In it, Meyer made an average speed for the race of 95.253 miles per hour, and had no trouble with his carburetion

Meanwhile, the other front-drive went ahead, driven by Dave Lewis, Harry Miller's brother-in-law, and won second place in the race at 100.82 miles an hour—faster than first place in this year's race.

In winning seventh place with a Coleman front-drive, the entry of the Coleman Motors Corporation, of Littleton, Colorado, Phil Shafer demonstrated the correctness of the theory of the Coleman. Its front end embodied many of the features of the Coleman four-wheel-drive truck on a smaller scale. The Coleman broke all racing tradition and calculations by carrying most of its motor weight unsprung, the front motor support being on the front axle. The Coleman differs from other front drives in that it has only one front axle, the driving one, and not a subsidiary one to carry the weight as is the case with others.

SHAFER, in averaging 90.921 miles an hour with his car, which has a top speed of about 103 miles an hour, miscalculated the speed at which the race would be run and held resolutely within striking distance of 93 miles an hour, his estimate of the winner's average. The motor used in the Coleman was a 183 cubic-inch Miller four-cylinder. Another Coleman, driven by Lou Moore, was in a crash and did not finish the race.

The car to finish in eighth place has a stock Studebaker eight President motor; and many of its chassis parts, including the frame, are stock. Snowberger's performance was noteworthy. His top speed was approximately 104 miles an hour but a broken shock absorber stud caused him to decrease his speed and he lost his chance to win.

Leslie Allen's Allen-Miller Products car was strictly a racing car, with a four-cylinder Miller engine of 183 cubic inches. The remarkable part of Allen's average of 85.749 miles an hour was that he put a valve through one of his pistons, with more than 100 miles to go, yet he drove to the finish at a speed of 80 miles an hour on three cylinders.

The seven front drives in the race gave a better performance than any other group in Indianapolis race history, where they have been performing since the 1925 race. With the exception of the two Colemans, all of them were of the Miller-made type, basically identical in construction of their front-drive units and used eight-cylinder engines.

The eleventh-place car was entered simply as a V-eight. It was in reality an Oakland V-eight engine, being the only V-eight in the race. It made a highly creditable showing for a motor that was all stock except its pistons, according to its entrant, Ira Vail. It had qualified at 97 miles an hour.

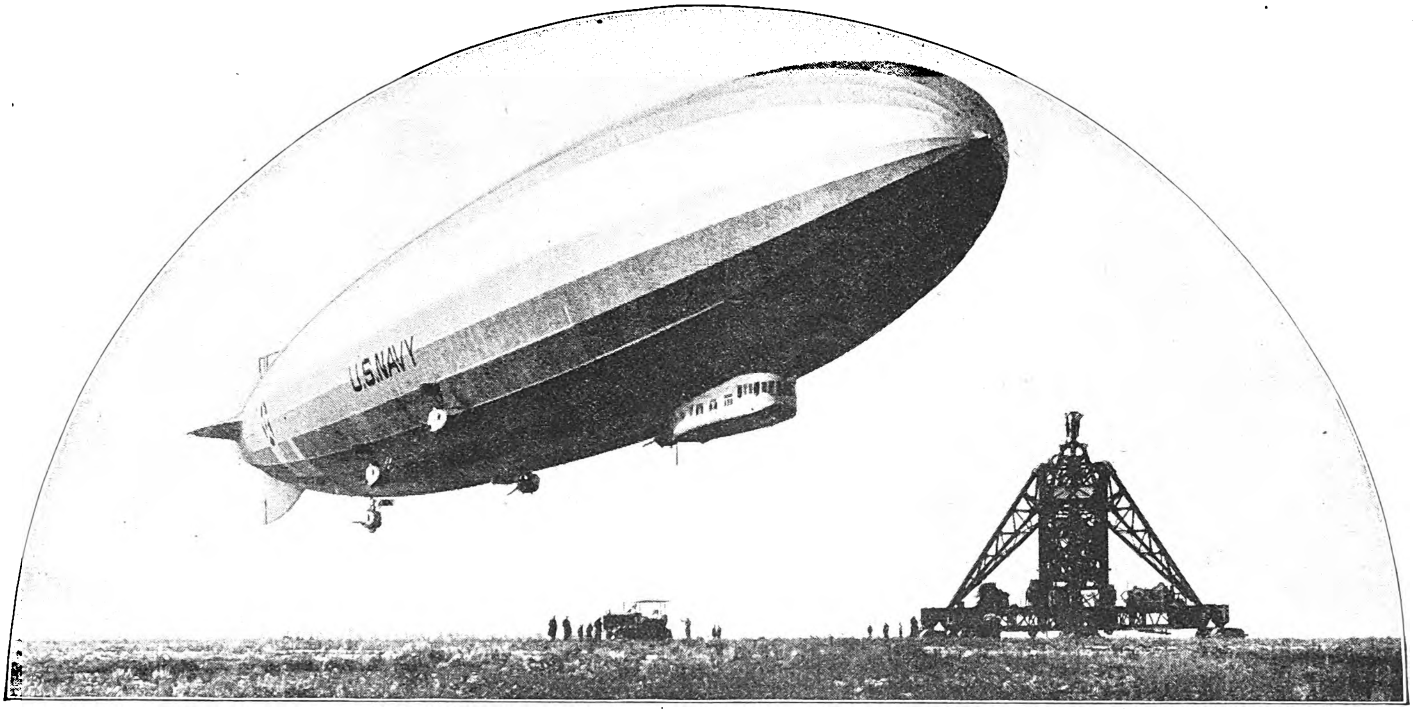
The twelfth car to finish, the Maserati eight, driven by Letterio Cucinatto, of Italy, was the only foreign car to finish, the other one, a sixteen-cylinder Maserati, stopping in the early part of the race with motor trouble.

The car running in thirteenth position was a Fronty Special. This little car, made up of Model T and Model A Ford parts, did especially well. Its transmission and clutch are Model A. The engine is Model T, with special Fronty head. The crankshaft, connecting rods, and pistons are non-stock. The chassis is Model T, including the transverse springs, front and rear. This car qualified by doing four laps of the track at 97 miles an hour. It was running the race at between 85 and 90 miles an hour, when the technical committee member in charge of the recording of car conditions, saw that the eye of the front spring was broken off when the car came in for gas. The driver explained that it had been that way for an hour and, beyond making the car difficult to handle on the turns, no serious difficulty could result. The technical man was obdurate, however, and insisted that something be done. Accordingly, Stanley Reed and Tom Mulligan, entrants of the car, ran into the infield at the track and turned the first Model T Ford they came to up on its side and took off the front spring. They put it on their car, after the Fronty had been delayed 41 minutes. After the car finished the race they hastily jerked the spring off, and put it back on the car from which it had been borrowed, Reed says, without the car owner being any the wiser.

THE fourteenth, and last, car to be running, was the Butcher Special, entered by two Butcher boys of Wilmington, Illinois, one of whom drove while the other acted as mechanic. This car was a big Buick motor mounted in a small Buick chassis, cut down to a wheelbase that would do for racing conditions. It ran throughout the race, but at a very low average.

There were 37 cars entered in the race, but only 14 were running at the close of the race.

There were numerous car failures due to such causes as cracked cylinder heads and broken wrist pins, gas tanks, connecting rods, valves, water jackets, and clutches. Several serious smash-ups occurred.



The *Los Angeles* makes ready to tie up at the new mast

Mooring Dirigibles Mechanically

New Stub Mast and Other Equipment at Lakehurst Facilitate Mooring and Housing

A FEW weeks ago there occurred at the United States Naval Air Station at Lakehurst an event which marked the passing of another milestone in the development of rigid airships. The *Los Angeles*, having been landed from flight, was secured to mechanical devices near the hangar and with about 60 men attending various stations on this equipment the ship proceeded under mechanical power to her berth in the hangar while over 200 other members of the ground crew stood by in unaccustomed leisure and watched this performance in which they have usually had to participate so forcefully with brain and brawn—largely the latter. The first demonstration of practically the full mechanical system for docking airships had been successfully conducted.

Every since the inception of American development of the rigid airship, it has been realized that the field of terminal facilities and other auxiliaries represented a weakness in airship operation. The success of airship operation, both military and commercial, depends very largely on the achievement and provision of adequate, efficient, and economical terminal facilities. From the very beginning airships had been handled in and out of sheds by groups of men placed at strong points of the ships to haul against direct winds and gusts, man-power, of course, having the virtue of being highly flexible. As the size of ships increased, ground crews grew to several hundred men.

Lakehurst, being rather unfavorably situated from a meteorological standpoint, has from the very beginning impressed our airship personnel with the fundamental necessity for improvements in airship mooring and handling.

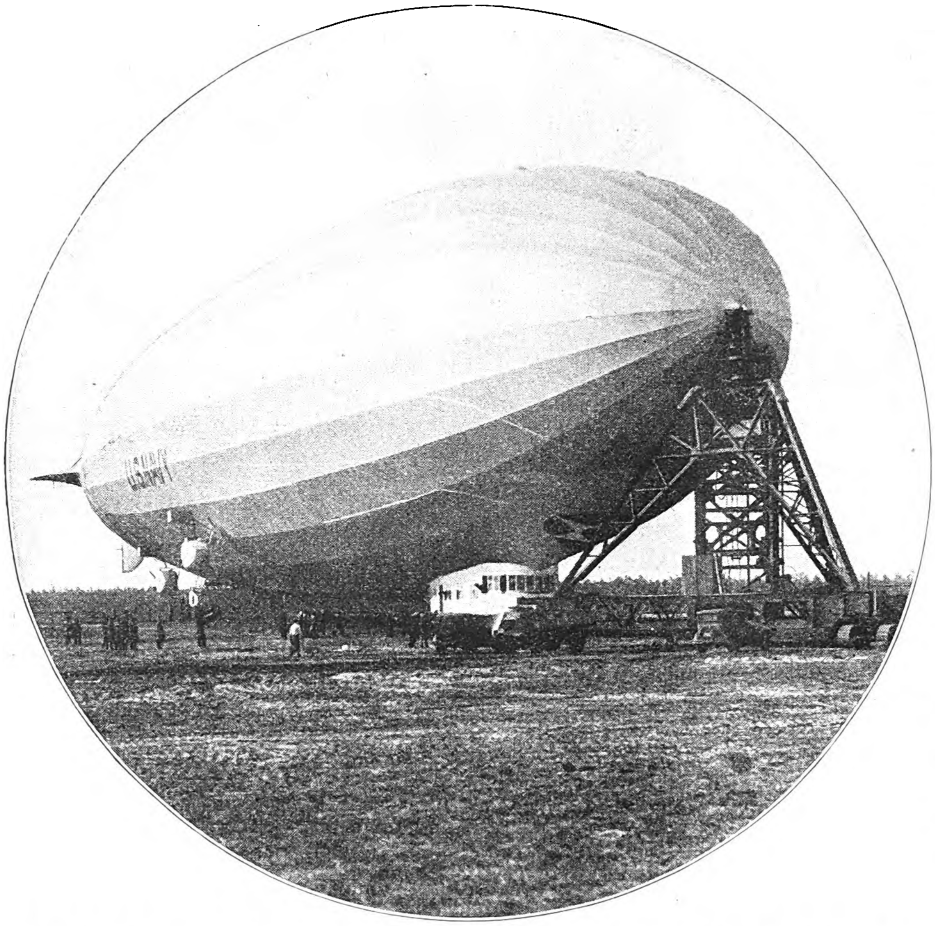
SHORTLY after the World War, the British developed an airship mooring mast which materially added to airship progress in making it generally possible for airships to remain at the mast until favorable conditions permitted housing them without difficulty, should housing be desired. One British airship remained based on a mast for a period of about six months.

However, this "high" type of mooring mast is not a "cure-all" for every airship need. Large ground crews are needed at some time or another when housing or unhousing becomes necessary. Consequently some unit other than the high mast had to be developed.

The method of housing and unhousing airships at first was to employ only men in groups about the ship, in a manner similar to the tugs around an ocean liner. Then there were added "docking rails" projecting along the sides of the hangar and extending out on to the field and over which there traveled trolleys, two on a side, attached to the ship by suitable lines. Additional groups of men steadied the ship against the wind as she had to be moved parallel to the hangar. Such was the extent of the "airship handling project" when taken up at Lakehurst.

The mooring and handling problems resolve themselves into three phases: (a) landing the airship from flight; (b) mooring the ship out or "anchoring" it to ride, ready for flight, as a surface vessel anchors or swings to a buoy; (c) housing or unhousing the airship just as a surface vessel docks or undocks. The problem was one of combining, if possible, these three functions in one set of equipment and making that equipment as efficient and simple as possible. Two phases of this problem have already been proved practical; the third is still in the process of development, but present indications give promise of early solution.

In landing from flight, an airship formerly proceeded over the landing point and was pulled to the ground by man-power using ropes dropped from



Anchored to the stub mast, the *Los Angeles* will safely outride winds of more than ordinary velocities. The cabin, it will be noted, is close to the ground

her bow. In landing to a mooring mast the process is that of being pulled down against her buoyancy by mooring wires dropped from her bow and connected to corresponding ground wires which are then hauled in by power-driven winches. One of these wires pulls the ship downward while two others, leading aft at an angle to the ship, steady her against yawing tendencies arising from gusty wind conditions. These same two wires also prevent the ship from over-riding the mast and thereby possibly fouling her hull against the mast. By means of these three wires the steel cone on the nose of the ship is maneuvered into a steel cup on top of the mast where it is firmly locked.

ALTHOUGH this original method of mooring to a mast has been successfully used a great many times, it does not fully overcome the irregularities of the wind. It has been demonstrated repeatedly that there exists the necessity for providing an additional force to overcome the tendency of vertical gusts to drive the ship downward. Such vertical tendency may, of course, be overcome to some extent by making the ship more buoyant, but there is a practical limit to this measure and, therefore, there exists the necessity for providing a corrective force outside the ship.

The solutions of these several problems worked out at Lakehurst center largely in the demonstrated success of a low or "stub" mooring mast some 60 feet in height as opposed to 171 feet and even 201 feet in modern examples of the "high" mast.

The principal unit employed in the new mechanical system at Lakehurst is a low mobile mast capable of movement over the ground. This mast not only acts as the principal unit of the handling equipment, but also serves as a mooring device to which the ship may be moored for indefinite periods. It incorporates a telescopic feature enabling its height to be adjusted to suit different airships.

To utilize the mast for "anchoring" purposes there is provided a mooring site or circle in the precise center of which the mobile mast can be placed. Surrounding the mast is a circular, standard-gage railroad track on which runs an especially devised car to which the after portion of the airship is secured. In this way the mooring airship is secured at two places, that is, with the bow in the mooring mast cup and the after portion of the ship attached firmly to the car which moves with great facility along the circular railroad track thus allowing the ship to answer fluctuations in the wind directions just as does a weather-vane.

At this low or stub mast, which is an American idea, the lower part of the airship is held within a few feet of the ground, thereby expediting repairs, transfer of loads and personnel, as well as keeping the ship close to the ground where winds are of lower velocity than at levels of the "high" masts. When riding to a high mast the free stern of the mooring airship is practically always going through vertical and horizontal oscillations due to irregularities in wind flow and to temperature changes which temporarily influence the ship's buoyancy. At the American stub mast, the ship, while free to answer horizontal fluctuations, cannot acquire any vertical motion whatsoever and, therefore, the crew of the ship are not continuously flying the ship as is the case when she is moored at a high mast. This stub mast idea has had very successful practical demonstrations at Lakehurst and it is felt that if further results continue to be uniformly successful this type of mooring equipment will not only be developed to a point of increased efficiency, but will at the same time reduce mooring and handling costs materially.

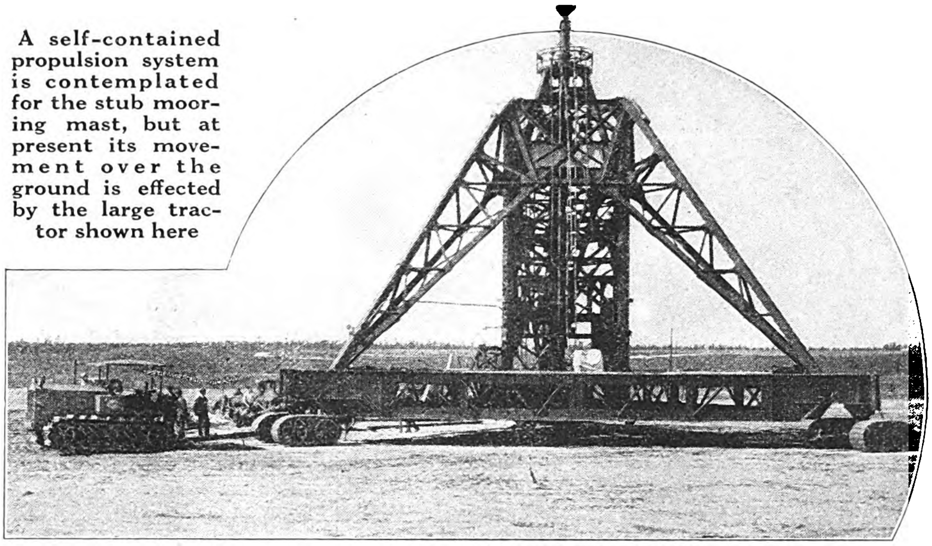
IF after landing from flight, it is desired to house the ship in the shed, the ground servicing connections at the mooring circle are disconnected from the mast and the after portion of the ship is freed from its car. The mooring mast then gets underway with the ship's nose remaining secured just as when moored. Under the stern of the airship, however, there is placed a pneumatic wheel device capable of castering in any direction as well as of furnishing smooth rolling contact with the ground while the mast, with the airship riding to it like a flag, travels from the mooring site to the vicinity of the shed in which the ship is to be docked. A specially devised "tail drag" attached by a line to the ship's stern, follows the ship over the field, but resists any tendency of the stern to lift vertically, by adding its weight to the ship as automatic ballast. Furthermore the mobile mast's own pump and tanks can furnish the ship water ballast if needed as it moves over the ground.

Having reached the docking rails which lie in the prolongation of the hangar direction, the mast comes to rest temporarily. The after part of the ship is secured on each side by an endless wire system which leads from four points on the ship to mechanical trolley systems which operate in the docking rails. These systems are provided with winches to haul the ship up against the wind load in case the wind direction is across the hangar, and enable the airship to be centered between the two docking rails. Held securely in this position, the mast, ship, and trolley systems get underway together and proceed into the shed. In undocking, of course, the reverse system is employed, the mechanical trolley bridle systems holding the ship against a cross wind until clear of the hangar where, by slacking off, the stern of the ship is allowed to swing until it finds its natural position of "nose into the wind." Signal lights similar to traffic lights, and a loudspeaker system mounted on the mast, provide the means for passing orders and information to units and personnel.

Having cleared the hangar, the ship can then either take to the air from that location or be towed to the mooring site or circle and remain there safely until its scheduled time of departure. The limitation on the wind force in which an airship can be docked and undocked by this mechanical means is dependent upon the strength of the airship itself.

IT would not pay nor is it necessary to build an airship structure strong and heavy enough to be capable of withstanding great forces in any direction or at random points. The *Los Angeles*, for example, was not constructed with any idea of mechanical handling devices being applied to it and still we find that the strength of the ship is adequate to allow it to be housed or unhoused in beam winds up to 20 miles per hour velocity. It would be, of course, expensive and complicated to change the structural characteristics of the *Los Angeles* to permit handling in higher winds. When, however, airships are originally constructed with a view to mechanical handling they can, of course, be made adequately strong for handling in greater wind velocities if desired.

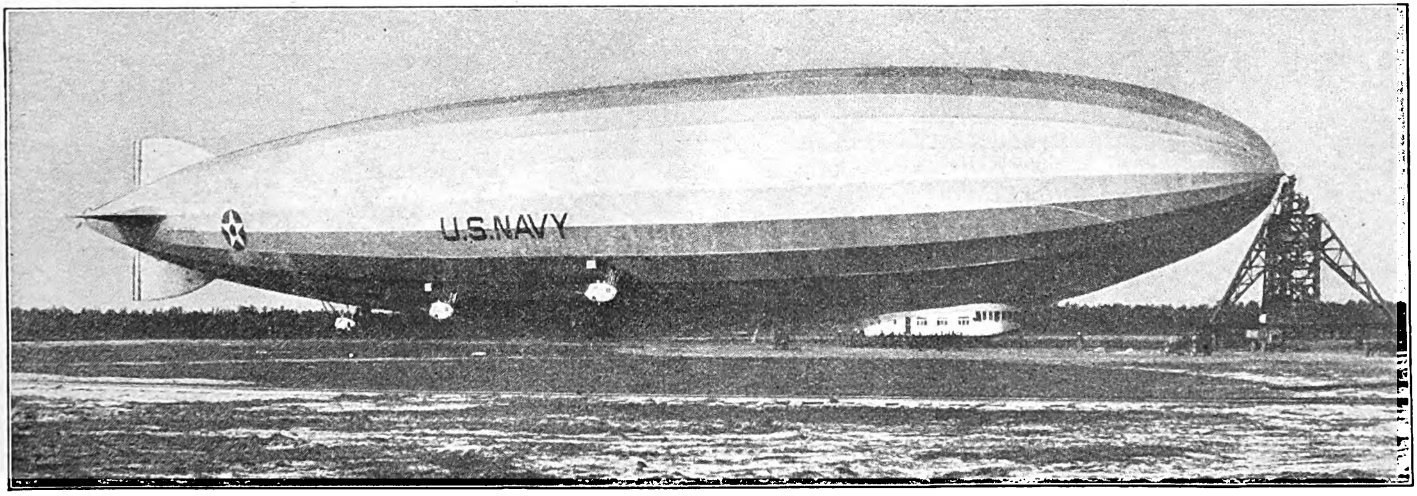
This mechanical handling system is not as yet a fully refined product. It will continue to be modified and perfected, perhaps for years, but fundamentally it has been proved correct. The "iron horse" of the mechanical handling system (as the mobile mast is often referred to) has already during its development period been used in handling the *Los Angeles* on over 30 occasions during the last few months, and by its use the *Los Angeles* has been housed and unhoused in cross-hangar winds of 17 to 20 miles per hour velocity; and it successfully handled the *Graf Zeppelin* while that ship was at Lakehurst last spring. At present its movement over the ground is by a tractor but a self-contained propulsion system for the mast is a contemplated refinement for the near future.



A self-contained propulsion system is contemplated for the stub mooring mast, but at present its movement over the ground is effected by the large tractor shown here

THE stub mooring mast, its mobile features, and other units of the mechanical handling system herein described have been devised, built, and operated by personnel of the United States Navy, principally through the efforts of the Bureau of Aeronautics, the Bureau of Yards and Docks, and the personnel at Lakehurst. No one else in the world has yet attained such solutions except the United States Navy which has been engaged in this arduous task for the past several years. Others, however, are now working on the problem. Recent press reports, for example, indicate that the British Air Ministry is now engaged in the provision of a mechanical handling system for airships, which, according to the announcements, appears to be almost identical with that developed at Lakehurst.

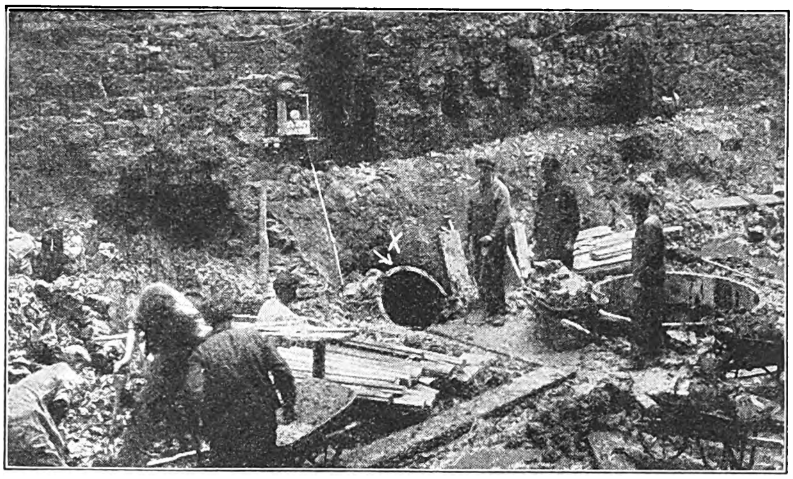
The mechanical handling system is but one of a number of most important airship projects and experiments being conducted by our Navy through the wise provision by Congress of funds for this most important pioneering work. By the continuation of sufficient funds for further experimental work, our Navy will undoubtedly soon contribute other very valuable features to airship operation and thereby expedite the attainment of the high value which the rigid airship potentially possesses not only for naval uses, but for commercial employment as well. With these developments, airship operation can be made practical and economical. We shall have added greatly to the naval usefulness of airships to our fleet. With our natural advantages, such as our helium resources and our great engineering resources, these recent developments should enable the establishment of an aerial merchant marine capable of carrying the American flag to the corners of the earth. In this as in many other pioneering fields, the way will have been pointed out by the Navy.



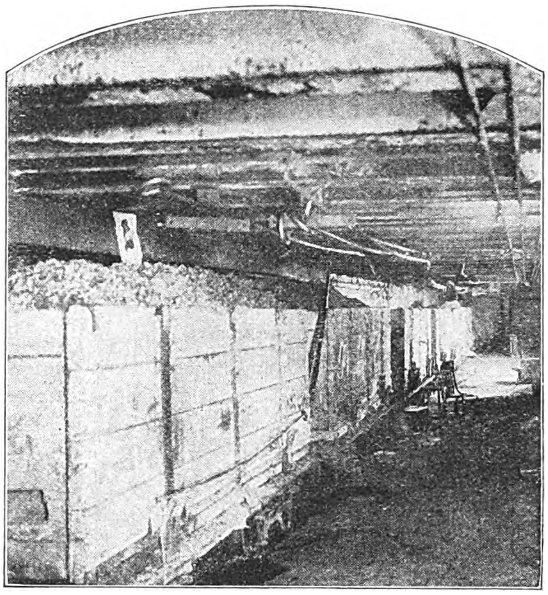
Swinging low enough for the convenience of passengers and for making repairs

distant as even the Field Museum. There are 3304 cars and 150 electric locomotives in use. The merchandise transported yearly amounts to 589,761 carloads, without counting coal, cinders, and excavated material.

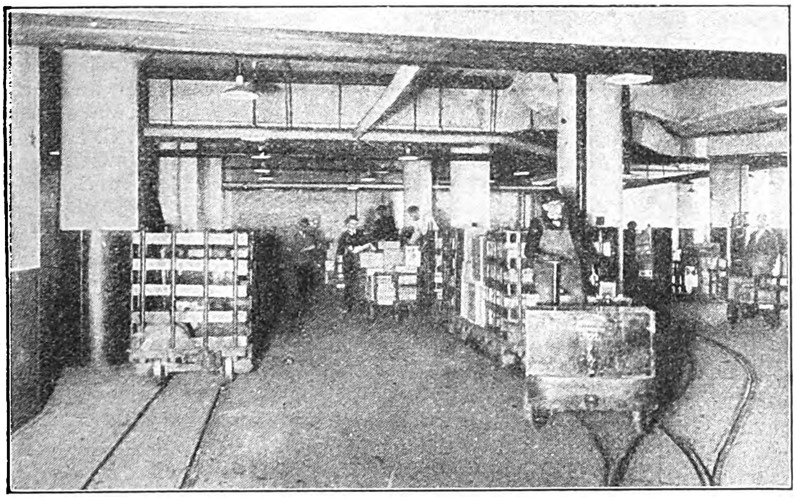
Freight is received at public stations, or directly from the railroads or from connected buildings anywhere along the routes. Ninety-six elevators give access to the tunnel level, the cars themselves being raised and lowered on them. As an example, let us consider a world-famed department store. All its coal is delivered, the ashes removed, and much of the merchandise received and shipped without turning a wheel on the streets. What would New York give for a similar system? The movement of package freight between freight terminals is one of the most important functions of the system. The tunnels are also assisting the new World's Fair by taking quantities of excavated material to the lake front. Our illustrations give an excellent idea of the tunnel, its size (gage 24 inches, size of tunnel 6 feet by 7 feet 6 inches) and its uses. We are indebted to Mr. J. H. Burke, Traffic Manager, for a private view of it.



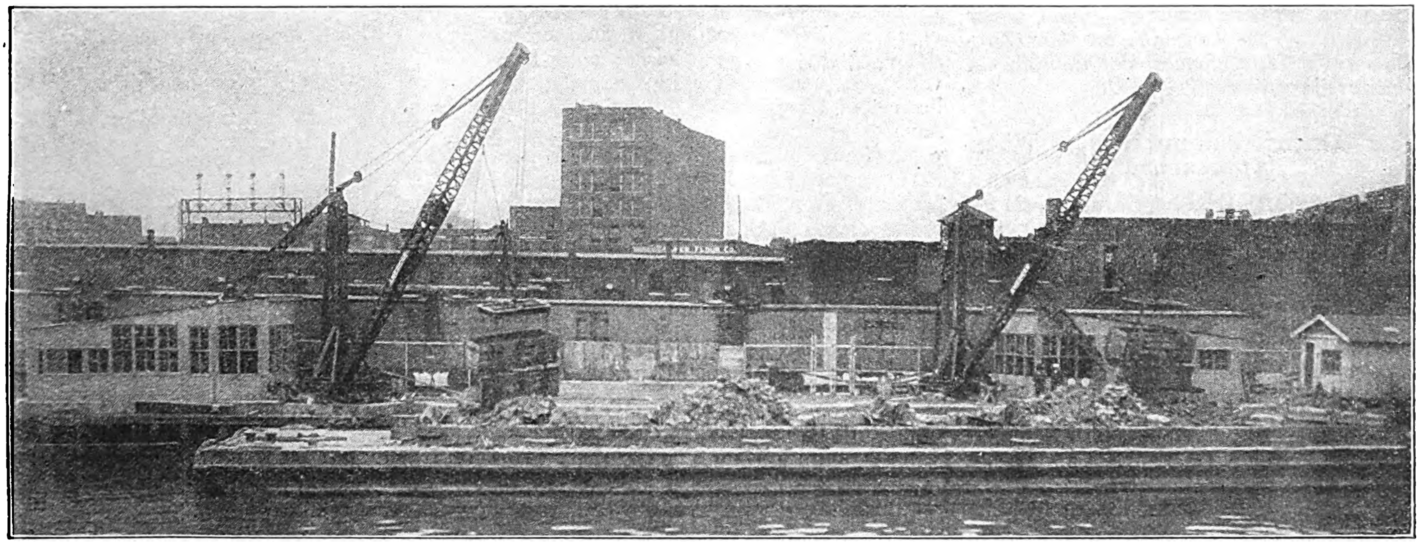
Excavation is easy in rockless Chicago if you are near the tunnels. You bore a hole and shoot the spoil through a chute to the waiting tunnel cars for ultimate disposal



The tunnel takes away the ashes for disposal by dumping them into the lake



Shipping room of a large commercial house showing how freight is loaded on to tunnel cars



Here we have the refuse disposal station where excavated materials, cinders, and other wastes are loaded on barges which are towed far out in the lake for dumping. A total of 102,179 car loads were disposed of in a period of one year

The Scientific American Digest

Conducted by F. D. McHUGH

Suspended Observation Car

THE Materiel Division of the Army Air Corps has employed a very simple, yet useful idea in connection with dirigibles. An observation car was suspended below an airship by a windlass and cable. By ordinary telephone, communication was successfully maintained with the pilot of the airship. Such a device would be invaluable in fog or in low ceiling work. The airship would hover aloft, while the observer reconnoitered, and then gave instructions for safe landing. Such a car was used by the Germans on their Zeppelin raids, and should be valuable in commercial operation.—*A. K.*

A valuable application of the photoelectric cell. It opens this restaurant door automatically

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Door Opens Automatically When Approached

HARD-WORKING hotel waiters, struggling through kitchen doors with heavily laden trays and performing like circus acrobats to make the passage safely, need no longer suffer these agonizing evolutions, for the photoelectric cell has come to the rescue. The General Electric Company recently demonstrated an automatic door-opener by means of which, without conscious human effort, a door can be made to open swiftly and silently—and, what is more, to close in the same manner.

A ray of light focused on a photoelectric cell passes in front of the door. When this ray is interrupted it sets a hydraulic door-opener to work, through the agency of a photoelectric relay. The cell and light are placed several feet from the door and, as a person approaches, his body interrupts the light ray directed at the cell.

The current, hardly great enough to be dignified by the name, is amplified through three large vacuum tubes, the last a power tube. It then sets in motion a small motor which operates the hydraulic device, thus actually opening the door. A lever, comparable to those found on ordinary door checks, forces the door open. A suitable time then elapses before the door closes. When the ray of light is again focused on the tube, the device is again ready for operation. The length of time during which the door is held open can be changed by adjusting the control

Largest Gas Tank Known

SUPPOSE you had 200,000,000 cubic feet of natural gas that you couldn't use immediately? Where would you keep it? The novel answer to this "poser," evolved by the Canadian government experts, is as simple as it is ingenious. They could think of no container big enough to hold such a quantity of gas except the container from which it came originally, namely, the bowels of the earth. Accordingly, they have determined to pump the gas from a producing field back into the earth in a field previously exhausted. This plan has been approved by the Minister of the Interior, the Gas Conservation Committee, appointed jointly by the Federal and Provincial Governments, and the Premier of Alberta.

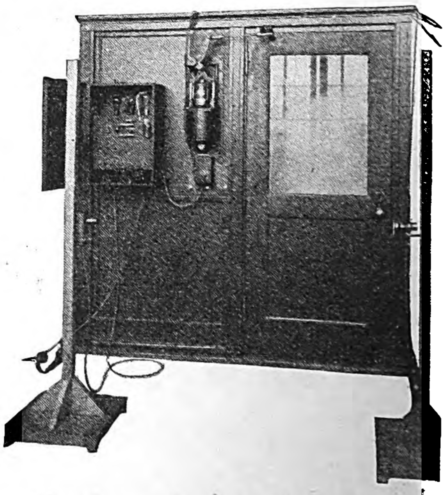
Among the conditions set out in the Order-in-Council under which the reservation has been granted, is the requirement that the company shall commence the actual injection of gas into the depleted sands not later than May 1, 1931, and the amount of gas to be so injected each year shall be not less than 200 million cubic feet until the maximum pressure has been reached and maintained.

The Bow Island gas field, in which the interesting gas storage experiment is to be made, is located about 140 miles southeast of the Turner Valley and a slightly greater distance from Calgary. Prior to becoming depleted it was the principal source of the natural gas supply for the city of Calgary. Now it is proposed to rejuvenate the old wells by bringing gas from Turner Valley, where great quantities are being wasted at the naphtha wells, and to store this gas so that it may be used whenever the peak loads on the company's gas lines may require such reserve supplies.—*A. E. B.*

Ragweed Pollen

THE vast majority of cases of hay-fever occur in people who are sensitive to ragweed. In the fall ragweed pollen is exceedingly prevalent in the air and hay-fever sufferers journey hither and thither attempting to avoid it. Dr. O. C. Durham made a survey of the entire United States during 1929 to locate the boundaries of the ragweed district. He says that the potential ragweed district is the portion of the United States east of the Rocky Mountains, except the south end of the Florida peninsula. In all parts of the area, from one to seven species of ragweed are found.

Thus the actual part of the United States affected seriously by ragweed is little less than three fourths of the total area of the country, but this three fourths contains nine tenths of the population. For each section of the ragweed distric



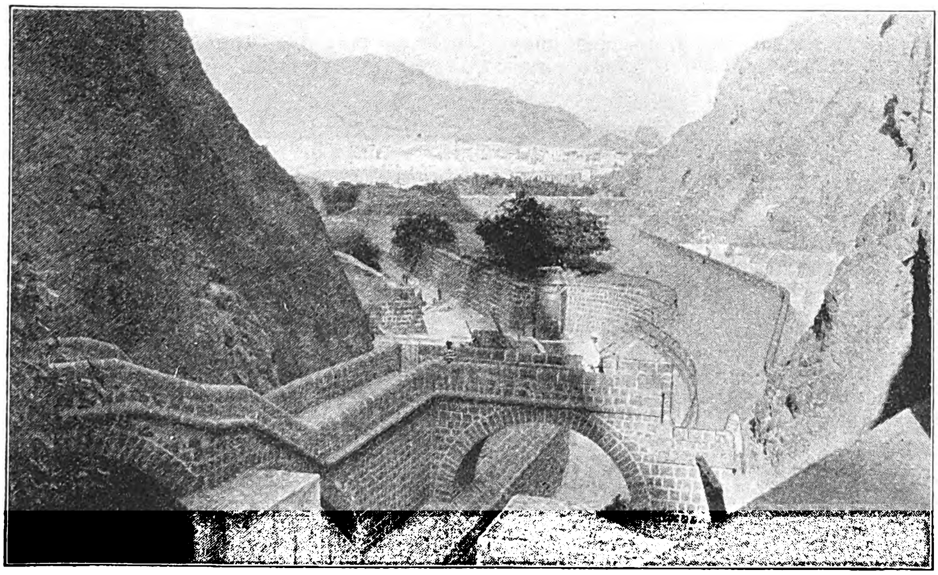
Experimental set-up of the photo-electric cell door opener. Light source is at right near knob and cell is directly opposite at left

the almost rigid dates of onset, climate, and termination of the season are being established, and it will soon be quite possible to tell the hay-fever sufferer exactly what day his symptoms are likely to commence in any definite region and almost the day on which they are likely to terminate. It will then be possible for him to move from the district or to take the necessary preventive measures exactly as they are needed.—*M. F.*

Elaborate Ancient Reservoirs

ADEN, on the Arabian peninsula, is a barren spot, for on the mountains and flat sections of this region there is not a spear of green growing things. Near the city of Aden, however, an elaborate series of 12 reservoirs collect what little rain falls and this is used for irrigation. The water quickly becomes foul and cannot be used for drinking purposes.

The reservoirs which empty into one another were partly excavated out of the solid rock many years ago. Of Persian origin, they were discovered in 1884 by a British officer and restored to the condition shown in the accompanying illustration.



Beautifully built ancient masonry reservoirs near the city of Aden

The Hearts of Athletes

FOR years it has been known that intensive athletic effort places a severe strain upon the heart which may result in chronic disability or even in immediate fatality. It is generally thought that the strain produces enlargement of the heart and cases have occurred in which acute dilatation has resulted. Recent investigations made by Dr. T. K. Richards indicate, however, that in the majority of instances after a hard race the heart is small.

When the athlete collapses he seems to be utterly exhausted, gasping for air, and unable to take a full breath. He complains of abdominal pain and lies on his side with his legs doubled up. Although he perspires freely, his body feels cold. In order to determine the condition of the heart, arrangements were made to look at the heart by means of the X ray before and after the race. Members of Harvard's varsity and freshman cross-country squads and individual distance runners of national fame were studied for the purpose. After a race, the hearts were constantly smaller than before the race. Moreover, the hearts of distance runners who had had many years of competition showed the greatest decrease in diameter after racing. As the man's condition improved, the excursions of the heart became greater and sometimes after an hour more the heart seemed to be dilated.

The theory as to these changes that occur is that the contracted heart of athletes is the result of some form of muscle cramp due to excess of lactic acid in the muscle. The cramp can be relieved by inhaling carbon dioxide which sets free the lactic acid. It seems likely that the general collapse is due to the fact that the contracted heart is unable to supply the brain with sufficient blood and that the collapse is therefore due to some form of anemia of the brain.—*M. F.*

The "storage battery" hydro-electric plant described in the accompanying text. During periods of low power demand, the pumps in this plant draw surplus power from the line and pump water uphill into the reservoir to furnish a head sufficient to run the generators during peak load periods

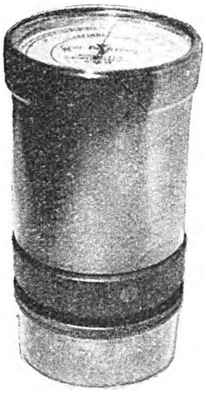
A "Storage Battery" Hydro-Electric Plant

ON the Housatonic River near New Milford, Connecticut, the Rocky River hydro-electric plant of the Connecticut Light and Power Company pumps a river uphill in order to store up a sufficient head of water to run its own generators. It is the first plant in America to pump water for power generation. In general, the pumping is done when there is a surplus of power at other hydro-electric plants in the system. This water supply is used when there is a peak load on the system.

One 30,000-k.v.a. hydro-electric generating unit and two pumps, the latter driven by 8100-horsepower electric motors, have been installed. The head on the units varies from 200 to 230 feet, depending upon the level of the water in the reservoir.

Each of the two pumping units, which were designed and built by the Worthington Pump and Machinery Corporation, has a capacity of 112,500 gallons per minute, or 162,000,000 gallons per day. They are of the vertical-shaft, single-inlet, single-stage, bottom-suction, volute type.

On each pump, the driving motor is mounted directly on top of the casing. These motors are General Electric synchronous motors rated at 7900 k.v.a., 13,200 volts, and run at 327 revolutions per minute.

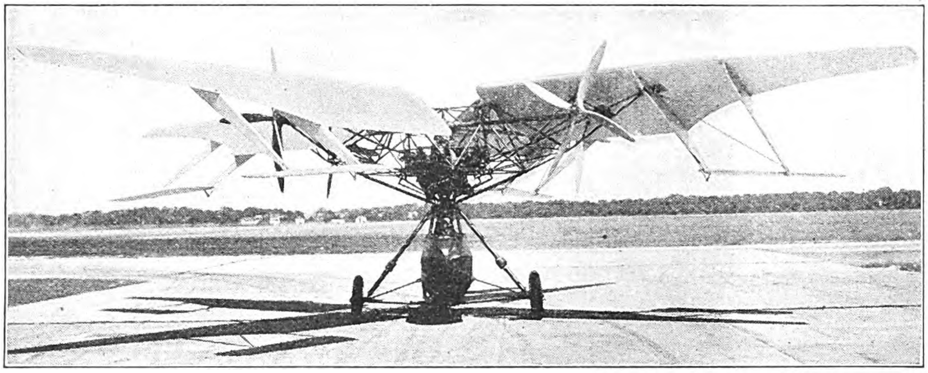


The indicating gas detector

Indicating Gas Detector

IN various industries there has long been an urgent need for a gas detector which reads directly the amount of gas in an atmosphere being tested. Such a device has been developed in Austria and has been put on the market by the Bureau für Wärmewirtschaft, Laboratorium für Brennstoff-Untersuchungen, of Vienna.

This detector consists of a flexible metal membrane, resembling the case of an aneroid barometer, which is closed by a porous clay plate on one end. When the device is brought into an atmosphere containing diffused gas, the gas penetrates the porous clay and fills the space between the clay and the metal membrane. The pressure therein is increased so that the membrane, which is connected to a pointer on an indicating dial, is distended. As the pointer moves, it indicates on the dial the approximate amount of gas in the air.



First of the experimental helicopters to give some promise of successful vertical flight in taking off and landing, designed by a young aeronautical engineer

Navy Enlists Gas to Build War Ships

GAS has been enlisted by the United States Navy to play a large part in the construction of future vessels, according to reports from the Mare Island Navy Yard.

Although it was used in the past to cut up old battleships, gas played a larger part in building the recently launched U. S. S. *Chicago.*

The 1,500,000 rivets required were all heated in specially designed gas ovens because the uniform heat produces stronger rivets and prevents oxidizing, according to the report. All the zinc used to galvanize the inner bottom of the cruiser for machinery foundations and for her fresh water tanks was melted in gas-fired vats. Gas was also used to bend all copper pipes installed and for much of the welding.

The Curtiss-Bleecker Helicopter

THERE is no doubt that the helicopter has possibilities of usefulness. It is unlikely ever to compete with the airplane on the score of speed or load carrying, but it might well act as an auxiliary to the airplane, bringing passengers, for example, from the heart of a city to the transport terminal. The helicopter also has military possibilities, such as for observation work in very rugged country where the airplane itself would be helpless. Such services by the helicopter have long been admitted as plausible, and great ingenuity and vast sums of money have been spent on the development of various types of direct ascent machines. Unfortunately, the history of the helicopter has been marked by a succession of failures. In many cases a reasonable conception has been ruined by insufficient fundamental research. Inventors have been too eager to build and fly their craft.

Now the Curtiss Aeroplane and Motor Corporation has entered the lists with a young engineer, Maitland B. Bleecker, as the inventor and designer of a helicopter. The Curtiss company cannot be reproached with too hasty construction. Systematic research was begun as early as 1927. This has covered aerodynamic work in the wind tunnel, investigations on the cooling of the engine, and so forth. At least we have here a brilliant young engineer, supported by a great company and with all technical aids at his command.

Brief descriptions of the helicopter have appeared in the daily and technical press. The writer has had an opportunity to examine the novel craft. The Curtiss company, however, has been chary of issuing adequate descriptions so far and the following remarks, although carefully considered, must be ragarded as reasonable conjecture for the most part.

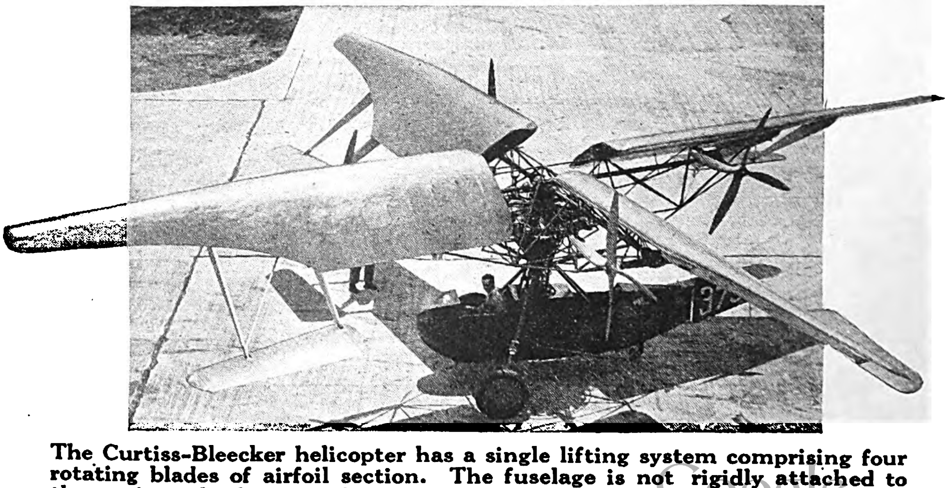
The Curtiss-Bleecker helicopter has but a single lifting system, comprising four rotating blades of airfoil section. With a single rotating system, if the engine were rigidly mounted to the fuselage or nacelle, then the fuselage as a whole would turn in space (action and reaction being equal and opposite) to the great discomfort of the pilot. This difficulty has been met by having the engine free to rotate in suitable bearings in the nacelle. The engine is mounted somewhat above the nacelle and behind the pilot.

The question of transmitting power from the engine to the main rotating blades is a difficult one. Nothing would appear simpler than to gear down from the engine to a vertical shaft, which would, in turn, rotate the blades. Unfortunately, a large speed reduction is necessary. The engine must revolve at high speed—2000 revolutions per minute or thereabouts—while the lifting elements should, for maximum lifting power, revolve slowly, say 150 revolutions per minute. The problem of gearing down and transmission without excessive weight, is a formidable one.

Again, the rotating blades must vary their incidence, or pitch, as they move along their circular path. The pitch must be varied rapidly for control or for descent with power off. The design of a good transmission system is complicated by these additional requirements. To avoid these difficulties, Mr. Bleecker has hit on a novel method of attack. He connects the engine through shafting to a number of small propellers, which, in turn, pull the lifting blades around, but leave the lifting elements more or less free from the transmission machinery. The central vertical shaft running from the horizontally placed Pratt and Whitney Wasp air-cooled engine is geared to four horizontal shafts, which again are geared to four, four-bladed propellers of relatively small diameter. The transmission system is external to the main lifting elements which are rotated by the thrust of the small propellers.

Another difficulty in the single-lift-screw-system helicopter is that, in forward motion, the blade advancing into the wind is meeting the air at a greater speed than the blade moving away from the wind. Therefore if the pitch on both sides is the same, the blade advancing into the wind will have a greater lift than the blade retreating from the wind. The result is a powerful rolling moment tending to bank the machine about its main or longitudinal axis. Such a rolling moment would be difficult to resist by the controlling means placed at the pilot's disposal, and even if met by the pilot would leave him dangerously little lateral control.

To meet this situation it is necessary to vary the pitch or angle of incidence of the blades automatically, as they whirl round. Herein lies the function of the auxiliary vanes or "stabovators" as they are termed by the Curtiss company, disposed at some distance behind the main blades. The area of the wings is 322 square feet and the stabovators have an area of 12½ square feet each. The main blades are presumably hinged at such a point along their chord that they tend, under a gravity moment, to increase their angle of incidence. When the stabovater is moving rapidly into the wind, its aerodynamic moment becomes greater in proportion to the gravitational moment. Therefore the stabovator tries to bring the wing down to a smaller incidence or pitch. If the whole delicate situation is correctly adjusted, then the decrease in pitch of the advancing blade balances the effect of the greater speed, and the lift on each side of the airplane is equalized. The dangerous rolling moment disappears. We believe this explanation to be an entirely plausible one; but later disclosures may modify it.



The Curtiss-Bleecker helicopter has a single lifting system comprising four rotating blades of airfoil section. The fuselage is not rigidly attached to the engine; the latter is free to rotate in suitable bearings in the nacelle

The designer of the helicopter has also worked out a system of control about all three axes. The directional control, or rudder, is mounted at the rear of the short nacelle. Contrary to practice with the conventional rudder, the helicopter rudder is hinged about a longitudinal axis. This is evidently so as to provide steering when the helicopter is either climbing vertically or soaring. Under such conditions, the rudder is in the downward slipstream of the main blades. If it were hinged about a vertical axis, nothing would happen. With the rudder hinged about a horizontal axis at its top edge the craft will turn to the right when the lower edge of the rudder is swung right. Our readers will no doubt agree with this supposition after a little reflection. For lateral control and longitudinal control, an ordinary "joy stick" is placed in the nacelle. The joy stick is so connected with the rotating blades that the pitch can be changed either on the right or left side, or ahead or behind the pilot. We imagine that a system somewhat analogous to the floating aileron is employed. Thus a complete control system is provided for.

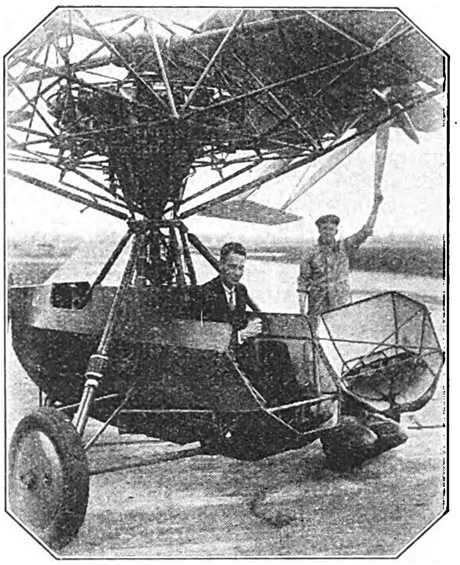
All the main blades can also have their pitch changed simultaneously. This means that they can be given a negative pitch when the engine fails. The blades will then continue to rotate as a wind-mill, providing lift for either vertical descent or descent on a steep path. Ability to change the pitch is also important from the point of view of maximum climb and forward speed. In vertical climb the pitch should probably be somewhat greater than in forward flight. To secure forward flight, the elevator system is employed to tilt the machine slightly down by the nose, so that a part of the lift now acts to give forward pull.

A great deal of thought has gone into the power plant system. Gasoline and oil tanks are mounted so that they rotate with the engine. Electrical connections are taken off the rotating system through the use of a commutator. Through an ingenious system of gearing the pilot has normal throttle control available. A tripper device allows the gasoline feed system to be shut off while the rotor is in motion. To cool the engine, since it is *not* in the slipstream of the conventional propeller, a 32-inch diameter propeller-type fan is placed above the engine, with special baffles to guide the air all around the engine.

The landing gear is more or less conventional but the travel of the oleo struts is exceptionally large, to allow for vertical descent with power off. The tail wheel is of the caster type.

The gross weight of the helicopter is 3400 pounds. The useful load is small and some 20 percent of the gross of this useful load—180 pounds—is in fuel.

The main criticism of the helicopter is complication and the fact that there are so many transformations of energy to be reckoned with. The engine drives shafting. The shafting drives the small propellers. The propellers pull the main blades round. The main blades tilted forward provide the forward pull for the entire craft. Each of these transformations spells a loss. There is no doubt, however, that the Curtiss company will proceed with the utmost caution and will persevere, meeting difficulties as they occur and improving the machine step by step. We wish them every success.—*A. K.*


Cock-pit of the helicopter, showing connection of engine and body

Exports of Farm Machinery

EXPORTS of agricultural machinery and implements in 1929 amounted to 140,800,000 dollars compared with 116,000,000 dollars in 1928. This increase of 21 percent over the high record established in 1928 is of importance to business, as it relates to one of the great industries that is a large employer of labor and an extensive consumer of raw materials. Barring unforeseen calamities to the crops, the outlook seems to be for a continued increase in these products both at home and abroad.

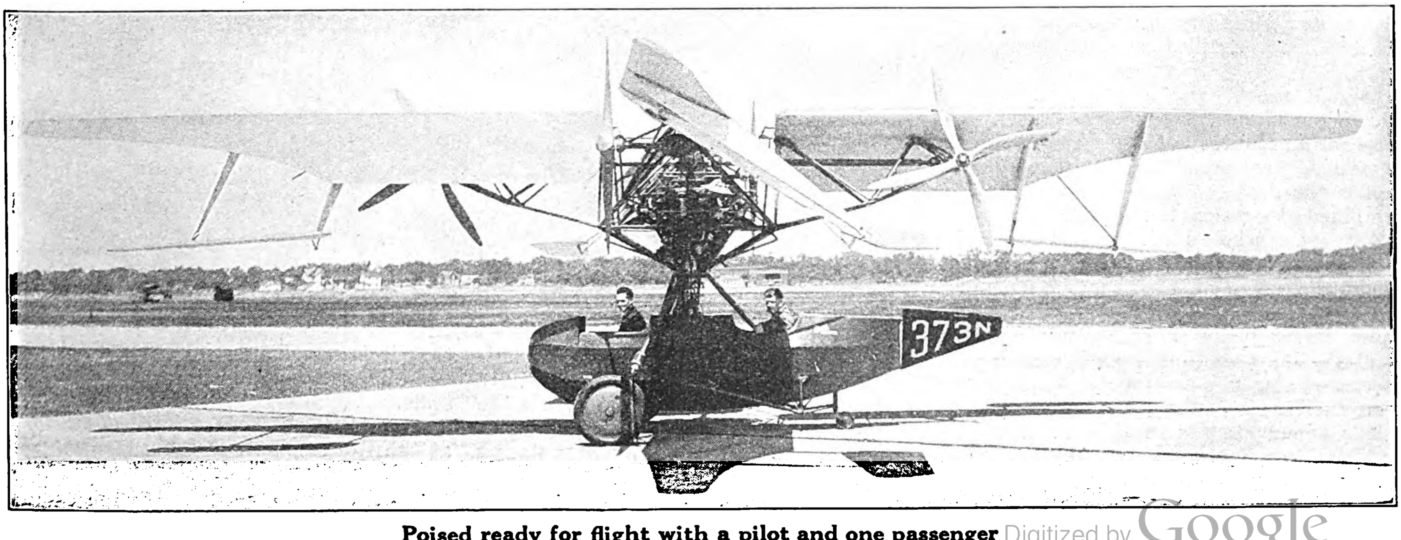
The manufacture of farm machinery and implements in 1928 accounted for 2,200,000 tons of steel, or 6.5 per cent of the total consumption of steel in domestic industry. As the railroads used 16 percent of the country's steel, the farm-machinery business called for 40 percent as much as the railways. This business also called for almost exactly the same tonnage of steel as was exported. Sales of this type of machinery in 1929 were larger than in 1928, due in part to the increase in exports. Thus the export field demonstrates its importance in maintaining one of our great manufacturing industries.

The great increase in power-farming machinery shipped out of the country shows that the trend towards the mechanization of agriculture is not an exclusively American feature. Canada and Argentina, great export wheat-growing countries, and Russia, a "hope to-be" exporter, are the leaders in this kind of machinery. Tractors are one of the features of these exports to the wheat-growing countries. Doubtless our new plan of "farm relief" by reducing acreage and raising less will receive the enthusiastic endorsement of these three countries that stand to profit by taking whatever trade we shut ourselves off from supplying.

Of those countries, Canada, Argentina, and Russia offer great possibilities for power farming. Canada's prairies are especially adapted for it, and the great increase in such heavy machinery taken in the past year shows that the farmers there are appreciating the value of mechanized agriculture. All such methods of production as this decrease the cost and make it possible to sell wheat at lower prices in the world markets. When crops are fairly good, therefore, it stands to reason that this line of manufacture will prosper both at home and abroad.—*Barron's.*

Refrigerating Fresh Fruits

FRESH Georgia peaches at Christmas-time are the latest triumph in food preservation by freezing. Advances in refrigeration practice accompanying the freezing, distribution, and display of frozen food-stuffs were featured at a recent meeting of the American Society of Refrigerating Engineers, held in Atlanta.



Poised ready for flight with a pilot and one passenger

Plans for the production of frozen Georgia peaches on an extensive scale were described by W. R. Tucker. Sliced peaches packed with sugar are to be quick-frozen in one-pound waxed paper containers and then held to supply the "out-of-season" high quality demand.

Extensive experiments covering more than two years preceded the plans for large-scale production. Unsatisfactory for canning because of the very delicacy of cellular structure that is their chief asset from a flavor standpoint, Georgia peaches have presented a difficult over-production problem. Flooding of the market during the brief season in which they reach maturity could be avoided, Mr. Tucker said, by withholding in a frozen condition a sufficiently large part of the crop.

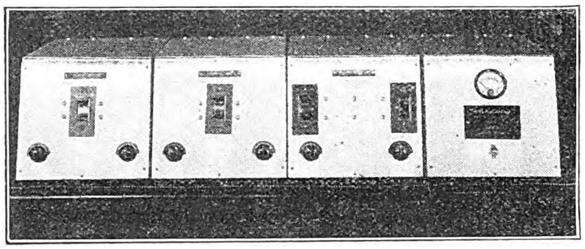
As a result of experiments made last year, the most satisfactory varieties, the proper freezing time, freezing and holding temperatures, and container size have been determined definitely. More than 10,000 pounds of peaches were frozen by Mr. Tucker and his associates at the height of the producing season last year, and stored until Christmas time. Then they were packed in solidified carbon dioxide and sent to leading hotels, representative peach growers, home economics bureaus, and other interested individuals. An amazing unanimity of opinion to the effect that these peaches were indistinguishable from freshly picked products resulted from this test. With the plans that have been developed, large-scale production will make it possible to market frozen peaches at a price that is considered reasonable for such high-quality products. It is planned eventually to effect national distribution throughout the period when fresh fruit is not available, Mr. Tucker said.—*A. E. B.*

The Trend to Short Waves

THE growing use of low waves for broadcasting is creating a demand for low-wave receivers, which is being met by several manufacturers, one being C. R. Leutz, Inc., makers of the short-wave Model C receiver illustrated in these columns.

The Model C is of unit construction, allowing maximum flexibility; either two, three, or four units may be used together as a complete receiver. The simplest combination is the detector stage and audio unit combined, to which the first and second RF stages can be added. Since each unit is in a separate aluminum cabinet, double shielding is effected, each radio frequency stage, the detector stage, and the three audio stages being in separate compartments. The resultant isolation between the tuned stages is an important factor in the performance of the set.

The tuned circuits in this receiver are designed for maximum and uniform efficiency over the entire frequency range. Ordinary short-wave adapters obtain a wide range by the use of small coils and a large tuning condenser. Vacuum tubes, being voltage operated, require maximum inductance and low capacity, to meet which demands a higher manufacturing cost than is the case with the first-mentioned method of obtaining width of range. But in the Model C short-wave receiver, efficiency displaces cost as the determining factor. Of course, the receiver is unsuited for ordinary broadcast wavelengths, but its efficiency on the short waves is very high. The condensers are of fine construction and of the low loss type; the various tuned circuits are completely shielded; and there has been provided an elaborate system of chokes and by-pass condensers, which confine the radio frequency currents to their proper paths.



Panel of the four-unit Model C short wave receiver. Either two, three, or four units may be used as a complete receiver

One of the problems of short-wave receivers using few tubes is to secure sufficient amplification in the detector circuit to operate properly the powerful audio amplifier. To meet the requirements, the Model C receiver has two tuned radio frequency stages. The push-pull audio amplifier has been purposely omitted since the extra input signal required to secure full output cannot always be conveniently obtained in a short-wave circuit. A receiver employing push-pull would operate well enough on strong signals, but the weak ones would be entirely lost. The sensitive cascade amplifier guarantees loud speaker volume.

The Model C short-wave receiver is sold without coils, which may be purchased separately to cover any desired bands or wavelength ranges.

Mineral Oil and Cancer

BECAUSE of the publicity given in recent years to the possibility of producing cancer in human beings by contact with lubricating oils, Dr. Francis Carter Wood of the Columbia University Institute of Cancer Research undertook a study to determine definitely whether or not the ordinary mineral oil used for laxative purposes might have any effect in stimulating the growth of cancer. It is well known that "mule spinners" in the cotton industry, whose clothes are saturated with lubricating oils from the machinery which they use, develop cancers at spots where the skin is irritated by the clothing saturated with oil.

It has also been well established that cancer may be produced in mice by rubbing them with tar. It was found that painting the skin of mice with heavy lubricating oil would produce irritation and overgrowth, but painting the skin of mice of the same type with mineral oil of the kind used for laxative purposes did not produce anything resembling cancer. Feeding of mice with mineral oil did not produce any changes in the intestines or stomach, neither did the feeding of rats with such oil have any cancer-producing effect. It is well known that the skin of the albino mouse is just as sensitive to irritation by oil as is the human skin, and that both albino mice and rats may develop spontaneous cancer of the intestines.

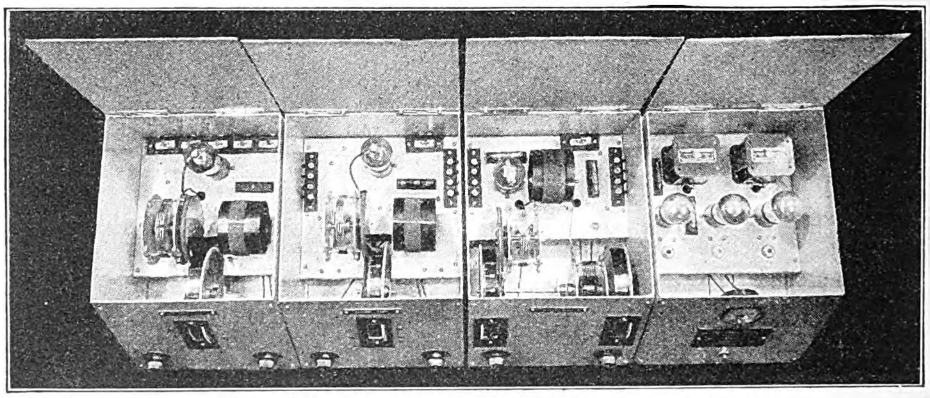
Hence there is no reason to believe that mineral oils, as used in modern life for the treatment of disease, have any cancer producing effect.—*M. F.*

Air Trespass Over Private Property

WE pointed out in an editorial in our May issue that the old theory that a property owner's rights extend to the skies has no basis in fact. A federal court, sitting in Cleveland recently, apparently concurred with us in this opinion, but the decision of the court did give to the property owner "possession" of the air up to a height of 500 feet above the land he owns. This is an interesting commentary on the growing need for study of the many legal problems confronting aviation today and, so far as we can learn, is the first really definite legal opinion that a plane may be actually liable for trespass even though it does not touch the ground over which it illegally flies.

Salvaging Everything but the Rattle of Derelict Cars

FOLLOWING the systematic wrecking of more than 18,000 antiquated motor cars, the Ford Motor Company recently announced that the salvaging of materials obtained in this manner is practical and that it is now increasing its facilities for continuing the work on a more extensive scale.



Interior view of the radio receiver illustrated above

At the present time a force of 120 men at the Rouge plant, Dearborn, dismantles these apparently worthless hulks at the rate of 375 cars every 16 hours. Many parts, such as tires, are salvaged in their entirety and other materials are being converted into useful articles, while the steel is remelted in furnaces to do its bit in the manufacture of Ford cars and Ford trucks.

The derelicts are bought from dealers at a fixed price of 20 dollars a car. There is no restriction as to make, age or condition, except that all cars must have at least some semblance of tires and a battery.

The salvaging of cars that have outlived their usefulness serves three ends. It will rid highways of motor menaces that are dangerous both to life and traffic; it will, to a large extent, free the landscape from unsightly junk piles; and it will convert into usefulness material that would otherwise go to waste.

The present method is, first, to drain the cars of gasoline and oil, both of which are salvaged. Grease is also saved. The cars are then hauled into the building and placed on a progressive conveyor. The headlight lenses and lamp bulbs are recovered. The spark plugs and battery are taken out. All glass is removed. That which is whole or may be cut to useful sizes is utilized for glazing in Ford plant buildings. The broken bits are sent to the Rouge glass factory for remelting. Floor boards travel to the box factory to be used for crate tops.

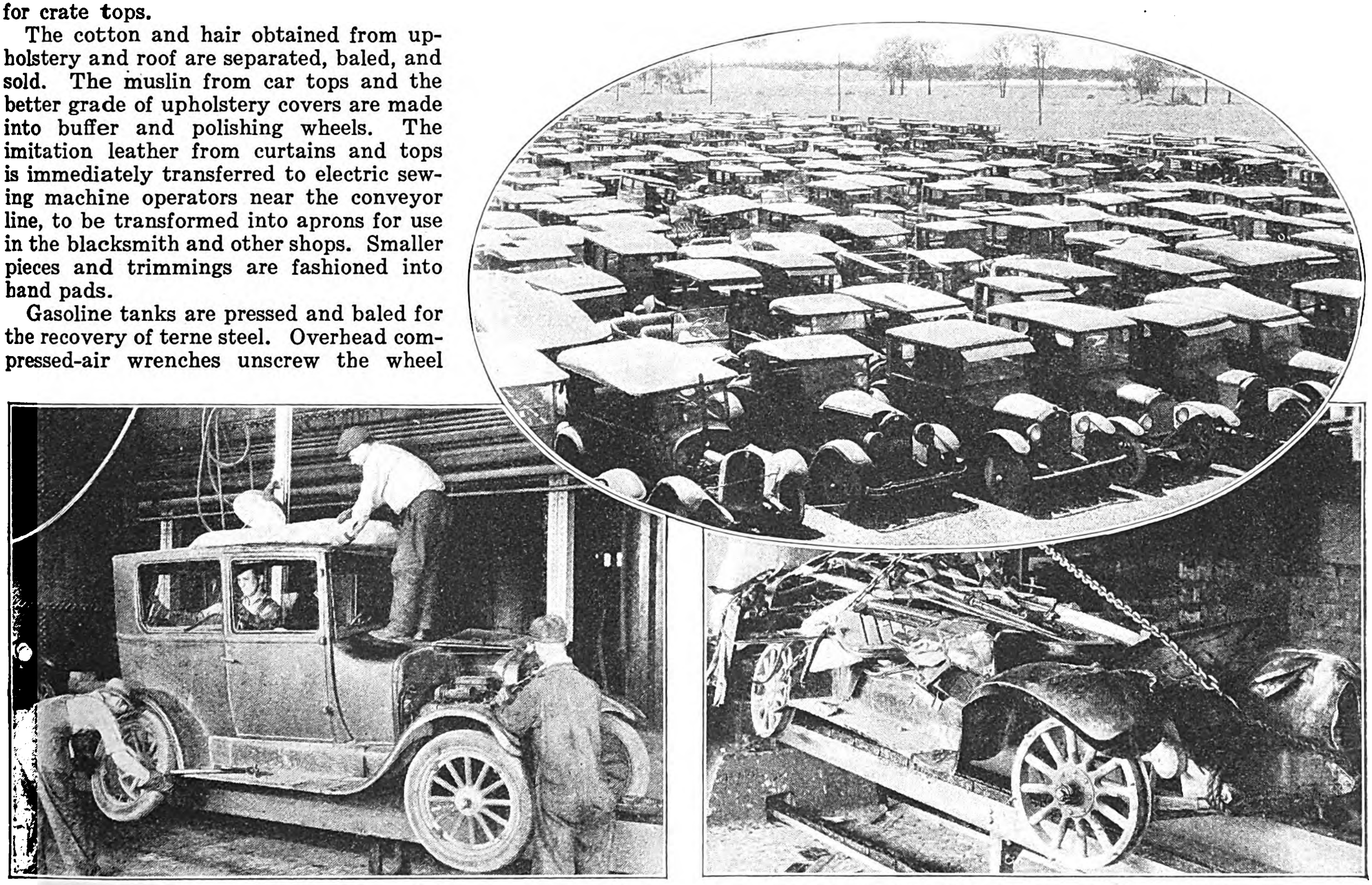
The cotton and hair obtained from upholstery and roof are separated, baled, and sold. The muslin from car tops and the better grade of upholstery covers are made into buffer and polishing wheels. The imitation leather from curtains and tops is immediately transferred to electric sewing machine operators near the conveyor line, to be transformed into aprons for use in the blacksmith and other shops. Smaller pieces and trimmings are fashioned into hand pads.

Gasoline tanks are pressed and baled for the recovery of terne steel. Overhead compressed-air wrenches unscrew the wheel nuts. When the wheels are removed the tires are inspected. If the tread is good they are sold as used tires at the commissary; otherwise the entire unit is placed in automatic shears which sever both tire and rim. The tire is quickly stripped and tossed into a waiting cart to be sold as old rubber. The rims join others for use as furnace scrap.

Horns are salvaged. Likewise hubcaps for aluminum, ignition wire for copper, oil cups for brass, bushings for bronze, and other bearings for babbit. All metals are kept separated by depositing each kind in steel barrels.

As the conveyor-propelled, and now all but dismantled, cars reach a station near the end of the salvage line, men with oxygen torches burn the motors loose from the frames. Overhead compressed-air hoists are attached to the motors and they are swung to a washer. This bath of boiling water and soda ash expels them from the opposite end free from grease and dirt. Meanwhile what is left of the cars continues on the conveyor into a 22-ton press which crushes them. The remains are then transferred to the third conveyor which carries them to the furnace doors.

All Model T engines are conveyed past the washing machine to a group of specially designed presses where they pass through a special process of disassembly.



In the three views above, the oval shows a section of the receiving yard at the Ford plant where old cars are stored awaiting junking; below at left, workmen are stripping the car; at right, car pressed after stripping

553 Hours in the Air

In the refueling endurance record flight of John and Kenneth Hunter, which ended late in the afternoon of July 4, the engine was put through the most grueling test to which an airplane engine has ever been subjected. The Hunter brothers remained in the air for 553 hours, 41½ minutes.

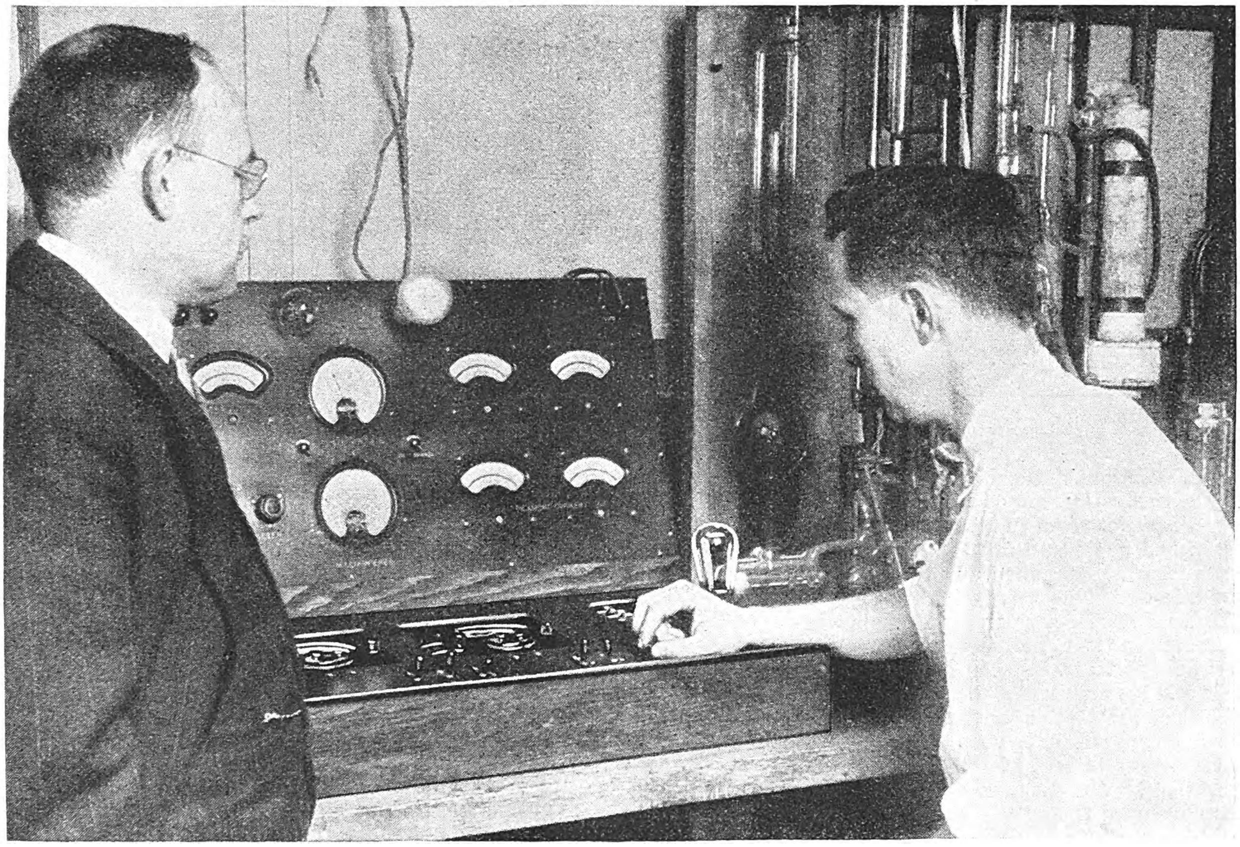
The engine used was a Wright Whirlwind 300, which, before the beginning of the flight, had already had 300 hours service. During the endurance flight, the plane flew approximately 40,000 miles, non-stop, around and around in the vicinity of the airport. This figure, however, is small in comparison to some of the performance statistics of the flight. The revolutions made by the crankshaft were 52,000,000; each valve opened and closed 26,000,000 times; strokes made by each piston were 104,000,000; each piston traveled 9025 miles; and the revolutions made by the supercharger amounted to 405,600,000!

Brain Changes After Gas Poisoning

Poisoning by illuminating gas containing carbon monoxide is one of the most common conditions in modern life. So wide are the uses of gases that the hazard is almost constant. Only the high development of modern plumbing keeps the gases within reasonable limits. Moreover, there is also a hazard from carbon monoxide due to the amount of the gas contained in the exhausts from automobiles. Many cases occur every year due to running the car in a closed garage.

The immediate symptoms after gas poisoning are unconsciousness; if a sufficient amount of the gas has combined with the red coloring matter of the blood death promptly ensues. If the patient recovers, nausea, vomiting, headache, and weakness are not infrequently seen. After the patient recovers, even from severe cases, he may develop secondary conditions, including pneumonia, gangrene, and particularly changes in the nervous system. The nervous system of the human being is such a delicate structure and so highly developed that it is particularly sensitive to poisonous influences.

In a case described by R. P. MacKay, a locomotive fireman 29 years of age who was found unconscious in his garage due to inhaling exhaust gas from his car, developed serious disturbances of the nervous system and symptoms like those of shaking palsy, his speech became monotonous, and his hands and head were subject to tremor.



"SUBSTITUTE NICKEL *for* PLATINUM! we can do Better *than that*..."

When the radio industry was young and only a few thousand technically minded enthusiasts were hooking up receiving sets, radio tubes were a laboratory product. The use of costly platinum-iridium for their filaments was not a handicap. For comparatively few tubes were in demand.

Westinghouse engineers, however, foresaw a serious situation. When millions of radio sets came into use there would not be enough platinum available to make the tubes they would need. A substitute material just as satisfactory must be found. Westinghouse laboratories set out to find it.

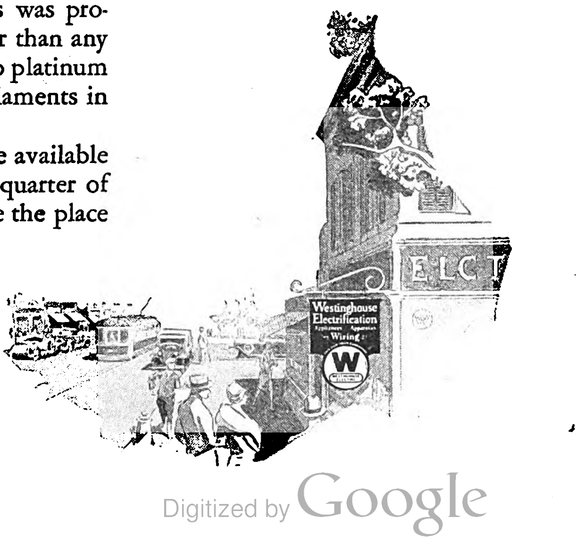
Soon a young engineer reported that nickel would meet the requirements. From a practical standpoint it made as good filaments as platinum. It would do. But Westinghouse engineers said: If a pure metal is as good as platinum, it should be possible to produce an alloy that will be far superior.

Months of tireless research and experimenting followed — development work that called into play the broadest scientific knowledge. Eventually the ideal combination of metals was produced, Konel metal, stronger than any alloy steel, and far superior to platinum as a core for oxide-coated filaments in radio receiving tubes.

If sufficient platinum were available it would take more than a quarter of million dollars worth to take the place of the Konel metal used in vacuum tubes each month. And vacuum tubes are only one of its possible applications. Konel metal meets severe service requirements such as those confronted in gas engine valves and spark plugs. Its commercial possibilities have only been touched.

Tune in the Westinghouse Salute over WJZ and the coast-to-coast network, every Tuesday evening.

Westinghouse



Calcium chloride in its new "flake" form, is also finding growing application in the construction of concrete highways. It may be coated on the surface of the finished paving or added to the concrete mix. In the former case, the calcium chloride cures the concrete by supplying moisture—from the air—for the surface of the new road, thus preventing premature drying of the base as well as the surface. When the chemical is added to the concrete mix—two pounds, in solution, for every 100 pounds of cement—it eliminates all other forms of curing, such as straw covering, and gives a pavement that may be opened to traffic in one half the time required by the old methods.—*A. E. B.*

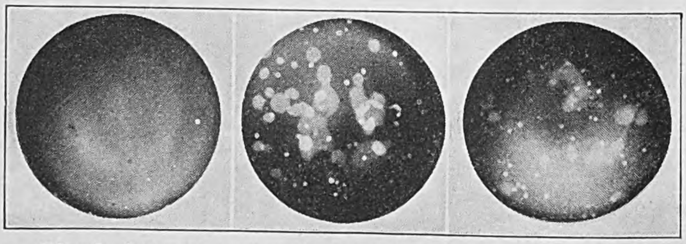
Calcium chloride, a snowy white chemical, coaxes moisture out of the atmosphere when it is spread on dirt roads. This deliquescence keeps the dust down because of the wetness. The chemical is also mixed with concrete to eliminate the costly process of watering the laid concrete or covering it with straw. Above is shown a calcium chloride spreader in action and at right a concrete mixer where the chemical is used

The Germ in the Blood

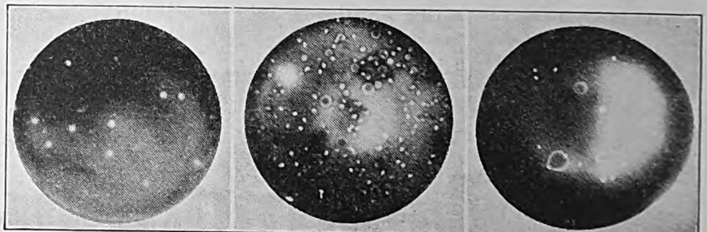
ORDINARILY the blood is free from germs. One may take specimens of blood and put them in a bacterial medium again and again and fail to grow a single germ from the specimen. In times of serious infection, however, germs get into the blood. Since the germs vary in their virulence and in their character it is, of course, desirable to know as soon as possible the type and the numbers of the germ involved. In order to settle this fact, various bacterioologic techniques have been developed, one of the most interesting having been devised recently by Dr. Reuben Ottenberg, who has developed the system called "differential blood cultures."

In system, blood is taken directly from the internal jugular vein, or from the arm vein, or perhaps from a vein directly draining the spot at which the germs are supposed to be developing. Another specimen is taken from a vein at a distant point and the number of germs in the blood taken from two or three places is compared on blood culture plates. If, for example, there is a severe infection of the mastoid or of the blood vessels on either side of the skull, the blood taken from the jugular vein on that side will contain many more germs than the blood taken from the arm vein or the leg vein in the same patient.

As is shown in the illustrations, the method works out satisfactorily and is of great value in making the diagnosis and in determining the procedure to be followed. Doctor Ottenberg applied the method in 29 cases with satisfactory results. Of course, the failure to find the germ in any of the cultures does not absolutely indicate its absence but may indicate the necessity for making a further study one or two days later.—*M. F.*



Blood plates ot a case of thrombosis of the left lateral sinus, showing: left, blood culture from left jugular; middle, from the right jugular; and right, from arm



Plates from a case of thrombosis of right lateral sinus, showing: left, culture from right jugular; middle, from left jugular; right, from arm—white spots are bubbles

Launching and Picking-up Seaplanes

SO far, in using a seaplane in conjunction with a steamship, attention has been concentrated on specially prepared runways or on catapults. For picking up a seaplane from the water, cranes have been employed. *The Aeroplane* (London) points out that long runways are difficult to install, catapults are expensive, and fast steamers are not supposed to stop in the middle of a run.

Therefore an entirely new method of launching and picking up seaplanes, invented by a German engineer named Kiwull, is of decided interest.

The Kiwull "Watersail," as it is called, consists of a spread of canvas about 98 feet long and 33 feet wide, with spreader booms on the under side. One end of this canvas runway is attached to the deck over the stern of the steamship and the other end terminates in a kind of drogue made of wide-mesh netting. This end is attached to the ship by two ropes. The action of the drogue is to cause the water to roll in over the end. This makes it easy for the seaplane to taxi behind the steamer and run onto the trailing runway. When the seaplane is once on the runway, the floats are attached to skids and the whole machine is hauled up the inclined canvas slope. The process may be be reversed for launching.—*A. K.*

Hen Changes to Rooster, Then Changes Back Again

AHEN that became a rooster and then exercised the prerogative of her former sex and changed her mind, becoming a hen again, is the freak fowl described in the *Journal of Heredity* by Drs. R. A. McCance and A. Walton of the pathological department, King's College Hospital, London.

The bird, a light Sussex pullet, was hatched with seven other pullets in March, 1925. In October of the same year all eight commenced to lay and continued to do so until the spring of 1926. All then moulted and while the normal birds soon put on their new plumage, this freak remained practically nude all summer and autumn.

Early in 1927 she slowly assumed male plumage and grew spurs, but no comb. She also put on additional height, becoming two inches taller than her sisters.

She (or "he") commenced to rule the farmyard. She called the other hens to food, escorted them to the nest boxes, shepherded them about the yard, and in general conducted herself like the "cock of the walk." And she laid no eggs at all. In the autumn of 1927 she failed to moult with the others.

During the following spring she was seen going to the nests and clucking. A dozen eggs were placed under her as an experiment. Still wearing her male feathers, she faithfully sat on them, hatching out 11 chicks and proving an excellent mother afterwards.

Subsequently, still in male disguise, she began to lay eggs again. That autumn she moulted, resuming female feathers, but keeping her spurs. Throughout the winter of 1928 and spring of 1929 she laid regularly, mostly doubled-yolked eggs.

Usually when a hen reverses her sex, an examination of her internal organs will disclose some diseased condition, most probably in her ovaries. But when this hen-rooster-hen was killed and all of her glands subjected to minute examinations, nothing whatever could be found wrong with them. She remains an unsolved physiological riddle.

The editor of the *Journal of Heredity* adds a note telling of a somewhat similar case recorded a couple of years ago in this country. A hen assumed male feathers, but continued to lay. While she was still disguised as a rooster she was mated to a real White Leghorn male bird, and produced fertile eggs. She did not, however, raise her own family. Subsequently she moulted and her new feathers were those proper to her female sex.—*Science Service.*

Calcium Alloys Find New Uses

NEW commercial calcium alloys have been studied by Prof. J. Meyer, of Breslau, Germany, and are finding various uses. They are rather sensitive to air and moisture, forming a dense white smoke when burned. For some purposes the activation of calcium by sodium is of significance.

Chemical and Metallurgical Engineering reports that experiments by A. von Antropoff at Bonn have proved that minute quantities of metallic sodium at the surface of calcium can incite its reaction with nitrogen. Calcium filings can be activated by precipitated sodium fumes. The same investigators likewise report on the reaction of calcium and nitrogen in the presence of the rare gases, by which argon, for example, can be quickly and completely freed of nitrogen. The use of this process for the extraction of helium from natural gas seems to offer interesting possibilities.

Measuring Height in Seaplane Landings

A CABLE from London to the *New York Times* reads as follows:

"Experiments carried out at Calshot make night flying possible for seaplanes by means of small searchlights fitted beneath each wing. The rays converge at a predetermined distance from the plane, forming a large patch of light on the water and revealing exactly how far the pilot is above the surface when he is coming down."

It is quite difficult to estimate the height above water even in the day time, because definite points of reference are lacking. At night this is well nigh impossible. The cable needs a little interpretation, however.

If the small searchlights are placed under

Miles and Miles of Yellow Strand

This is the age of big projects—the deepening of waterways; the digging of great canals for transportation and drainage; the erection of mammoth dams to impound water for irrigation and power.

It is no mere coincidence that miles and miles of Yellow Strand Wire Rope are constantly employed in these enormous construction projects. The excavating and handling machinery are of the largest capacities obtainable—and each year finds them larger, putting ever increasing strains on their wire ropes. Only such rope as Yellow Strand can stand the gaff—economically.

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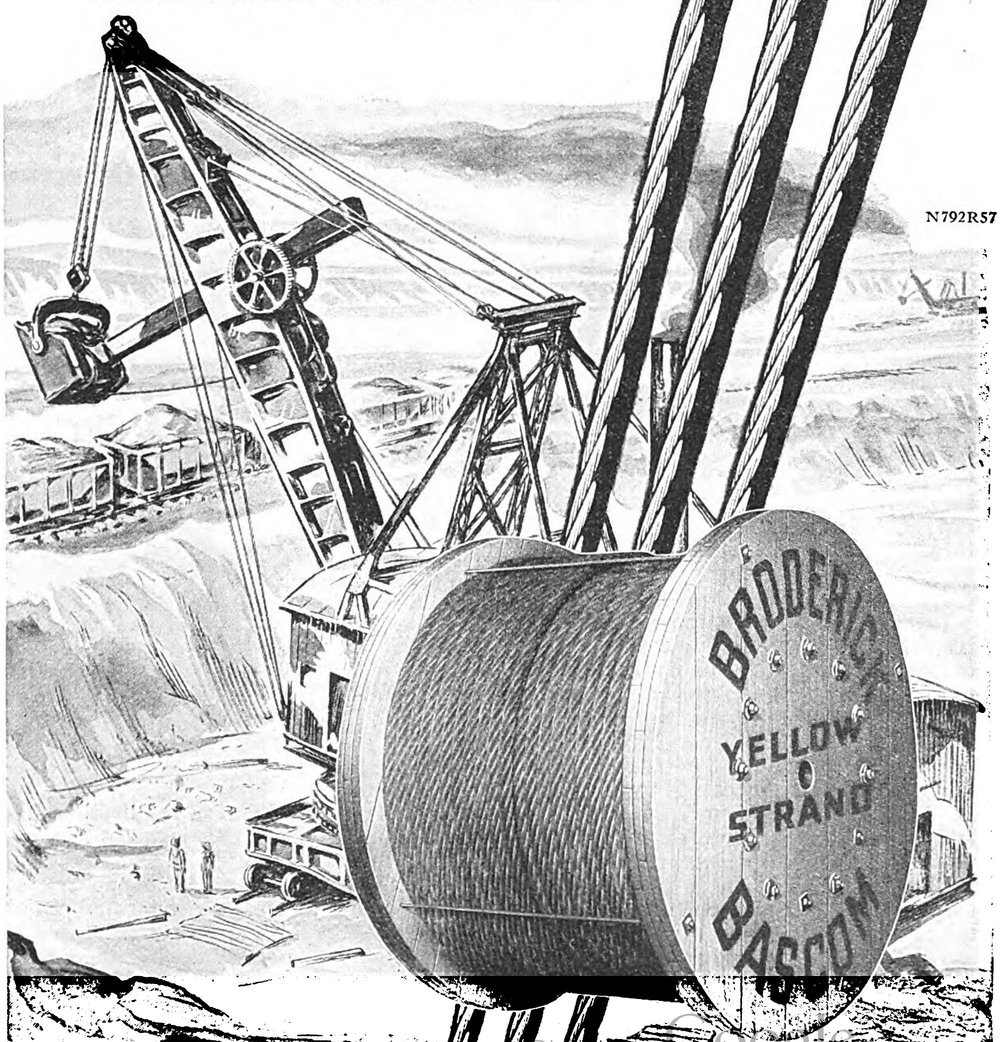
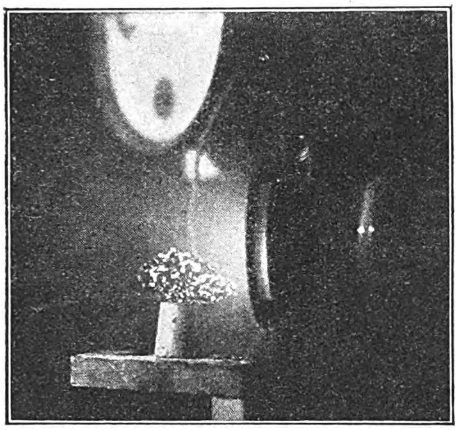


each wing tip, at the proper angle to one another, their lights will indeed converge at a certain fixed distance from the wing. If the distance between the searchlights and the angle between them are both known, this distance is readily calculated. Now suppose that, by means of an inclinometer, we can tell the inclination of the plane to the horizontal. Then we can calculate its distance above the water. The naviagtor in these experiments probably sights the patch of light, reads the inclinometer, and picks off the height from a large and clearly visible chart mounted on the dashboard in front of him.



How minerals glow when subjected to the influence of cathode rays

The device is only in its experimental stage, but is evidently correct in principle, and may be very helpful in the night flying of seaplanes.

Cathode Rays Detect Synthetic Jewels

SYNTHETIC sapphires can be detected readily from the natural stones by means of the cathode-ray tube. The use of the tube in this work is the first commercial application of the apparatus which was developed in the research laboratory of the General Electric Company by Dr. W. D. Coolidge about four years ago.

Sapphires, next to diamonds in hardness, are used by the company at the rate of more than a million and a half a year as jewels for bearings in meters and other delicate electrical instruments.

Trays of sapphires, both natural and synthetic, are exposed in a dark room to the powerful rays of the tube for a few seconds. All glow or radiate colors while exposed to the rays, but when the rays are turned off, the natural stones cease to glow whereas the synthetic stones continue to glow.

In addition to sorting the natural from the synthetic sapphires, the rays also help determine where both the natural or factory-made gems come from, an important advantage according to engineers.

"Should sapphires from Montana be mixed with stones from Australia, we could find this out with the cathode rays," B. W. St. Clair, of the company's standardizing laboratory at Lynn, Mass., explained. "In the case of synthetic stones, in most cases we can determine which factory made them by the different hue of the glow while the rays are on.

"We have one particular kind of natural sapphire which does not glow at all. In this case, the lack of glow under the rays immediately tells us its origin."

Tests have been made with diamonds and it has been found that synthetic stones turn decidedly brown when placed in the rays, whereas there is no change in natural stones. However, these tests have been but meager and no definite conclusions have been reached.

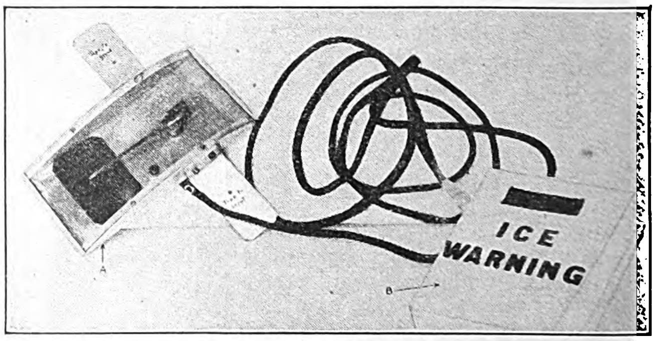
An Ice-Warning Thermometer

IN our July 1930 issue we described the very interesting experiments of Dr. Geer of Ithaca, whereby rubber, oil-impregnated airplane "overshoes" seem to have met the danger of ice formation. It still remains to be seen whether practical aviators will resort to these overshoes. Airmen have a horror of gadgets, and operators may fear that the added cost and a possible decrease in aerodynamic efficiency will be prohibitive. In the meantime it is the concensus that it is a very sound plan to warn the pilot that he is flying in a danger zone, namely where temperatures are between -4 degrees and 0 degrees, centigrade, and when he had better proceed to a zone of higher or lower temperature. A special instrument designed to warn the pilot of this danger zone is described by H. B. Hendrickson in *Instruments*. It is shown in the photograph. Essentially it is a temperature-actuated switch which controls a red light on the instrument board of the airplane.

Rough sapphires, synthetic and natural, are sorted by cathode rays

The thermal switch A is placed on the strut or other exposed part of the airplane, while the indicator box B is installed in a convenient place in the cockpit. The light behind the window in the indicator appears only at the above mentioned temperature range, -4 degrees to 0 degrees. For ease in installation on the ship, the instrument is made up in a unit with its own battery, using pocket flashlight cells of standard size, located in the box B.

The unit A in the illustration at the right is the thermal switch of the ice-warning thermometer. The box B is the indicator, and contains the battery



A bi-metal coil moves the switch, as the temperature decreases or increases and expands or contracts the coil. The contact points are made of coin silver. The lower contact is made crescent-shaped so that the switch arm can easily ride over it without jamming. When the temperature is in the danger zone, the switch assumes such a position that the circuit is closed and the battery lights the lamp.

Although the bimetal coil and contact points are enclosed to provide protection against the weather, tests show that the lag is not appreciable. Severe vibration does not interfere with the instrument.—*A. K.*

Mechanical Exercisers

DURING the past year there has been a great vogue for vibration and shaking of various portions of the body by the use of machines especially built for the purpose. These machines have been sold with claims that they would reduce weight, increase health, and in many ways take the place of exercise. Actually the machines are simply devices for producing passive motion in some part of the body. Moreover, cases have occurred in which the machines have been used by people with ulcers of the stomach and intestines or with swollen gall bladders, and the results of the agitation have been to burst the ulcer or to increase the inflammation and thereby to cause serious illness if not death of the patient.

The Council on Physical Therapy of the American Medical Association has recently issued a report governing the use of these devices. The Council argues that the point of view which their use develops in the patient is wrong. The advertisements and the instructions for their use often convey the impression that the machine will do the work necessary to cure the patient and that the patient does not have to work. Volitional effort is not encouraged, and the machine often is regarded as the only factor in the cure. The more expensive the apparatus or installation, the more this thought will be developed. These machines do not develop volitional effort of any kind—the work being done for and not by the patient. This develops a poor mental attitude in a patient and will react to his detriment.

These machines do nothing that can not be accomplished equally well by simpler apparatus or none at all. For example, many of these machines are sold to reduce excessive abdominal adipose tissue. In these cases the same results could be accomplished by leg and abdominal exercises without apparatus, with the patient giving himself heavy kneading massage at the same time that he is taking his exercises. In most cases, for general weight reduction, much better results could be attained by a walk or a slow run in the fresh air.

These machines treat only one part of the body at a time and do not have the advantages of general exercise in developing other parts of the body. Vibratory massage of the abdomen with a strap attached to a motor for 10 minutes can not give as much benefit as does a 10-minute fast walk with conscious effort given to pulling in the stomach. The benefit of deep breathing, exercise of many muscles, and increase of circulation is actually obtained under the latter conditions.

The use of apparatus is stereotyped and monotonous. The physician prescribing one of these machines is making the same mistake that he would by prescribing only one form of massage or exercise. The patient will soon tire of its use. This form of massage vibration and shaking has little place in treatment, and better results could be secured by definite exercises varied enough to prevent monotony or by occupational therapy to prevent loss of interest.

The physiologic effect of mechanical exercisers is the same as of that form of massage which gives vibration and shaking. The effect of this form of massage has not the same effect as active exercises and can not have the same benefits.

The mechanical exercisers are often actually dangerous. The Council on Physical Therapy has records of severe injuries caused by these machines—ruptured appendix, hernias, ruptured bladder, ruptured duodenal ulcer, pleurisy with effusion, and torn penis.

The Council on Physical Therapy of the American Medical Association therefore condemns the sale of these mechanical exercisers to the public for the following reasons:

1. Volitional effort is not encouraged.
2. The same results could be accomplished without an apparatus.
3. Treating only one part does not give any of the advantages of general exercise.
4. The use of such apparatus is monotonous and the patient loses interest in treatment.
5. The effect is that of massage and lacks the physiologic benefits of exercise.
6. Such apparatus is definitely dangerous.—*M. F.*

Could Pave Broadway With Silver—But Won't

THE world production of silver for the entire period from 1493 to 1927, inclusive, has been over 14,000,000,000 ounces, or about 14 times the weight of gold produced in the same period, according to the United States Bureau of Mines, which has conducted an economic survey of the subject. This amount of silver would make a cube measuring 114½ feet on an edge; or it would pave Broadway, New York, six inches deep, from the Battery to Central Park, a distance of over four miles. Since 1888, more silver has been produced in the world than in the period 1493 to 1887; in other words the production of 396 years has been exceeded by the production of the last 39 years.

In spite of the greater relative increase in the production of gold than that of silver, the price of silver has declined. This decline in the price of silver has been a result of a lessening demand rather than an ab-

(*Please turn to page* 226)

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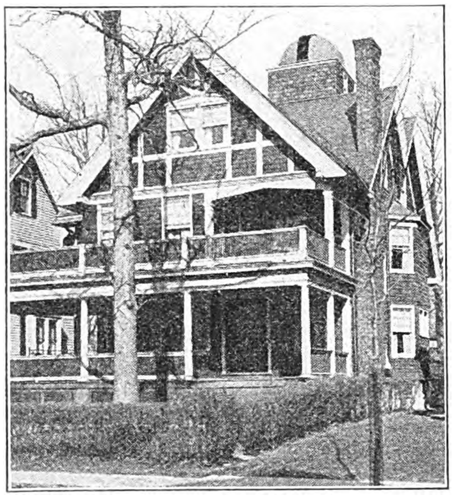
The Amateur Astronomer

Conducted by ALBERT G. INGALLS

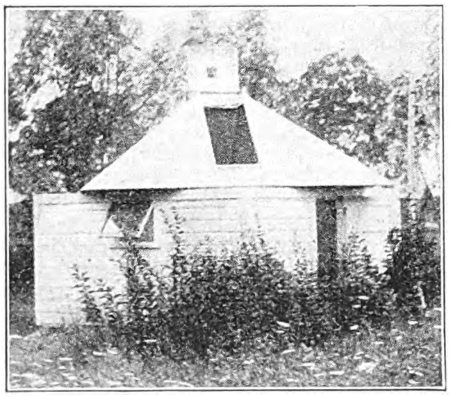
NOW that cooler days to work in are in sight, it may be about the psychological time to think of building a private observatory to house the telescope for more comfortable use in the cold months. It seems odd that more amateur telescope makers have not thus equipped themselves.



Pickering's housetop observatory

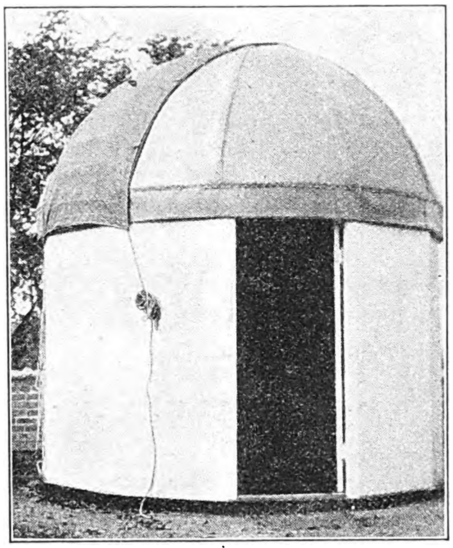
One of the best observatories is the simple straight-sided box type, equipped either with a slide-off roof or a traveling gantry roof as shown on the opposite page. However, there is this to be said: None of these straight-line "chicken-coop" types of structure look much like an astronomical observatory. The amateur may perhaps be pardoned if he prefers his neighbors and townspeople to know that the structure he creates houses a telescope.

To build the hemispherical type of dome requires no particular skill, though admittedly it involves considerable fussing and fitting. Designs vary widely. Usually the dome proper consists of a horizontal wooden ring and a number of upright curved ribs, covered with some kind of roofing and provided with a slot opening for the telescope. The whole dome is mounted on rollers and turns on the plate of the fixed building.



Yalden's design, turned cornerwise

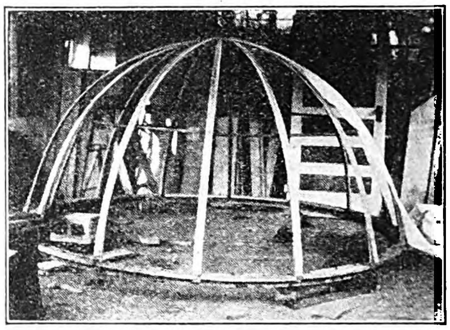
This building may be round or square, but many of those who have "been there," and who speak from actual experience, will swear by the square type of building, because its four corners give room for a small built-in desk, for built-in seats, cabinets, bookshelves, and for a parking place for visitors, who sometimes get under foot in the more constricted, round type of observatory.



One of Schroeder's designs

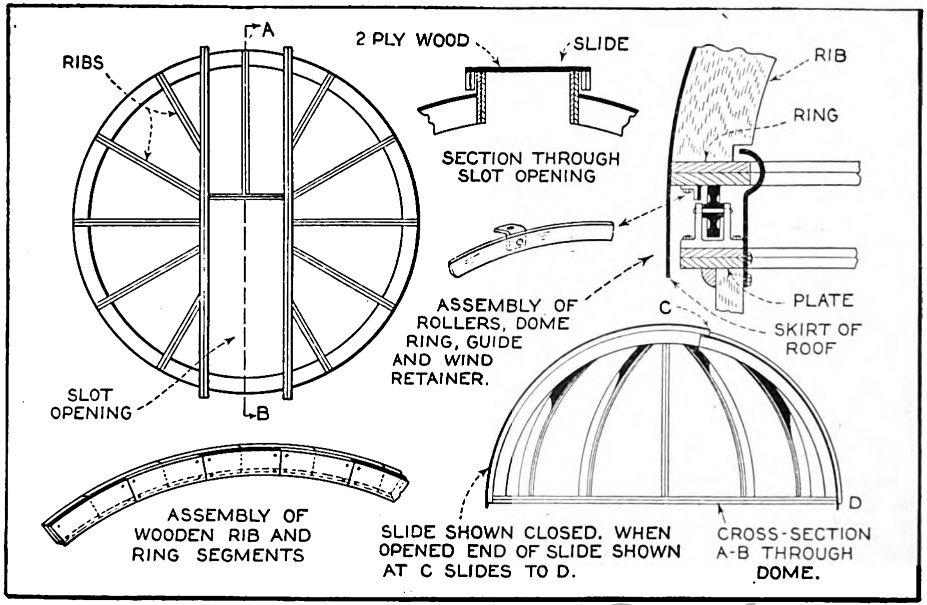
THE roof-top observatory of D. B. Pickering, of East Orange, New Jersey, the well-known variable star observer, is a good illustration of the square type. There is no mystery about the building proper, exclusive of the dome; it is simply a square structure built on top of the house. Note that the entrance is not through a trap door in the floor but from the roof through a door. This leaves the floor clear. Pickering did not run a masonry pier to the ground, as many think imperative, but rested the telescope pedestal on cross timbers attached to the roof. Will the vibrations of the house not destroy the good seeing? Pickering's success in variable star observing says at least, "not necessarily." The same bogey was faced when a large telescope was placed on the roof of a 13 story building at Columbia University, but the predicted ruination of seeing due to vibration did not materialize (*Popular Astronomy*, June–July, 1928; also same, Oct., 1926). Pickering saw to it, however, that the immediate flooring of his observatory did not touch the support of his telescope; he also insulated the floor against heat from the house below.

Another square type of observatory is that of George Waldo of Fairfield, Connecticut, designed by J. Ernest G. Yalden of 120 Woodbridge Place, Leonia, New Jersey, a variable star observer. This has a pyramidal "dome" which rotates on a circular track. The side shutter lifts off, while the small level truncation at the top has a lid that tips back. By the way, the shutter should be at least 24 inches wide; a narrower one is a nuisance. It may, if one prefers, be made in two halves, like a sloping cellar door, opening outward.

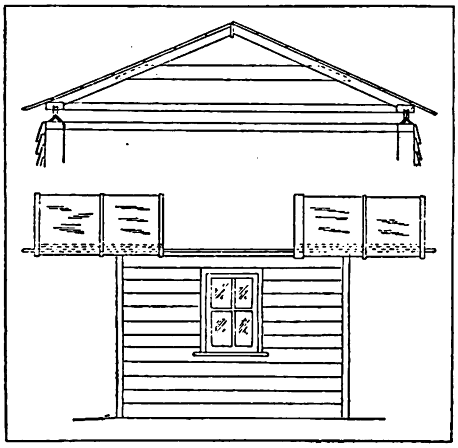


Light weight dome (by B. W. St. Clair)

ALBERT F. SCHROEDER, 1075 Forest Cliff Drive, Lakewood, Cleveland, Ohio, kindly let us see some drawings from which several observatories, including one


A
RIBS
2 PLY WOOD
SLIDE
RIB
RING
SECTION THROUGH SLOT OPENING
ASSEMBLY OF ROLLERS, DOME RING, GUIDE AND WIND RETAINER.
PLATE
C
SKIRT OF ROOF
SLOT OPENING
B
D
ASSEMBLY OF WOODEN RIB AND RING SEGMENTS
SLIDE SHOWN CLOSED. WHEN OPENED END OF SLIDE SHOWN AT C SLIDES TO D.
CROSS-SECTION A-B THROUGH DOME.

Assembly of a typical observatory dome, after Schroeder in China, have been made. The original drawings can not be reproduced but the accompanying sketches based on them may serve to give ideas concerning a good structure. The main elements are: A solid circular track, for which wood, if leveled well, will do; about eight good rollers (Charles D. Higgs of Fontana, Wisconsin, used roller skate wheels—see *Popular Astronomy*, Aug-Sept. 1928); some kind of device or guide to keep these rollers on the track (here Mr. Higgs used eight more skate rollers bearing sidewise, while the sketch shows Schroeder's method); something to keep the dome from being lifted off by the winds, (Mr. Schroeder uses simple iron hoop stock bent to embrace but not touch the dome ring, as shown on sketch). The maker may juggle and recombine or revise these or other elements to suit his own taste. Past experience with amateur ingenuity in telescope construction gives promise of a wide variety of new ideas; some of which will be good and a few better yet. The average amateur dislikes being pinned down to a standard, inflexible design to copy. He prefers to do most of his own designing.



Courtesy *English Mechanics*

W. R. Evans' design—gantry type

A good dome ring can be made of ⅞-inch pine stock cut to proper radius, lapped alternately, glued and screwed together. The vertical pieces are made in the same way. This makes a heavy dome, but one that will "stay put" in all weather. Any kind of roofing will do, from unsupported canvas, giving the "starved dog" effect, to sheet metal—suit your own skill, taste, patience and pocketbook.

SOME good hints and a few plans will be found in Bell's "The Telescope," Chapter 10, and others in various back numbers of *Popular Astronomy* (see A.T.M., page 260). In the average case, however, an ingenious amateur will prefer to "roll his own," thus giving him the right to take credit for the whole job. We have no "blueprints, instruction pamphlets, or set specifications" of any kind. Those who expect to hire a carpenter to do the job may need these, it is true, but if anyone plans to have it done in that manner the best thing is to go to a professional designer of observatories. The above, which is not too precise a description, was written for the fellow who enjoys doing his own jobs.

Amateur telescope making fans may be interested in knowing that the hobby is still going strong—stronger, in fact, than at any time since 1926. This is the first year in which interest has not dwindled to a tricklet during the hot months.

—Analyzed
—Dissected
—Interpreted
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HOTELS STATLER

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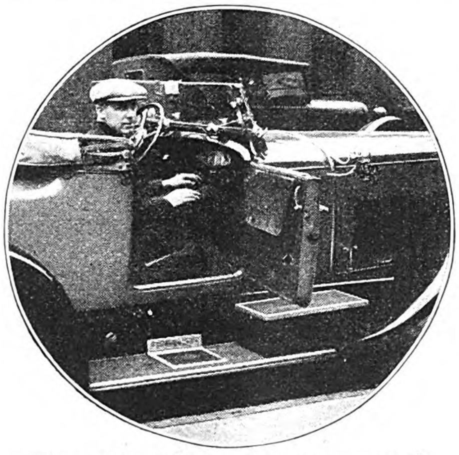
BUFFALO ST. LOUIS
CLEVELAND NEW YORK
[Hotel Pennsylvania]

The Scientific American Digest

(*Continued from page* 223)

normally increasing supply. The lessening demand has been due very largely to demonetizing of silver during the latter part of the 19th Century by the principal nations of the world. Demonetization became possible through the enormous increase in gold production that followed invention of the cyanide process in 1887 and development of the gold fields of South Africa, yet a number of countries still retain the silver-gold standard. Most orientals use silver as a medium of exchange almost to the exclusion of gold. Silver may thus be regarded as a second line of defense for the maintenance of the metallic foundation of monetary systems, but the future of its production will be influenced largely by the production of gold.—*A. E. B.*



The auto-radio receiver is mounted in a box on the running board

Gas Is Big Factor in Aviation Safety

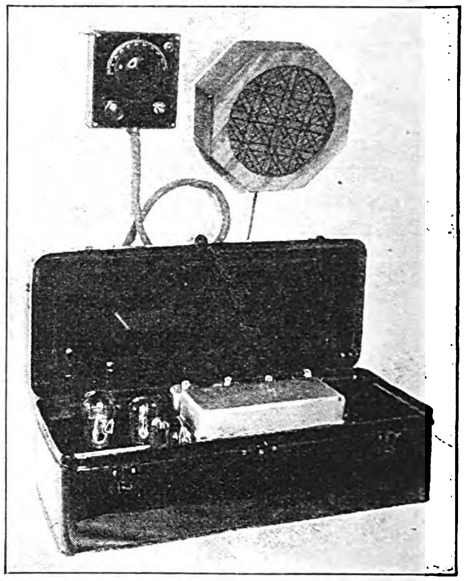
In aviation a man's life literally "hangs by a thread," but the strength and importance of this "thread" depends on gas, according to *Industrial Gas*.

The manufacture of tie rods and tie wire for heavier-than-air machines relies largely on the steady, intense heat of huge gas-fired ovens. These parts, the "threads," are subjected to a temperature of about 300 degrees for six hours for the purpose of driving off any hydrogen that may have been absorbed by the steel wire. This process makes the wire strong and slender in order to assure the least possible air resistance.

Auto-Radio Kit

Practically all of the automobile radio receivers that have appeared so far are intended for concealment behind the instrument board or under the engine hood. A new set in kit form, recently placed on the market by the Pilot Radio & Tube Corporation, is rather unusual in that it is designed for mounting on the running board, or possibly in the rumble seat of roadsters or coupés. The new outfit, bearing the name "Auto Pilot," is supplied in kit form and must be assembled, wired, and installed by the individual purchaser, who will find the work easy, interesting and enjoyable.

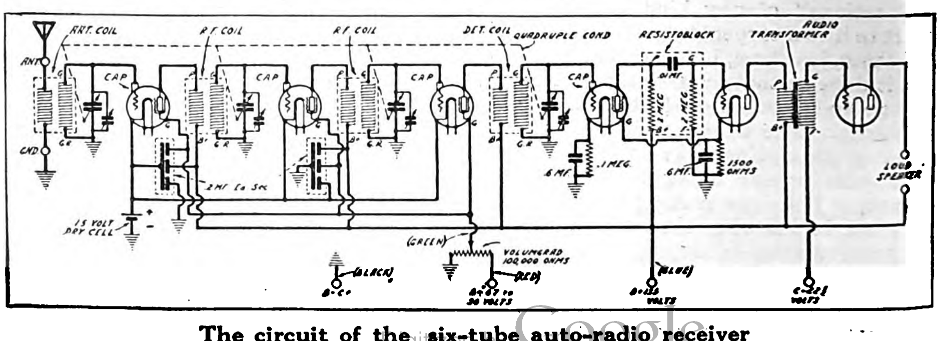
The receiving unit itself is contained in a black japanned steel case. This is 22 inches long, 8 inches wide, and 6⅞ inches high, flat enough to let the doors of all makes of cars clear it by a comfortable margin. The set is controlled from the inside of the car by means of a flexible cable which terminates at a control box 5½ inches square and 2 inches deep. The cable is six feet long and is enclosed in a protective sheath of waterproof fabric.



The assembled auto-radio in its box; the control panel that is placed in the car; and a small loudspeaker

The movement of the tuning dial on the control panel is transmitted to the shaft of the variable condenser by means of two brass chains fastened to pulleys at both ends. These chains slide in separate flexible tubes, and run smoothly in spite of their length. The other devices on the control panel are the usual pilot light, volume control, and filament switch. The volume control is a potentiometer that regulates the voltages to the screens of the R. F. tubes.

Electrically, the receiver is of simple but reliable design. It makes use of three stages of tuned R. F., a screen-grid detector, one resistance-capacity audio stage and one transformer stage. All the parts are mounted on a formed and drilled



The circuit of the six-tube auto-radio receiver

aluminum chassis or foundation unit. Six tubes are employed: four 224's, one 227, and one 245. Plate voltage is supplied by three 45-volt "B" batteries.

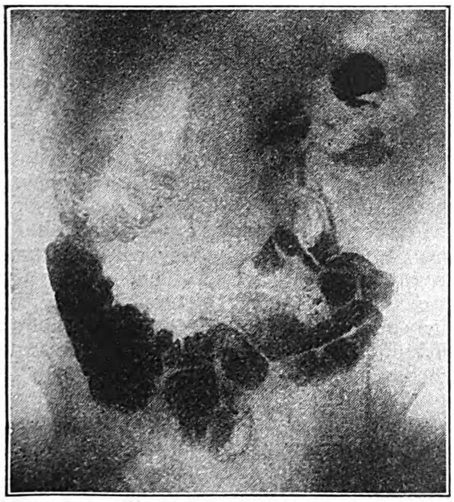
The radio-frequency gain in this receiver is pushed quite high and little attention is given to selectivity because this matter is taken care of automatically by the necessarily small antenna that is used. For an aerial, a pair of wires strung between the front and rear axles, under the car, has been found very effective. Where the shielding effect of the chassis is too great, a piece of copper screening may be tacked to the inside of the top of the car, or a wire run around the edges of the running boards.

Air Swallowers

ONE of the most common American complaints is the swallowing of air, sometimes called "aerophagy." At least 60 percent of people with disturbances of the gastro-intestinal tract swallow air and belch. In fact, the habit is not associated merely with modern man, since it is referred to in the writings of the ancient Greeks and Romans, including Martial and Petronius. Among the causes particularly for the swallowing of air and its return are rapid eating, gulping of food, and involuntary swallowing of air during breathing. With almost every swallow of food or saliva air enters the esophagus and is either eructated at once or goes into the stomach.

Dr. Asher Winkelstein has given special attention to this trouble, and mentions the fact that there is one group who voluntarily swallow air in large quantities and expel it at all times and in all places. These people are usually neurotic and perhaps indulge in this performance as a means of expressing themselves.

Another group has various forms of gall-bladder, intestinal, heart, or liver disease, with a constant sense of pressure in the abdomen. Having learned that belching will relieve their sense of pressure in the abdomen they swallow air, belch, and thus temporarily obtain a sense of relief. When air is swallowed, it is trapped in the stomach by a contraction of the end of the esophagus and by a spasm of the pylorus through which the stomach empties into the intestines. It requires some time or activity to cause the air to leave.

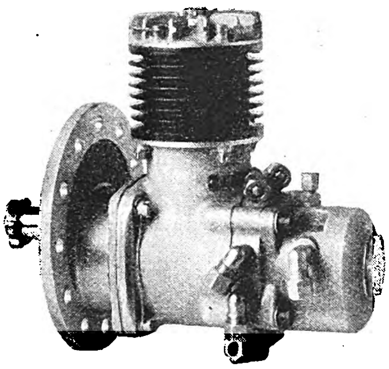


X ray shows the distended stomach and intestines of an air-swallower

In the control of the condition, Doctor Winkelstein recommends the training of habits so that air will not be swallowed, the use of mild sedative substances, and occasionally instrumental dilation of the end of the esophagus which has not only the instrumental effect but the possibility of powerful psychologic effect. It is, of course, necessary for the physician who examines such a patient to determine definitely that this symptom exists and not anything more serious as, for example, heart disease, intestinal obstruction, or fermentation.—*M. F.*

The Heywood Injection Starter

SWINGING the airplane propeller in order to start the engine will soon be entirely a thing of the past. The dangers and discomfort of swinging have been replaced by starters of various types—electric, inertia, hand, and pressure-injection types. The Heywood starter, of the latter type, built by the Sky Specialties Corporation, has been fitted successfully to many engines and in many planes.



Compressor of an injection starter

The Heywood starter consists of a small air compressor, a steel tank, a pressure regulation valve, a starting valve, inlet valves for each of the cylinders, tubing, pressure gage, and primer. The weight of the starter is about 30 pounds.

The small air compressor, shown at the top part of the accompanying photograph, is driven off the rear of the engine shaft, requires only one quarter of a horsepower, and can refill the starting tank in one minute.

The tank (not shown in the illustration) has a capacity of about one half of a cubic foot, and holds air at 400 pounds per square inch pressure.

When starting the engine, the pilot primes in the usual way, but the gasoline does not go directly to the cylinders or the manifolds of the engine, but into a small gas chamber on the starter where it is held until the starter trigger is pulled.

After the ignition is switched on, the starter trigger is pulled. The trigger allows the air to be released from the tank and to go to a chamber in the starter where it is routed by means of a rotating disk that is timed on its shaft with the engine. This rotating disk has one large and one small hole, and rotates close to a stationary disk that has as many holes as there are cylinders in the engine. The large hole in the rotating disk registers with the appropriate hole in the stationary disk and allows the compressed air to go through to the cylinder which is in position for a power stroke. This starts the engine in rotation.

Simultaneously, part of the air in front of the rotating disk goes to the gas chamber, and forces the gasoline through a small

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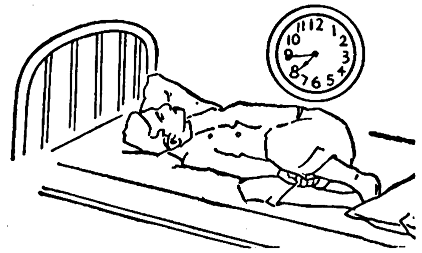
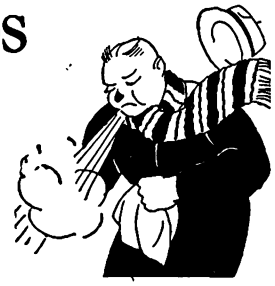
●

ACROBATICS while you SLEEP



Are you *sure* that you "slept like a log" last night? Or, would a moving picture machine reveal you rolled up like a ball, twisted like a rope or hanging over the side of the bed like a line of clothes? Drs. Johnson, Swan and Weigart took movies of 150 sleepers. The results were astonishing. They showed that a soundly sleeping, healthy man may struggle through forty or fifty different positions nightly, not one of which will be held more than an hour. A description of this extraordinary, scientific experiment, with pictures of 33 "sleeping beauty" postures appears in the September HYGEIA, the Health Magazine of the American Medical Association. It is a real contribution to an all important subject.

COLDS *and The Other Fellow*



You have heard that colds are contagious, and you would like to know just how they are spread so that you can allay unnecessary fears and sensibly avoid the cold-infection. The September HYGEIA contains a timely discussion, by Dr. Rachael Ash, especially directed to parents and teachers, explaining the way colds spread and how to keep yourselves and your children from catching the debilitating cold germ—a most helpful article with the cold season just around the corner.

Other Vital Features in HYGEIA

"How Much Should the Patient Know"—"The Tardy but Tempting Tomato"—"The Movies in Medicine"—"The Undernourished School Child"—"Questions and Answers"—these are only a few of the features of the September HYGEIA. Every article is written by an authority who proves theory with practice. The language of HYGEIA is non-technical, simple and even entertaining. Every issue is a gold mine of reliable health information. As you value your health you will value HYGEIA.

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carbureter nozzle that projects into the center of the rotating disk and up to the small hole that also registers with a hole in the stationary disk, and allows gas to flow to the appropriate cylinder.

There is therefore simultaneous rotation of the engine and injection to the cylinders from a small gas supply of a richly carburetted mixture. The starter rotates the engine at 400 to 500 revolutions per minute.

It is claimed for the starter that it will function under almost any weather conditions, that it does away with the danger of back-firing, and that it is simple, dependable, and easy to operate.—*A. K.*

Explosions in the Laboratory

THE hazards of industry are seldom considered as concerning the research worker in the laboratory. Nevertheless, the chemist, the pathologist, the bacteriologist, and indeed even the physicist are constantly working with chemicals, germs, poisons, and electrical materials which can put them in jeopardy. Dr. John A. Marshall has reported an unusual incident in the laboratory in the University of California devoted to the staining of tissues.

In the incident reported, sections of bone and teeth were being stained by the silver nitrate method. The dishes containing a solution of ammoniacal silver oxide were left standing in the sun from Saturday noon until Tuesday morning. There were traces of alcohol in the silver solutions, carried there by the pieces of tissue which had been previously immersed in alcohol. The sunlight hastened the chemical change between the silver, the chemical, and the alcohol. As a result a highly explosive, sensitive, and unstable compound called silver fulminate developed. When the dish was taken up to be emptied and cleaned, it was warm from the sun and the mere movement of the liquid caused the fluid to explode.

As a result the warning is issued that one should never work in the direct sunlight with silver solutions or leave bottles or dishes containing them exposed. Every precaution must be exercised to keep out ethyl alcohol, and containers for silver solutions should be immersed promptly and carefully in cold water.—*M. F.*

Inventor of Ethyl Gasoline Scores Again With New Refrigerant

THE "big news" of the recent meeting of the American Chemical Society in Atlanta was the announcement of a new refrigerant, non-inflammable and non-toxic, by Thomas Midgley, Jr. Anything that Midgley announces is apt to be big news, for he has a way of striking out on entirely original lines and developing something that boosts General Motors stock. Midgley is the chemist who discovered the anti-knock properties of tetra-ethyl lead, and he was the first president of the Ethyl Gasoline Corporation. Now he has turned his genius to the perfecting of a refrigerating medium that his company can use in household electric refrigerators without the remotest risk of danger from leaky coils. His discovery of the suitability of dichlorodifluoromethane gives promise of the early use of refrigeration for air cooling in homes and theaters and other public gathering places where refrigerating engineers have hesitated to risk accidents with poisonous or explosive refrigerants.

Dichlorodifluoromethane is made from carbon tetrachloride (a common fire extinguisher) and antimony trifluoride. Human beings and animals can inhale vapors of dichlorodifluoromethane without the least ill effects. It is not only non-inflammable, but it is actually a good fire extinguisher. Of course, it is stable and possesses the necessary vapor-pressure characteristics for a good refrigerant. It boils at -30 degrees, centigrade, and freezes at -155 degrees, centigrade. It is non-corrosive with steel, aluminum, copper, tin, and monel metal.

Thus, while proponents of diverse standard refrigerants were arguing the question of which was the safest and best, Mr. Midgley settled the question in characteristic style by creating a new one which left no grounds for argument.—*A. E. B.*

The Future of the Aviation Industry

THE Curtis Publishing Company has recently issued a magnificent book summarizing a long and thorough survey of the aviation industry. The study is most comprehensive, covering planes, schools, markets, speed, comfort, air transport, financial, and many other aspects of the industry. The material presented is accurate but not new. What is valuable is the conclusions of careful and independent observers as to the "underlying trends." These conclusions appear in the very first chapter and are of interest to any one who is at all concerned with the future of American aviation. We quote from this chapter in part:

"We have confidence that the aviation industry will develop into a large and sound industry. This confidence is based on two facts. First, the idea of air travel is sound. Air travel is certainly the quickest, we believe it can be made the most comfortable, and ultimately we think probably the least expensive method of long distance travel."

"Enthusiastic service appears to be more true of aviation than any other form of transportation and also more true of aviation than of any other industry we have studied. . . ."

"It seems to us likely that ultimately all first-class mail will be carried by airplane wherever an airplane can speed delivery; that a majority of 'Pullman class' day travel for distances in excess of 100 miles will be by air; that air package transport may exceed first-class mail and passengers combined."

The report is equally enthusiastic about the possibility of privately owned planes having a large market. The findings are qualified, however: "If through the autogiro or some other principle, it comes about within the next five years, that planes when they lose speed will settle to the ground without damage, if they can be taken safely into and out of a four-acre lot, and if a person with average mechanical training can in a short time at small expense learn to fly a plane safely, and if, furthermore, planes are sold at prices comparable with automobile prices, within fifteen years, there should be 1,000,000 privately owned planes in operation with an annual market of 250,000." This view defines at least the problem before our constructors and they will certainly do their utmost to meet the challenge successfully.—*A. K.*

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

WILL THE WOOD INDUSTRIES OF AMERICA FOLLOW BEATEN PATHS OR BLAZE NEW TRAILS deals with potentialities of cellulose and lignin. The rise in the production of wood plastics has been phenomenal. *National Lumber Manufacturer's Association, Transportation Building, Washington, D.C.—Gratis.*

THE AMMONIA-CHLORINE TREATMENT OF WATER by J. F. T. Berliner is a digest and bibliography of the subject. *National Ammonia Company, Inc., Frankford P. O., Philadelphia, Pa.—Gratis.*

THE OBSTACLES AND PITFALLS OF INVENTORS, by Joseph Rossman, Ph. D., gives the views of a chemical engineer who is an Associate Patent Examiner, U. S. Patent Office. *Address Joseph Rossman, U. S. Patent Office, Washington, D. C.—Gratis.*

WORKING PROPERTIES OF TANTALUM (Technical Publication No. 278, Class E, Institute of Metals, No. 105. The American Institute of Mining and Metallurgical Engineers) by M. M. Austin. *American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City.—25 cents.*

SCIENCE IN THE KITCHEN (Radio Publication No. 58, University of Pittsburgh) consists of a series of popular radio talks broadcast by research specialists of the Mellon Institute for Industrial Research, Pittsburgh, Pa. *Radio Manager, University of Pittsburgh, Pittsburgh, Pa.—60 cents.*

TWENTIETH CENTURY WHALING (Bulletin New York Zoological Society, Jan.-Feb., 1930. Vol. XXXIII. No. 1,) by Dr. C. H. Townsend, is a splendid discussion of an ever popular subject written by the Director of the New York Aquarium. *New York Zoological Society, Zoological Park, Borough of the Bronx, New York City.—35 cents.*

FLORA OF THE INDIANA DUNES by Donald Culross Peattie is a handbook of the flowering plants and ferns of the Lake Michigan coast of Indians and of the Calumet district. This 432 page book will be a boon to all who visit this locality. *Field Museum of Natural History, Chicago, Ill.—$2.20, mailed.*

AIRPORTS IN LATIN AMERICA (Trade Information Bulletin, No. 696, U. S. Department of Commerce) is a bulletin describing the airports, landing fields, and weather conditions in 26 countries of Latin America. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

AUTOMOTIVE EQUIPMENT AND CONSTRUCTION PREFERENCES IN FOREIGN COUNTRIES (Trade Information Bulletin, No. 695, U. S. Department of Commerce) is a bulletin noting many changes in foreign preferences as regards automobile construction, equipment, and color. *Superintendent of Documents, Washington D. C.—10 cents (coin).*

CORN IN KANSAS (Vol. XLVIII. No. 191, Report of the Kansas State Board of Agriculture for the Quarter Ending September, 1929) is the subject of this fully illustrated 283 page book. While it is intended primarily for distribution among Kansans, outside requests are honored where the book is really desired. *Address J. C. Mohler, Secretary, Kansas State Board of Agriculture, Topeka, Kansas.*

CORROSION OF ALLOYS SUBJECTED TO THE ACTION OF LOCOMOTIVE SMOKE (Technical Publication 293 Class E, Institute of Metals, No. 104) by F. L. Wolf. *American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City.—25 cents.*

REPTILES OF MARSHALL FIELD NORTH ARABIAN DESERT EXPEDITIONS, 1927-1928 (Publication 273 Zoological Series, Vol. XVII. No. 6) by Karl P. Schmidt. *Field Museum of Natural History.—25 cents.*

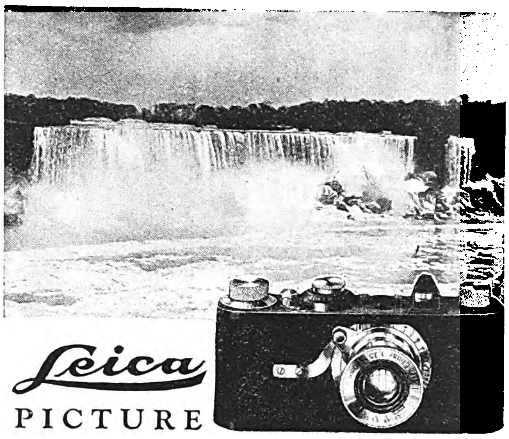
THE SOVIET AND RELIGION (No. 261 of International Conciliation) contains the debate in the House of Lords, decree of All-Russian Control Committee, and the Protest of His Holiness Pope Pius XI. *Carnegie Endowment for Industrial Peace, 44 Portland St., Worcester, Mass.—5 cents.*

LUBRICATION OF HYDRAULIC POWER GENERATING EQUIPMENT (Vol. 16, No. 5 of Lubrication May, 1930) describes the problems of oiling these ponderous machines. *The Texas Company, 135 East 42nd St., New York City.—Gratis.*

PROPERTIES OF HAYNES STELLITE is the first of a series of booklets embracing Haynes Stellite products, their uses and methods of application. *Haynes Stellite Company, Kokomo, Indiana.—Gratis.*

THE 92 ELEMENTS is a folder giving their numbers, names, symbols, atomic weights, melting points, and years of discovery. *P. C. Kullman & Co., 110-116 Nassau St., New York City.—Gratis.*

ACUTE RESPONSE OF GUINEA PIGS TO VAPORS OF SOME NEW ORGANIC COMPOUNDS. I. ETHYLENE DICHLORIDE (Reprint No. 1349 Public Health Reports, Public Health Service, U. S. Treasury Department) by R. R. Sayers, W. P. Yant, C. P. Waite and F. A. Patty. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*



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Brown Indicating and Recording Remote Type Instruments (Catalogue No. 7501) deals with instruments for measuring pressures, liquid levels, and flows, and for indicating positions. *The Brown Instrument Company, Philadelphia, Pa.—Gratis.*

Serpents of the Eastern States (Bulletin No. 3, Vol. XXXII) by Dr. Raymond L. Ditmars, is a comprehensive study of the harmless and dangerous snakes in the region covered, which includeds New England, parts of New York, Pennsylvania, and New Jersey. *New York Zoological Park, New York City.—35 cents, not gratis as previously stated.*

Diamond Core Drill Fittings (Commercial Standard CS17-30, Bureau of Standards, U. S. Department of Commerce). *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

An Annotated List of the More Important North American Forest Insects (Miscellaneous Publication No. 74) by F. C. Craighead and William Middleton, gives a list of insects and the damage they do. There is an excellent bibliography. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Direct Bone Formation in the Antler Tines of Two of the American Cervidae, Virginia Deer and Wapiti (Zoologica, Vol. XI, No. 3) by Charles V. Noback, Ph.D., and Walter Modell, B. S. *New York Zoological Society, Bronx Park, New York City, N. Y.—65 cents, mailed.*

Timber Growing and Logging Practice in the Northwest (Technical Bulletin No. 166, U. S. Department of Agriculture) by Samuel T. Dana, with an introduction by William E. Greeley, treats of the measures necessary to keep forest land productive and how to produce full timber crops. *Superintendent of Documents, Washington, D. C.—40 cents (money order).*

Vitreosil deals with vitreous silica and forms a valuable treatise on fused pure quartz and fused pure silica. *The Thermal Syndicate Limited, Schenectady and Atlantic Avenues, Brooklyn, N. Y.—Gratis.*

Studies in the Electro-Deposition of Metals (University of Illinois Bulletin No. 206, Engineering Experiment Station, Urbana, Ill.) by Donald B. Keyes and Sherlock Swann, Jr. *University of Illinois, Urbana, Illinois.—10 Cents.*

Propagation of Aquatic Game (Farmer's Bulletin, No. 1612, U. S. Department of Agriculture) by W. L. McAtee. Full information regarding a small but growing industry, fully illustrated. *Superintendent of Public Documents, Washington, D. C.—10 cents (coin).*

Manufacture and Properties of a Cellulose Product (Maizolith) from Cornstalks and Corn Cobs (Miscellaneous Publication No. 108) by C. E. Hartford, describes the utilization of agricultural wastes. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

The Relation of Carbon Residue to Lubricating Performance. Lubrication, January, 1930. *The Texas Company, 117 Battery Place, New York City.—Gratis.*

Foundry Patterns of Wood (Commercial Standard CS19-30, Bureau of Standards, U. S. Department of Commerce) contains a fine plate giving standard pattern colors. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Laboratory Tests of Reinforced Concrete Arch Piles (Bulletin No. 202, Engineering Experiment Station, University of Illinois) by Wilbur M. Wilson. *University of Illinois, Urbana, Ill.—55 cents.*

Weather and Health (Bulletin No. 75 of the National Research Council) by Professor Ellsworth Huntington is a scientific effort to determine the relation between weather and health. *National Research Council, Washington, D. C.—$2.00.*

Warning Agents for Methyl Chloride in Refrigeration Systems is a contribution to the household refrigeration industry from the *Roessler & Hasslacher Chemical Co., 10 East 40th St., New York, N. Y.—Gratis.*

Slope Corrections for Echo Soundings (Special Publication No. 165, Coast and Geodetic Survey, U. S. Department of Commerce) by A. L. Shalowitz, deals with the "fathometer" invented by Dr. Reginald A. Fessenden and the proper corrections to be made. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Durability Tests of Spar Varnish (Bureau of Standards Reprints, No. R.P. 146). *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

A Young Man Looks at the Eastman Kodak Company gives a quick glance at a great industry and the opportunity that it offers to ambitious men. *Published by the Training Department of the Eastman Kodak Company, Rochester, N. Y.—Gratis.*

Sickness Among Industrial Employees (Reprint No. 1347, Public Health Reports,) by Dean K. Brundage. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Triangulation in Colorado (1927 Datum) (Special publication No. 160, Coast and Geodetic Survey) by Oscar S. Adams. *Superintendent of Documents, Washington, D. C.—15 cents (coin or money order).*

Mining in the Fortymile District Alaska (Bulletin 813-C, Geological Survey, Department of the Interior) by J. B. Mertie, Jr. *Superintendent of Documents—Washington, D. C.—5 cents (coin).*

International Trade in Mica (Trade Promotion Series No. 95, U. S. Department of Commerce) gives valuable information about this type of mineral deposit. *Superintendent of Documents, Washington, D. C. 10 cents (coin or money order).*

Our Point of View

The International Bank

(*Continued from page* 175)

contention among world powers is a reasonable certainty to all acquainted with European history.

If this new bank cuts deeply into the profits of central banks of England, Germany, and France, its existence may be brief. Pretexts for its dissolution could quickly be produced. Its attitude during war, or even a period of strained relations between European powers, would be difficult if not impossible. Most of its optimistic founders calmly ignore the possibility of future European wars in forecasting its future, but war comes unbidden to most of his hosts.

We welcome the new bank and are proud that American bankers were its originators. Undoubtedly American membership on its staff will involve us still further in world affairs, but we are so thoroughly involved already that the new bank adds little to our commercial ties with Europe and nothing to our political responsibilities.

CIVIL AND MILITARY AUTHORITIES

THE time is near when our civil authorities will be obliged to pay more heed to their military and naval advisers than they have in the past, else the interests of the United States will suffer. The substance of the defense of the naval treaty by our delegation was that "it was the best we could get because both Japan and England had out-built us, and naturally we could not expect them to scrap ships already built or building." Yet in 1921, Mr. Hughes, ostentatiously refusing to consult with our naval officers, did scrap our battleships and battle cruisers. Americans should remember that, under the auspices of Mr. Hughes, we were willing to sacrifice naval superiority in 1921-22; and in 1930, Japan took advantage of her actual naval position to upset the naval ratio between the two countries. We will be under a handicap during the life of this treaty but we can overcome it easily in the period 1935-40 if we have really learned the obvious lesson.

OUR NEW MERCHANT MARINE

ONE of our few industries that is doing better in 1930 than in 1929 is shipbuilding, and for this we can thank the recent legislation by Congress, specifically designed to encourage the rebuilding of an American merchant marine. Four of our largest shipbuilding companies show an increase of 21 percent in the number of men employed. This increase is spread through all the skilled trades and crafts needed in the construction of a modern sea-going vessel. The support of Congress was extremely timely for under the severe competition of foreign companies that can build and operate vessels with cheaper labor, our shipyards were being abandoned and the many trained artisans necessary to that industry were being dispersed to other trades.

Efficient shipyards and skilled shipwrights are essential to our foreign trade in peace and to our fleet in war. Other nations give much care to their shipbuilding industry. Thus, at the London Conference, Japan insisted that she be allowed special permission to replace some of her submarine tonnage before it become obsolete in order to insure permanent employment to her trained shipbuilders. If with her present financial burdens, Japan can subsidize her shipyard workers, we can certainly afford to reassemble our workers before they are entirely absorbed into other trades.

FRENCH EVACUATION OF THE RHINELAND: INCREASE IN ITALY'S MILITARY FORCES

ALMOST simultaneously with the announcement of the evacuation of the Rhineland by the French forces in accordance with the provisions of the Dawes-Young plan for reparations, comes the news of further increases by Mussolini of Italy's land, sea, and air forces. At first glance these two occurrences may seem a mere coincidence, but it is well known in Europe that France does not wish to confront Italy with a large part of her army in Germany. With Italy scarcely concealing her conflicting ambitions, France naturally hastens to reduce her differences with Germany, re-group her armies, and strengthen her Italian frontier. Franco-Italian jealousy may prove a blessing to Germany.

To view further the already complicated European picture, in parts of Jugoslavia anti-Italian demonstrations have taken place. Americans can scarcely imagine the war-scourged Serbians considering another resort to arms so soon, but Mussolini regards the French-Jugoslavian menace sufficiently real to increase Italian taxes to add to his armed forces. As Mussolini has heretofore steadily reduced imposts on his heavily burdened people, the significance of this increase is apparent.

THE SEA FRONTIERS OF THREE NAVAL POWERS

THE London Conference called the world's attention to a wet triangle that can be somewhat loosely inclosed by lines drawn from the south point of Formosa to Guam, thence to Hong Kong, then returning to Formosa. This area of mixed land and water includes the sea frontiers of the three naval powers, Japan, Great Britain, and the United States. In a political sense, this wet triangle resembles the "buffer states" of a generation ago, the most famous being the Balkan States whose boundaries were fixed by various European conferences to reduce the risk of war between the three land empires, Russia, Austria and Turkey.

A glance at a world chart will reveal the importance of this area navally and commercially. It controlls the routes from the Far East to Europe and to Australasia, and the routes from the west coasts of the Americas to the Philippines, Southern Asia, and India. For this reason, Great Britain insisted upon the right to create an impregnable first-class naval base at Singapore, when at the Washington Conference Japan succeeded in restricting any further fortifications at Hong Kong or Manila. We did not appreciate the necessity of naval bases for our fleet and in consequence, our nearest naval base, Honolulu, is almost 5000 miles distant. It is hoped that our Delegation to the Naval Conference in 1935 will go with a mandate to redress the naval balance in this area.

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Similar Food Trademarks Allowed

IN a recent decision, First Assistant Commissioner Kinnan held that the Lush'us Products Company, of Chicago, Illinois, is entitled to register as a trademark for canned peas, a composite mark consisting of the representation of a chef holding a dish of peas in one hand and lifting the cover of the dish with the other, together with the words "Lush'us Peas," which words are disclaimed, notwithstanding the prior adoption and use by the California Canneries Company of the term "Lusk's Luscious" as a trademark for canned fruits and vegetables.

The ground of the decision is that the two marks have nothing in common but the descriptive word "luscious" and since no one is entitled to the exclusive use of the word, there is no likelihood of confusion by reason of the use of the two marks.

After stating that the word "luscious" was obviously descriptive of the goods and it is a matter of common knowledge that it has long been applied to both fruits and vegetables, the First Assistant Commissioner said:

"No one is entitled to exclusive appropriation of the word. The opposer is only entitled to exclude others from using this word in the particular and distinctive way it has used the word on its goods; that is, in connection with the word 'Lusk's.' The applicant is likewise entitled to use this word, misspelled as it is shown, in connection with the other distinctive features which constitute the entire mark. This descriptive word, which is open to everyone to use in connection with the goods of this character, being the only feature of similarity between the two marks, it is believed the opposer cannot prevail."

Concrete Mixer May Be Beautiful

THE Court of Customs and Patent Appeals has held that a specific design for a concrete mixer truck body and frame constitutes proper subject matter for a design patent, and has overruled the decision of the Patent Office refusing an applicant a design patent, according to *The United States Daily.*

The beauty and ornamentation requisite in design patents is not confined to such designs as may be found in the "esthetic or fine arts," the majority opinion states. Tools and mechanisms which are patentable because of their utilitarian qualities, it was further ruled, also may be properly the subject matter of design patents if they possess qualities which the law requires.

Articles of manufacture, the ornamentation of which, owing to their nature, are of no concern to anybody, are not proper subject matter for design patents, the majority opinion states, but held that the particular article did not come within this class.

While the concrete mixer has movable parts, there is nothing connected with the mechanism, or with the machine as a whole, which produces such a multiplicity of designs, the opinion states, as to require the refusal of a design patent.

In the dissenting opinion, it is contended that the design disclosed and claimed does not represent patentable subject matter. "It has escaped our observation," the two members of the court state in their dissenting opinion, "if the pulchritude of articles like concrete mixers has ever excited any great public consideration."

Bottle Cap Not Mark for Milk

RECENTLY First Assistant Commissioner Kinnan held that the Walker-Gordon Laboratory Company, of Plainsboro, New Jersey, is not entitled to register, under the Act of 1905, as a trademark for milk, a mark defined as consisting of a "substantially silver colored cap for milk bottles."

The ground of the decision is that the alleged trademark is a mere color of the container of the goods or a substantial part thereof.

In his decision, after noting the grounds above stated, on which the examiner refused registration, and applicant's argument that, by reason of its long use of such colored bottle caps, that color constituted a trademark, the First Assistant Commissioner said:

"It is well settled that mere color aside from some particular symbol or design, such, for example, as a circle, square, triangle, cross, or star, cannot constitute a valid trademark. (Decisions cited.) There is no contention here that it is new to employ a metal cap upon a milk bottle which is attached to the bottle by being bent down over the top much in the way the applicant uses the cap. This being true the applicant is merely seeking a trademark for the color of the cap of the bottle which contains the goods."

The First Assistant Commissioner further noted patent No. 531,796, disclosing and claiming a "tin-foil cap for milk bottles," and said:

"Since tin-foil is either what the applicant here employs or is substantially the same and has a substantially silver color, the registration sought by the applicant would, if granted, be in effect a perpetual patent upon a tin-foil milk bottle cap. The Hall patent expired 18 years ago. If registration were granted the applicant neither Hall nor the public could use the device of that patent without infringing the applicant company's trademark. It is obvious enough under these conditions registration must be refused."

Fly Sprays to be Correctly Labeled

FLY sprays for animals are not "100 percent effective," or "safe," or "non-poisonous," or "harmless," and neither do they "prevent infectious diseases," nor do they "increase milk production" above normal, and if they are claimed to be effective for longer than 8 hours they are open to question, says Dr. C. C. McDonnell, in charge of insecticide control, Food, Drug, and Insecticide Administration, the organization of the U. S. Department of Agriculture which enforces the Federal Food and Drugs Act, the Federal Insecticide Act, and other Federal regulatory laws.

"There is a marked difference in the action of sprays on various species of flies, and broad claims to the effect that a product is effective for all flies are unwarranted," says Doctor McDonnell. "In defining the action of fly sprays, a distinction should be made between preparations that actually kill flies and those that only repel them."

Not only must the label on fly sprays be free from false or misleading statements, but if the product contains any inert ingredients the label must state the name and percentage of each inert ingredient, or the name and percentage of each active ingredient and the total percentage of inert ingredients.

Name for Glass Must Not Mislead

USE of the word "Jena" either independently or in conjunction with the word "Glass" will be discontinued by a corporation in the sale of medicinal supplies and syringes designed for use by the medical profession.

According to a stipulation agreement between this corporation and the Federal Trade Commission, the company will not use the word "Jena" in any way as descriptive of its product so as to mislead the public into the belief that its product is Jena glass, which is understood by the scientific and professional world to be that glass manufactured by a competitor of the respondent company.

(Names of individuals or firms signing stipulation agreements are not mentioned in the commission's press releases or publications, but the facts in each proceeding are presented to show methods of competition condemned by the commission as unfair, for the guidance of industry and protection of the public.)

Refrigerator Trademarks Clash

IT has been held by Assistant Commissioner Moore that the McKee Refrigerator Company is not entitled to register, as a trademark for refrigerators, the term "Iced-Aire," both because it is confusingly similar to the term "Frigidaire" previously used by the Frigidaire Corporation, of Dayton, Ohio on the same goods and because it is descriptive of applicant's goods.

In his decision, after noting the holding of the examiner of interferences that the notation Frigidaire is descriptive and therefore not owned by the opposer, and the use of that notation would not therefore support a claim to damage, the Assistant Commissioner said:

"That it is not necessary, in order to sustain an opposition, that the opposer shall own the trademark, registered or not, before he can oppose the registration of the mark to another person, has been held in many decisions, both by this office and by the Court of Appeals of the District of Columbia. . . . A comparison of the two marks shows that they both have the same ending and the same suggestive meaning, namely, that the air as in a cold state. While the word Iced and the word Frigid do not look alike, yet it is believed that, since they convey the same meaning, their concurrent use on refrigerators would be likely to cause confusion or mistake in the mind of the public as to the origin or ownership of the refrigerators to which the marks are appropriated."

With reference to the character of the marks, after stating that the examiner of interferences did not exceed his authority in holding the word descriptive, he said:

"The mark Iced-Aire, when applied to refrigerators, would convey no other meaning than that the air is rendered cold by the application of ice, and, if the applicant's refrigerator does not operate on this principle, then the mark is deceptive and, in either case, should not be registered."

"Special" Price Must be Special

MISREPRESENTATION of the regular price of a course of instruction as a "Special" price, will be discontinued by an individual engaged in the sale and distribution of certain formulae and courses of instruction in resilvering and replating metal goods, the respondent having signed a stipulation agreement to this effect with the Federal Trade Commission.

Specifically, he agrees to cease and desist from the use of such a statement as "I will send all for only 5 dollars, the regular price being 10 dollars, but for a limited time only the price has been reduced to 5 dollars" when such is not the fact.

He agreed also to stop using the word "Special" to designate the price of his products when in fact such price is not special but is the regular and customary price asked in the usual course of business.

The respondent further agreed to desist from the statement "I am the sole owner of 14 patents, grants, and copyrights" so as to imply and mislead the public into believing that he actually owns the specified number of patents, grants, and copyrights, all of which relate to the art of plating or the process of mirror silvering, when in truth such is not the fact.

Legend Not Allowed As Trademark

IN a recent decision, First Assistant Commissioner Kinnan held that Chevy Chase Dairy, of Washington, D. C., is not entitled to register, under the Act of 1920, the notation "Safe Milk for Babies" as a trademark for milk, cream, buttermilk, cheese, and eggs.

The ground of the decision is that this legend or notation does not constitute a trademark as it does not indicate origin or ownership of the goods.

In his decision, after stating that applicant had already registered a composite trademark which included the legend in question, and now seeks to register the legend alone, he said:

"It is believed entirely obvious this legend does not function as a trademark but constitutes a mere laudatory statement as to the character of milk sold by the petitioner. When used upon milk the purchasing public would merely understand this legend to mean that the milk was safe as a food for infants. When used upon the other goods specified, the cheese, butter, eggs, et cetera, the legend would not be interpreted by purchasers to refer to the goods at all but to constitute a mere laudatory advertisement or statement that the petitioner also sold milk of this character."

Description of Function Not Registrable

IT has been held by First Assistant Commissioner Kinnan that the National Licorice Company of Brooklyn, New York is not entitled to register, under the act of 1905, the notation "Helps," as a trademark for licorice cough drops, since this notation is merely descriptive of the goods.

In his decision, after noting the argument that the mark was suggestive rather than descriptive, and pointing out why certain decisions cited in support of that contention were not conclusive of the question, and noting that registration had been refused of certain marks which were descriptive of a quality of the goods such as "Getwell" for a medicine, "Health Food" for a food product, "No-D-Ka" for a tooth paste, he said:

"In view of the foregoing, it seems clear enough the notation here sought to be registered is descriptive of the function or effect of the use of the goods and is, therefore, merely descriptive."

Duplication of Words Voids Trademark

THE mark "White Cap" with or without a representation of ocean waves having white surfaces, is deceptively similar to the mark consisting of the words "White Cap" above a representation of a rounded cap such as is frequently worn by chefs.

Because of this similarity and the further holding that baking powder and self-rising flour are goods of the same descriptive properties, the Court of Customs and Patent Appeals has held that "White Cap" is not registrable for use on "plain and self-

Patents Recently Issued

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Pertaining to Aeronautics

Amphibian Airplane—Having provision for alighting upon water, ice fields, level or otherwise, or desert sands, a stabilizing apparatus functioning in such manner as to retard the descent, in the event of an emergency. Patent 1765214. Frederico G. Diago.

Parachute and Aerial Life Buoy—Whereby a bouyant body is provided using gas, and a smaller spread to the parachute presenting a floating structure when landing on water, and whereby a comparatively slow descent is secured. Patent 1765075. Edward G. Johnson.

Pertaining to Apparel

Waterproof Overalls—Which may be open at the front while sitting, but having a shield and drain so that water caught by the opening will pass off at a point exteriorly of the garment. Patent 1765096. Meyer Reingold.

Rubber Heel—Having an outer face formed of a plurality of ribs, and grooves spacing the ribs from each other with passages extending lengthwise through the ribs, the body being provided with sockets for securing the heel. Patent 1765155. Harry Heady.

Garment—Which may be readily placed upon an infant, secured in place, and conform to the body to allow free movement without binding, and which obviates the need of the ordinary rubber pants, which bind the legs. Patent 1765105. Bertha B. Skinner.

Chemical Processes

Process for Purifying Pearl Essence—Which consists in bringing the pearl essence to a state of aqueous paste incorporating amyl acetate collodion containing from 8 to 14% nitrocellulose, liberating the water, and washing the product with clean ammoniacal water. Patent 1760771. Jean Paisseau.

Fertilizing Solution for Seed Treatment—By treating the seeds with chemical agents so that the chemical action may in due time promote the growth of the plants or increase the quality or the quantity of product therefrom. Patent 1762294. William F. Gericke.

Designs

Design for an Ensemble Suit—The inventor has been granted two patents, numbers 81394 and 81395. Dorothy Long.

Design for a Mirror Stand—Patent 81345. Frank N. Mariani.

Electrical Devices

Electromagnetic Ignition Device — Adapted to light gas-nozzles, burners, stoves, or fuel mixed flames in general, is very compact comprising but three elements, namely a fixed core, a vibratory blade, a substantially fixed blade, and the usual magnatizing coil. Patent 1763443. Ruggero Righetto.

Electric Tea Urn or Perculator—Comprising a water vessel, electrically heated, on top of which is a steam-tight vessel, having at its bottom a tea receptacle, and a pipe extending into the lower vessel, allowing steam to be passed through the tea. Patent 1762303. John A. McBride.

Generator Circuit Protector—Which will automatically shut the current from a generator to a resistance when the current is not being used for charging a battery, or when faulty connections exist between the generator and the battery. Patent 1762297. Elton R. Hopkins.

Shade Holder for Electric Lamps—A semicircular wire strand, for attaching a glass hood rising flour," in view of the prior registration of the similar mark for baking powder.

While there is no evidence that the two products have ever been manufactured by the same producer, the opinion states, still their relation to the art of cooking and their use in the production of bread and other food products is such that confusion is likely were similar marks for both registered.

"Suntan" Not a Trademark

THE notation "Suntan" for use on various articles of wearing apparel, including bathing suits, dresses, hosiery, caps, and so on, is not registrable as a trademark in the Patent Office, because descriptive of the goods, the Assistant Commissioner of Patents has ruled.

By extension of the meaning of the term the opinion states, "it now designates not only a color simulating that produced by the sun, but also the characteristic of wearing apparel which permits the direct action of the sun's rays upon portions of the body in order to produce a tanning effect."

Fictitious Names in Business

AN individual doing business under his own name and initials, followed by the word "company," is not required to comply with the provisions of the so-called fictitious name statute, since the name is not fictitious, the Supreme court of California has just ruled.

The statute, the opinion explains, provides that every person transacting business in this state under a fictitious name and every partnership transacting business in this state under a fictitious name or a designation not showing the names of the persons interested as partners in such business "must file with the clerk of the county a certificate stating the name and place of residence of the person or persons interested in the business."

Prior Disclaimer Nullifies Usage

THE disclaimer of any rights to the words "Liquid Solder" in an application for a trademark previously registered precludes a subsequent application to register these words as a trademark, where they have since the disclaimer been registered to another, even though their use by the applicant as a trademark was prior to their registration by the other party, the Court of Customs and Patent Appeals has ruled.

The court overruled a decision of the Patent Office which had ruled that a disclaimer in a trademark proceeding may not be urged, by subsequent users of the mark disclaimed, as an estoppel.

Foreign News Reels Allowed in Italy

THE Italian government ban on the reproduction of foreign dialogue in sound pictures has recently been lifted to the extent of permitting the exhibition of news reels containing foreign dialogue, according to a report received in the Department of Commerce from Trade Commissioner Geroge R. Canty, Paris.

The following is a translation of the communique: "While the existing regulations forbidding the public showing of foreign dialogue pictures are still in force, the ministry of the interior has deemed opportune to concede the permission to show films containing talking sequences and dialogue in foreign languages when such films are taken from real life and reproduce: 'Actualities, ceremonies, sporting tournaments, military exercises, characteristic scenes or events, and so forth.' "

of the sectional type commonly employed for enclosing a portion or all of an electric bulb, adapting the same for use as a colored decorative light. Patent 1765212. Jay J. Decker.

Of Interest to Farmers

CHICKEN ROOST—Which may be suspended from the roof or placed just above the floor, will be proof against lice or other insects, due to the fact that receptacles containing insect-exterminating liquid or powder, are suspended under the roosts. Patent 1760748. Henry Fintel.

AGRICULTURAL MACHINE—Of the disc gang harrow type, whereby the disc blades of each gang may be set to a desired working position so that the soil broken by the leading gang will be further broken by the trailing blades. Patent 1760569. James S. Stewart.

COTTON HARVESTER—In the form of a vehicle adapted to be drawn over the rows of cotton plants with means incorporated for removing the cotton and discharging it into a body mounted on the vehicle frame. Patent 1762045. Arthur V. Benson.

COTTON HARVESTER—Adapted to be moved between rows of cotton plants, and having mechanism for removing cotton directly from the bolls of the plants and placing them in a predetermined manner in a container, ready for bailing. Patent 1763607. Julian E. Watkins

COTTON HARVESTER—Whereby the bolls and open cotton may be stripped from the stalks and the cotton which is left, together with the loose cotton, driven off and carried up by strong currents of air from the machine. Patent 1767979. Bedford Hestand.

RAKE CONSTRUCTION—Which not only facilitates the collection of matter by the rake, but functions effectively to clear its teeth or tines of matter adhering to or impaled thereon providing economy in labor. Patent 1768101. Erwin L. Bell.

Of General Interest

CIGAR LIGHTER—Having a simple and efficient means for throwing sparks from a block of pyrophoric alloy, to ignite a wick, will not readily get out of order, and may be easily assembled, adjusted or repaired. Patent 1762079. Charles Rubsamen.

LOUD SPEAKER—A central cylindrical internally threaded casing, in which a single diaphragm mounted within the casing is adapted to propagate sound waves from a plurality of tone chambers. Patent 1762050. Charles G. Cook.

SPRINKLER HEAD—Which operates with a minimum quantity and pressure of water and in a manner to produce a maximum of slow and even distribution over a given area, particularly adapted for sprinkling lawns and gardens. Patent 1760903. Frederick Henkel.

ROTARY GATE VALVE—In which gates or shoes are mounted on a rotatable element so as to form a tight seal when the valve is closed, but when open a fluid may flow there through without obstruction or the formation of eddies. Patent 1760951. Richard G. Manifold.

COMB AND GLOVE THEREFOR—A form-fitting cover of soft flexible material to be drawn over the teeth of the comb for dressing the hair, the attachment may be readily washed, kept free from dandruff and in a sanitary condition. Patent 1760928. Samuel W. Whitney.

PHOTOMETER AND EXPOSURE CONTROL—The inventor has been granted two patents for the measurement of light to determine the proper length of exposure and manipulation of the camera shutter, in the art of photography. The one is an independent apparatus, the other is attached to the lens for automatically adjusting the diaphragm, and also includes means for finding the proper exposure time. Patents 1762047 and 1762048.

Truth in Sales Schemes

AN individual engaged in selling to retailers such services as sales promotion schemes, advertising data, and specialty merchandise, signed a stipulation with the Federal Trade Commission agreeing to discontinue a number of unfair trade practices.

To retailers he sold merchandise and plans of merchandising involving operation of a lottery. A retailer would buy from him a padlock, a large number of keys, and one of three pieces of merchandise; namely, a radio receiving set, a boy's auto, or a child's scooter, with which he received a supply of advertising hand bills, and window cards. The retailer would then give a key to each customer purchasing merchandise to a fixed minimum amount. When the keys were all distributed, the radio, auto, or scooter would be given as a prize to the customer holding the key that would unlock the padlock.

In selling his products he declared that he manufactured radios, when in truth the respondent did not represent a syndicate or association of advertisers and did not own, control or operate a mill wherein the merchandise he sold was manufactured.

He advertised that certain of his products were offered for sale at factory cost when in fact all of his products were sold at a profit.

He shipped to merchants the instrumentalities and means of conducting a game of chance or lottery, with appropriate literature offering the gift or prize, and encouraged and enabled retail merchants by means of advertising literature to represent that they were selling merchandise at factory cost, when in fact it was sold at a profit.

Motor Bus Accidents Decrease

ONE motor bus passenger in every 1,250,000 passengers carried on buses in Ohio was killed during the last year, it was stated by the chairman of the public utilities commission, Frank W. Geiger, in noting marked improvement in the manner of operating buses since the commission issued a safety order some months ago.

During the year, the chairman said, motor buses carried 32,375,531 passengers, and of these 26 lost their lives in accidents. In this time, he stated, 1032 cars traveled a total of 56,224,254 miles.

Color in Rope Trademarks

THE Assistant Commissioner of Patents has ruled that a trademark for wire rope, consisting of a silver strand which is incorporated in the rope during its manufacture, is registrable in the Patent Office, even though the opposer has a registered trademark for a similar rope consisting of the use of a red strand in the rope.

The Assistant Commissioner found that there would be no confusing similarity between the products as marked by the two different colored strands.

Flat Asbestos-Cement Roof and Wall Sheet—Constructed to be applied directly to a vertical supporting frame member of a building without sheeting or horizontal supports and without overlapping, is not too flexible or brittle, and will form good insulation against heat and cold. Patent 1763469. Louis Lane.

Dispensing Container—For holding sugar, salt, pepper or the like, is sealed against the entrance of moisture, dust or insects, by the mere act of being placed upon a support, the upper end being completely closed. Patent 1763449. Henry T. Trautvetter.

Folding Chair—Having a canopy readily foldable with the chair, the construction is such that it may be readily set up for use, and easily folded to occupy little space for storage. Patent 1763455. Emil de Bruijn.

Pipe Insulation—Which may be mechanically constructed in sections, at little cost, and applied to refrigerating pipes and the like, has novel means for sealing the various sections, making the connections both weather and air-tight. Patent 1762276. George J. Schreier.

Attachment for Collapsible Tubes—In the form of a discharge nozzle which may be bent with the fingers without closing the passage to provide a terminal at an angle to a tube, to be used as an eye dropper or the like. Patent 1765114. George S. Turner.

Box—Which may be cut from a single pasteboard blank and shaped to be readily folded into a rectangular box structure having a retaining locking extension and an ornamental upstanding projection on top for receiving decorations. Patent 1765084. Edwin A. Locke, Jr.

Pin Hinge—For an ornament, wherein the hinge is molded on the ornament body as the molten metal cools, the mold parts being readily separable for the removal of the ornament. Patent 1765131. Israel W. Cooper.

Acoustic Device—More particularly a sound generator for radio loud speakers, comprising a diaphragm made in the form of a frustrum of a hollow cone, the sound reproducing apparatus being connected to the smaller aperture of the cone. Patent 1765124. Max P. Bonnat.

Cover Holder—For retaining the lid of a cooking vessel, kettle or like receptacle, in position and for preventing unintentional displacement while canting the vessel for the purpose of drawing off liquid. Patent 1765135. Eben G. Doland.

Steam-Pressure Cooker—Which is made of aluminum, with handles formed on opposite sides, with arms and spaced ears extending upwardly, which resiliently clamp the edge of the lid to withstand the steam-pressure. Patent 1765072. Takichi Hashimoto.

Container Head—Constructed of composition material covered with a layer of sheet metal, or fiber, which will provide an effective substitute for a solid wood or all-metal head, and comprises a complete unit. Patent 1764389 Herbert L. and James N. Carpenter.

Balanced Three-Way Valve—A self-closing valve wherein the outlet ports are so formed as to present a maximum opening, while preventing any parts being interfered with, may be used for many purposes where short admission of fluid pressure is desired. Patent 1765090. George G. Morin.

Closure for Toothpaste Tubes—Formed with a rotating closure plate capable of being moved to an open position by the thumb, and moved to a closed position by spring pressure, the structure coacting with a resilient lock. Patent 1765128. Claude A. Conover.

Tally Card—Especially designed for use in connection with card games, such as bridge-whist, in which the players are arranged at a number of tables for progressive play, the tally simultanously indicating the games played. Patent 1768020. Joseph J. Arnold.

Conical Grater—Having a removable grating chamber which is provided with a plurality of radially extending barriers adapted to retain the material to be grated against the grating surface. Patent 1768076. John W. and Arthur E. Klensch.

Clip—Known in the trade as a "money clip" for clamping bills of different denominations and which will permit the ready removal of a single bill from the stack without disturbing the other bills. Patent 1767973. Stanley L. Gedney.

Binder—Which is strong and durable and adapted to support a book or books or other objects for pivotal mounting in connection with a bookstand, and having means for locking the parts in operative position. Patent 1767978. Walter E. Haskin.

Envelope Sealer—Wherein means are presented for easily receiving and guiding the envelope and its flap so that the flaps will first be moistened and then pressed to a sealed position; the device may be applied to a wall or support. Patent 1767908. Benjamin Zuckerman.

Atomizer—In the form of a doll having one or more movable appendages, such as the arms or legs constituting parts of the doll, which may be manipulated to cause atomization of the perfume or other liquid used. Patent 1767911. Benjamin Berko and Joseph Brewer.

Pipe—A tobacco pipe, which may be constructed from a wide range of materials, and so formed that the various parts may be readily aired, cleaned, and kept in a sweet condition. Patent 1767997. Robert W. Nicholls.

Combined Seat and Carrier—A combined portable carrying case and seat, which is of simple construction and particularly adapted for outings or picnics for transporting luncheons and various articles for use on the trip. Patent 1767925. Thomas Hargreaves.

Envelope—A remailing envelope of the single pocket type formed of two sheets of paper with flaps disposed in opposite directions, the envelope being adapted to be folded upon itself when remailed as first class matter. Patent 1768164. Nathan Sternheimer.

Container—Having a hinged closure, and a resiliently raised article holder, which when opened will dispose articles such as cigarettes and matches, etc., to a position where they may be readily grasped. Patent 1768064. George O. Holben.

Attachment for Pencils—Which may be used for scraping, cutting or clipping bills of lading from packages and the like, the device may constitute a part of the main chamber or be used merely as an attachment for mechanical pencils. Patent 1767948. John C. Taylor.

Oarlock—Constructed of a minimum number of parts, so that on the pull stroke, roller bearings will engage one side, and on a push stroke the other side, the oar lock may be converted for sculling a boat. Patent 1768006. Arin G. and Harold M. Seberg.

Atomizer—By which the heavier hydrocarbons can be reduced to such a fine degree of atomization as to produce substantially perfect combustion, greatly facilitating the cracking in distillation of petroleum. Patent 1764107. Oscar Kay.

Bullet Mold—For casting hollow-point or solid point bullets as desired, the hollow point is automatically withdrawn when the mold is opened, the bullet readily dropping from the mold after casting. Patent 1763977. Marion G. McNeely.

Panel Construction—In the form of a removable panel construction, comprising a plurality of frames having panel receiving recesses for tile, marble, plate glass mirrors, which will eliminate waste of labor in assembling and installation. Patent 1763966. Louis Hoffman.

Gift-Dispensing Apparatus — Comprising a board in representation of a rainbow having chutes thereon for dispensing gifts to children, in a manner to carry out the mythical belief that at the end of the rainbow is a pot of gold. Patent 1763733. Alice C. Westgate.

Angle Trisector—Having a semi-circular shaped member, a radially-extending arm projecting therefrom, and a curved arm having its ends secured to the semi-circular member, for giving the proper point location for an angle between zero and 180 degrees. Patent 1764581. Sojiro F. Shibuya.

Display Rack and Stand—Having novel means for supporting a plurality of racks or casings so that they may be moved in a circuitous path with respect to their supporting member and with respect to each other. Patent 1767980. Raymond S. Hintzee.

Hardware and Tools

Saw Table—A movable frame for supporting a circular saw in substantially a horizontal plane, manual means being employed for moving the frame and saw, and its operating means, longitudinally of the table. Patent 1763478. Clarence E. Palmeter.

Window Fastener—Comprising a corrugated fastening strip secured to the frame and a hinged fastener with tension spring, for locking the window in any position against upward movement but allowing a downward movement at will. Patent 1762280. Arthur J. Slingerland.

Dado Cutter—A device of simple construction for cutting grooves, whereby a plurality of grooves may be formed of various dimensions through adjustable means for controlling the position of the cutters. Patent 1763463. John Garthe.

Combination Cleaver, Knife and Saw—Comprising a blade, the major portion of which forms a knife, the remainder being thickened to form a clever-like structure, the construction being such that the back of the blade will support a saw. Patent 1763452. Bert Williamson.

Ice Pick—A pick or awl-like member which may be safely disposed within the handle, when not in use, but may be readily projected and held in active position for breaking ice. Patent 1768035. William E. Domaratius.

Sharpening Device for Curved-Edged Tools—A manually operable sharpening tool for traversing and conforming to the swing of the curved cutting edge, making it possible to sweep the cutting edge at one stroke and at the proper angle. Patent 1767941. Norris T. Pindar.

Heating and Lighting

Revolving Broiler—Wherein different kinds of food to be cooked are carried by suitable supports, and caused to rotate while exposed to view, but remain unmolested until completely cooked, yet may be basted from time to time. Patent 1762035. George Soylian.

Apparatus for Utilizing Solar Heat—Which includes a chamber adapted to be exposed to the sun rays' and in which the sun's heat is concentrated, a steam generator into which heated gas is introduced under pressure for utilization. Patent 1765136. Charles H. Drane.

Cold-Water Tube and Cleaner for Domestic Boilers and Heaters—Wherein a clean-cut tube is provided which may be used by workmen for cleaning out a boiler or heater or may be used as a combined cleaner and cold water supply pipe. The inventor has been granted two patents of a similar nature. Patents 1767919 and 1768039. William Eiermann.

Machines and Mechanical Devices

Lubricant-Distributing Apparatus—By which the various movable parts of an engine or other mechanism, can be automatically lubricated, the feeding being increased or decreased according to the speed of the engine and excess lubrication prevented. Patent 1760902. David Grattan.

Beater—Which utilizes an electric motor and a form of planetary gearing whereby the beaters or stirring members may be grouped so that certain members will move in a circle and others will rotate in situ. Patent 1762081. George Schleicher.

Apparatus for Liquefying Solidified Honey—Whereby the liquefaction of solidified honey in cans, may be effected in order that the honey may be removed, without discoloration, thus maintaining its original market value. Patent 1761479. Aleck G. Kuykendall.

Load-Ejecting Apparatus for Conveyers—Such as dredgers, excavators, loaders and trenchers, having buckets or scoops in which loads of material are adapted to be transported and the material completely and automatically ejected therefrom with the utmost ease. Patent 1760964. Harold M. Ruth.

Speed-Changing Mechanism—Whereby a speed changing device is provided which gives four direct running speeds with three pairs of gears only, the transmission gears serving not only as idlers but themselves contributing to speed reduction. Patent 1762080. Charles Schaefer.

Hydraulic Actuating Mechanism—Whereby positive control of the valves is maintained, and the position of the valves, is totally independent of the particular construction of the engine, as the usual valve working rods, levers, and cams are completely dispensed with. Patent 1762068. Heinrich M. M. Mattern, Jr.

Fishing Tool—For removing from wells broken or lost parts of rotary bits; or other tools used in rotary drilling, in such manner that by removal of the drill pipe the obstructing object may be recovered. Patent 1761463. Govenor K. Beckett.

Well-Casing Shoe—For use in the sinking of outer or inner casings or screens, to afford means for introducing water under pressure to the lower edge of the shoe for eroding the formation through which the casing is being sunk. Patent 1762012. Elmer D. Every.

Combined Drying, Drumming, Cleaning, Caging and Finishing Fur Machine—Capable of effectively performing all the necessary steps to condition fur-skins or pelts for commercial purposes, incidentally accomplishing these results with comparative economy as to time, labor, and expense. Patent 1763462. Herman Gabbe.

Plaited Hat Lining and Method and Apparatus for Making the Same—A sewing machine with an attachment for plaiting hat linings in which a stiffening filler piece is employed to connect the side, crown and tip of the lining to give a highly tailored effect. Patent 1763468. Alfred Kurtz.

Road-Working Apparatus—Preferably in the form of a power operated vehicle having electromagnetic means adjustably mounted thereon, and to be transported along a road for picking up all ferrous materials or substances injurious to pneumatic tires. Patent 1763457. Charles R. Churchill and Joseph R. Haynen.

Fortilla-Forming Machine—A cake forming machine embodying a pair of coacting dough pressing rollers having means for detaching the dough from one roller and subsequently detaching the cut or stamped cakes from the other roller. Patent 1763445. Luis Romero.

Drawing-in-Filling Preventer—For preventing the catching of the remaining filling on a bobbin between the shuttle and box plate of the loom, and the breaking off at a moment of transfer of a new bobbin from the magazine. Patent 1763456. Theophile Caux.

Spray Gun—Which has novel means for actuating the air valve and paint valve simultaneously, whereby there will be no frictional contact, and means whereby the spray may be changed from a round to a flat. Patent 1762282. Emil H. Stephan.

Automatic Sash Machine—For use in the manufacture of window stiles, wherein means are provided for feeding the stiles to the machine, boring, grooving, molding the stock on two edges, and dressing to a desired thickness, in a series of operations. Patent 1762273. David B. Mackenzie.

Power Steam-Feed Lever—For operating the steam feed valve in a saw mill by mechanical power, which will eliminate fatigue on the part of the operator in using the hand-operated devices usually employed. Patent 1765069. Edwin J. Gibson.

Pump—Primarily designed for oil wells in which one or more controlling pistons are positively manipulated from above the surface of the ground, either hydraulically, mechanically, electrically, or by air or gas pressure. Patent 1765085. Harley H. Markey.

Semiautomatic Dipper Trip and Monkey-Line Winder—A re-winding mechansim for monkey lines, wherein the line may be maintained taut, taken in and allowed to slacken as desired, for maintaining a clam shell bucket in a swinging or desired position. Patent 1765089 George G. Morin.

Ship-Unloading Device—Whereby means are provided for quickly conveying merchandise from the hold to the deck, and by a chute directly from the deck to the quay or lighters, without encumbering either the hold or the deck. Patent 1765118. Mario Abriani.

Dispensing Device—Which is adapted to dispose in bottles predetermined amounts of liquid with means for varying the amount disposed, the operation continuing until the entire amount of liquid in the machine has been disposed of. Patent 1763971. James Kantor and Charles H. Miller.

Submarine - Salvaging Apparatus — A suitable number of floats carried by a submarine are released by the sunken boat, whereby a salvaging crew, with the aid of a mother ship, may raise the submarine without requiring divers to be sent down. Patent 1765101. John Schierenbeck.

Lawn Mower—Particularly adapted for cutting grass located adjacent to the trunks of trees or close to fences, walks, bushes or other parts adjacent to a lawn which have been inaccessible by the conventional type of mower. Patent 1762287. John H. Blair.

Vending Machine—Adapted more particularly for vending flat articles, such as newspapers, periodicals, etc., a slidable drawer permitting the delivery of the article after a required number of coins have been deposited. Patent 1765216. Major Duncan.

Boiler Flue and Pipe Cutter—In which a circular knife is moved into contact with a revolving pipe to be cut, a motor causing operation of rotating means, revolving means being manually actuated for causing the cutter to engage the pipe. Patent 1765208. James I. Cunningham.

Sheet-Cutting Machine—A rotatable work support and conveyer for moving rubber sheet material in a longitudinal direction for cutting sheets at predetermined points as the rubber is fed from the calendar. Patent 1765184. Elno H. Trump.

Bottle Washing Machine—In which the bottles are inverted and successively fed over jets of fluid containing solid objects such as rubber spheres, which are projected for removing foreign matter both from the interior and exterior of the bottle. Patent 1761492. Frank B. Reily.

Bit-Forming Machine—With which uniform shaped bits of comparatively superior construction may be produced expeditiously and for sharpening used bits of uniform shape, may be adjusted to different sizes. Patent 1767881. Jeremiah V. Gustin.

Pump—A rotary high speed submerged verticle type; the blades of the water wheel being constructed to obtain a greater lift in proportion to the horse power required, especially useful for irrigation purposes. Patent 1768130. Robert L. Meaux.

Lock—Designed to be gravitationally locked and electrically released although intended to broadly cover mechanical releasing means, particularly adapted for sliding closures, such as cages in banks, is simple and highly efficient. Patent 1768021. William E. Bauerband.

Multiple-Speed Transmission Mechanism—Which includes a shiftable carrier composed of sections which are sleeved on the drive and driven shafts, whereby various combinations of gearing and different speeds will be effected. Patent 1767909. Herbert G. Altvater.

Watch-Crystal-Fitting Device—Whereby the pattern and size of crystal may be readily and accurately traced on a crystal blank directly from the inside edge of the bezel of the watch case to which the finished crystal is to be applied. Patent 1767935. James B. McDaniel.

Cutting and Grinding Mill—For feed, silage, etc., having a stationary cutting knife at the entrance of the machine in connection with the rotary cutters, whereby the material will be cut into pieces before grinding so that no choking of the machine will occur. Patent 1767921. Steve R. Gately.

Machine for Cleaning Cotton and the Like—Which continuously utilizes the same current of air, so that the moisture content may be relied upon as being substantially uniform, and the change of air at short intervals obviated. Patent 1767957. John S. Bachman.

Floor Polisher—A unitary structure which may be readily applied to the floor and easily operated with means for adjusting the horizontal position of the brushes. Patent 1767983. William H. Hughes.

Closure-Operating Mechanism—By which doors, particularly garage doors, are adapted to be automatically opened or closed according to the vehicle approaching or leaving the garage, thus obviating annoyance in inclement weather. Patent 1764150. George G. Candee.

Apparatus for Automatically Determining and Recording the Specific Gravities of Fluids—For use in measuring gases, natural or artificial, flowing through pipes, where due to the mixture of different densities, it is desired to have a record of the specific gravity at all times. Patent 1764103. Harry A. Hurley and Herbert J. Tones.

Street-Marking Apparatus—Having one or more brushes, each rotatable about a vertical axis, in a manner to produce a painting motion for marking highways with lines for defining pedestrian and vehicular traffic zones. Patent 1764546. William B. Burnley.

Medical and Surgical Devices

Womb Medical Applicator—Comprising a ring of semi-flexible material, and a receiving bag associated therewith, with inwardly extending loops adapted to receive and apply a medicament to the cervix and associated portions of the female anatomy. Patent 1760751. Jose L. M. Guenard.

Test-Tube Rack—Composed of several parts which can be nested and conveniently carried from place to place in a satchel and set up for supporting the tubes during the heating and cooling action, and the draining and drying. Patent 1763461. Charles Fowler.

Musical Devices

Music-Teaching Device—Having a staff board and a number of lights representing notes on the scale, the lights being controllable by the teacher, whereby the students will quickly learn to sing at sight from the illuminated notes. Patent 1763444. Michael B. Rock.

Musical Instrument—Especially designed for use in children's bands, as a foundation for other instrumental work, it being constructed to start the coordination of the tongue, lipping and fingers, as used in wood wind instruments. Patent 1767998. William B. Parkinson.

Plumbing and Fittings

Plumbing Fixture—A pressure trap, having in combination therewith a pivoted buoyant valve member adapted to control the flow of fluid therethrough in a predetermined direction, the whole forming a simply assembled and disassembled fixture. Patent 1763466. Albert M. Khun.

Plumbing Fixture—A back pressure trap with leverage means for controlling the movement of an associated valve whereby the flow of fluid is confined to a predetermined direction and back pressure is prevented. Patent 1765078. Albert M. Khun.

Prime Movers and Their Accessories

Valve Mechanism for Internal-Combustion Engines—A valve in the form of a vertically positioned sleeve mounted to turn in a circular groove in the head of the engine, and held in place by a top plate, annular gear teeth imparting the turning movement. Patent 1763460. Jesse F. Fisk.

Reversing Gear for Reciprocating Engines with Hydraulically-Operated Valves—Whereby reversing is effected by altering the admission and discharge of the fluid to and from the pistons, by means of cocks or other control devices in the corresponding pipes for the liquid. Patent 1763474. H. M. Meier Mattern.

Valve Lifter—Adapted to be operated in conjunction with spring-actuated poppet valve members of an internal combustion engine, affording a positive vertical lift, simplicity in operation, extreme power, and insuring a positive lock at any height of lift. Patent 1765138. Willard J. Dunston.

Valve—Having novel means for directing the exhaust gas away from the valve head in an internal combustion engine, preventing the warping and leaking of the valve and keeping the valve head cool. Patent 1763951. Carl F. Burgmann.

Engine—Of the two-cycle principle, in which the customary piston is inverted and the explosion of the gas takes place within the interior of the piston, a novel water jacket cooling the inside and outside. Patent 1763959. Fred F. Finch.

Valve-Spring-Lifting Tool—For compressing the coil spring around the stem of a poppet valve of internal combustion engine to release the tension upon its supporting pin so that the pin may be withdrawn and the valve removed. Patent 1764519. Arthur L. Mettler.

Railways and Their Accessories

Rail Fastening—Including a fastener plate formed substantially H-shaped and having overhanging shoulders with the parts formed to be secured to ties by spikes, welding, rivets or other securing means. Patent 1760723. John G. and Arthur N. Snyder.

Dirigible Headlight—For locomotives, or the like, having a support responsive to gravity to cause the light to automatically illuminate the track in advance of the locomotive, whether the latter is traversing a curved or straight stretch. Patent 1761484. George G. McNee.

Flange Oiler—For oiling locomotive wheels whereby the lubricant may be directed against the flange of the wheel which is brought into direct contact with the sides of the treads of the rails. Patent 1765202. James C. Burford.

Air-Actuated Mechanism for Locking Throttle Levers—Wherein the air employed for positively locking the throttle lever may be passed to a bell-actuating mechanism for notifying persons upon the train or there around that the train is to be set in motion. Patent 1763954. William M. Cross.

Combined Tie Plate and Rail Anchor—Which will rigidly hold the rail against lateral or longitudinal displacement, obviates the need of the ordinary tie plate and protects the tie, and acts as a brace for the rail. Patent 1767937. William A. McFarland.

Signal Recorder—A recording mechanism for each actuation of a signal, which embodies a horological instrument and a pressure actuated time stamping mechanism operable incident to the action of the signal, or the actuation of a whistle on the locomotive. Patent 1768154. Harry O. Sampson.

Pertaining to Recreation

Toy Palpitating Heart—A toy of novel construction which may be used to simulate the action of a palpitating heart, for the purpose of surprising and amusing onlookers. Patent 1763467. Herman H. D. Klinker.

Swimming Device—By means of which persons not experienced in the art of swimming are able to keep afloat on the surface, to increase the efficiency of the stroke, and thereby reduce the muscular force exerted in swimming. Patent 1765116. Linwood R. Williams.

Game Board—Of the type in which objects moving about the surface of the board are controlled by a player, the board having a resilient mounting, may be readily tilted to various angles and inclinations. Patent 1768016. Arthur L. Walker.

Ski Sled—Which may be used as a sled and the runners thereof being in the form of skiis, may be readily detached for use in the usual manner for sliding over freshly fallen snow. Patent 1768046. Christian Fredrickson.

Pertaining to Vehicles

Vehicle—A pedal-operated device whereby smooth operation will be insured during all the various stages, and having means whereby the vehicle may turn a corner at a high rate of speed, with a minimum risk of overturning. Patent 1758957. Robert G. McKay.

Parking Device for Motor Vehicles—A simple attachment which may be used with a standard automobile, whereby the front wheels may be lifted and the rear end wheels swung about as a pivot, until a curbing, or the like is paralleled. Patent 1758964. John Myers.

Rumble-Seat Top—Which is incorporated in the car body during manufacture and completely housed in the seat structure when not in use, but readily capable of extension to completely house the occupants when required. Patent 1760334. Otto Altenbach.

Motor-Vehicle Seat—Particularly adapted for use in connection with the driver's seat, whereby the seat is so constructed that it may be adjusted to alter the vertical height to that most comfortable for the driver's personal use. Patent 1762046. Albert B. Blumenberg.

Lining-Gun Nozzle—Comprising a tapered tubular intake stem and a form of hair-brush or pencil, designed to be drawn along a moulding or the plain surface of a motor car, a drip container catching any surplus liquid. Patent 1762058. Herbert H. Harris and William T. Whittingslowe.

Steering Gear—In which the engine or motor is utilized to shift the angular disposition of the wheel, it being only necessary for the operator to initiate the movement. Particularly adapted for heavy vehicles requiring great strength. Patent 1763470. George E. Lemon.

Signal Mechanism for Automobiles—For automatically lighting the lamps at the front and rear to indicate turns, the mechanism being manually actuated, and independently functioning for lighting the lamps in different sequence, to indicate the turning motion. Patent 1763465. William F. Hild.

Device for Supporting Articles on Tires or the Like—For supporting, for instance, a mirror, on the spare tire, commonly carried on the running board, of an automobile, in such position that it may be conveniently observed by the driver, but secured against theft. Patent 1765099. Abraham W. Rosen.

Motor-Vehicle Brake—Wherein the brake band has one end fixed and its other end movable so that upon application of operating pressure the entire band will be circumferentially expanded against the brake drum. Patent 1768176. Gus Walker.

Recording Device for Automobiles—Which may be secured to the instrument board of a car, and swung from behind the latter into position for quickly recording various data relating to gasoline filling, oil, etc. Patent 1767924. Nelson L. Greene.

Signal Device for Motor Vehicles—An arm type of signal, for extension outwardly from the side of the vehicle to indicate to the drivers of other vehicles the stopping, slowing, or direction of turn, the device is manually controlled. Patent 1768034. John Deblieux.

Card Holder—Whereby a certificate or owner's registration card or the like, may be securely fastened in a conspicuous place on a part of the automobile, and means for preventing substitution of another card. Patent 1767993. Adolph G. Lorenz.

Theft-proof Tire-Valve Cap—A simple device which will be under control of an authorized person to make possible the application or removal of the valve stem cap, but impossible for unauthorized persons to remove the cap. Patent 1767884. Harison Heinrich.

Air-Pressure Gauge—A gauge for use in connection with an attachment employed for inflating tires, the device is of simple construction and arranged to permit the gagging and indicating of various pressures. Patent 1768275 William C. Urton.

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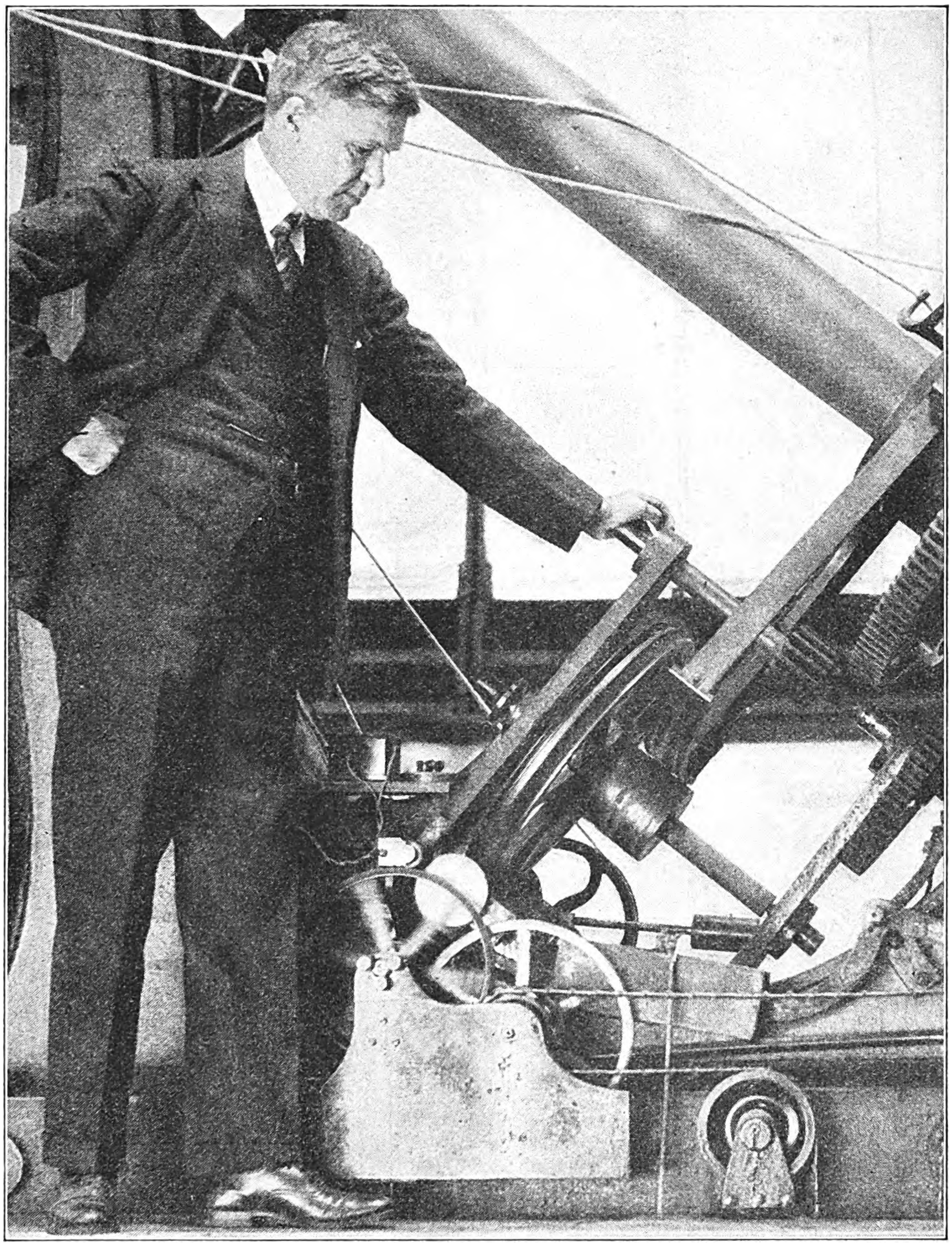


Photograph by David B. Pickering

S. A. Mitchell

FOR the determination of the distances of 1000 stars, Professor S. A. Mitchell, Director of the Leander McCormick Observatory at the University of Virginia, recently has been honored by other astronomers—as Professor Russell explains on page 280 of the present number. The stars whose distances were determined are within the galaxy—that is, within our own "island universe." They range from six to 600 light years. The work involved no simple, easy "mass production" method of ascertaining these distances, but each individual star required much painstaking labor and application. Dr. Mitchell's prominence in astronomy, however, is based not alone on this kind of research; he is a leading authority on solar eclipses, his large book, "Eclipses of the Sun," being the standard work on every aspect of the subject. Professor Mitchell also has done research at Yerkes Observatory, also at Columbia. He is a Canadian.

A group of members of the American Association of Variable Star Observers visiting Georgetown Observatory during a Washington meeting. About half are "professional" and half "amateur" astronomers, but in astronomy such a distinction seldom is made, because the amateur has done so much professional work in the past

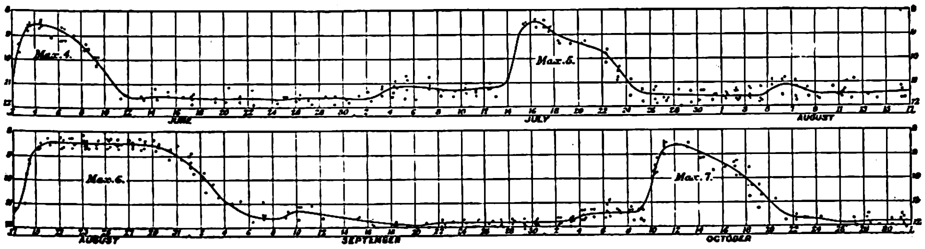
One Touch of Nature

By DAVID B. PICKERING

The American Association of Variable Star Observers

OF the tens of thousands of millions of stars which photographs taken through the world's great telescopes will show us, all but a few thousand, a mere handful, are staid, well balanced citizens of space. All, of course, are suns, larger and brighter on the average than our glowing orb of day, but so vastly distant that they appear but as points of light even through our most powerful instruments. In human affairs our concern is with those who disobey the laws of society and ignore its conventions. Even so, in the world of stars we are drawn to those nonconformists whose vagaries, in many cases, seem to be beyond the pale of the law. Unlike their more regular brethern, they dare to change their brilliancy—throwing into space at times vast quantities of light; while at other times, so prodigal of this commodity have they been, that they shine with but a fraction of their former brightness.

The basic laws that underlie these changes in brilliancy are, in many cases, still a mystery to man, but his urge to know the truth impells him, nevertheless, to study them with sometimes passionate intensity. These lawless ones are known as variable stars. In the catalogues of the heavens they are designated by certain Roman capital letters, and the name of the constellations in which they appear. Thus we have SS *Cygni* —the variable star SS in the constellation of Cygnus, the Swan. To an observer with a small telescope, this star remains in comparative obscurity for an indefinite period, and then with startling rapidity grows in brilliancy to nearly 100 times its former state. It is one of the most mysterious and and therefore most famous of all variables—a veritable François Villon of the skies, whose next daring move his closest observers may not even guess.



From the *Journal of the British Astronomical Association*

Light curve of the variable star SS *Cygni*, 1927, from observations by the Variable Star Section of the British Astronomical Association (another amateur and professional body—in fact, this point of view is world wide)

LET us recite an emotional experience from the life of any variable star observer:

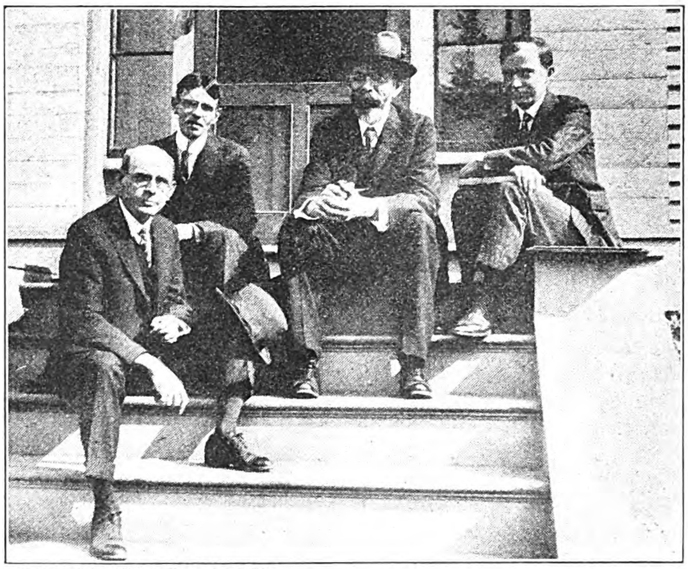
"Watchman, what of the night?" Many times throughout the day this phrase had trailed dimly through his mind as he sat in his stuffy office in the city, immersed in the details of accounts. Many times he had glanced quizzically through the window at the occasional clouds that sailed above the sea of brick and stone without. Later, from the window of the train that bore him to his suburban home, he noted with a thrill that the October sun decended through a cloudless sky.

As the evening meal progressed, as the dusk deepened and the lamps were lighted, wife and daughter wondered at his almost furtive manner. The faraway look in his eyes, the air of

"A.A.V.S.O's" hobnobbing. Left to right: Yalden, Godfrey, Miss Cannon, Miss Potter, Dean Potter, Professor E. W. Brown, Olcott

suppressed nervousness, led them to think that perhaps the daily office grind was proving too great a strain. With a guilty smile he excused himself before the meal was finished, and a moment later, as he passed through the dining room bearing the long yellow tube of his telescope, he was abashed by his wife's expression of quiet resignation. But, once the kitchen door had closed behind him, his spirit, imprisoned during the day, rose to meet the stars that kept their tryst with him—there in his own back yard.

He clamped the tube of his three-inch telescope into the cradle of the mounting atop the post that stood between the rose bushes, and adjusted the screen that shielded his eyes from nearby lights and kept the vagrant breezes from disturbing his charts on the little table at his side.



Photograph by William Henry, A.A.V.S.O.

Group at an A.A.V.S.O. meeting. Left to right: Pickering (the author), Olcott the founder, Yalden, Professor Harlow Shapley (Director, Harvard Observatory)

NOW his eyes rested for a moment on the stars overhead, then dropped westward to the great Cross of the North that glowed in that group called Cygnus — the Swan. There on its side it lay, submerged in the depths of the Milky Way. He lighted his dim lamp and let its red rays fall upon his star atlas. How still everything seemed, here in this secluded little garden. He swung his telescope until it was directed toward the slanting cross; then, while glancing at the sky along the edge of the tube, raised it until it rested some distance above the sparkling star Deneb.

He places eye to the eyepiece and cautiously moves the tube, slowly sweeping it back and forth, up and down. In the round, star-filled field of the eyepiece, the bright asterisms assume many and various forms, but with suppressed excitement he seeks one familiar form in particular. It is an "L" shaped group of stars, resembling a carpenter's square, opposite which is a group of fainter stars which, because of its dome-like shape, is known as the "bee-hive." Between these lies a triangle of stars, in which is located that elusive, mysterious variable, known to astronomers as SS *Cygni*.

On every clear night, for weeks past, he has sought this part of the sky—found and noted the familiar asterisms of this particular field—but on each night, though he knew the exact spot where it should appear, the object of his quest has eluded him. Last night again, it was beyond the power of his glass. Once more tonight, with the patience of a sleuth, he seeks the outlaw. Ah! here at last is the carpenter's square—and there the little bee-hive.

But—what is this! For an instant his heart seems to have stopped beating—then it begins to pound again—he is breathing faster. Something must have happened. Something *has* happened. SS *Cygni* is the brightest star in the field. Sometime within the last 24 hours, this giant sun has burst the bonds of mediocrity and is now radiating with one hundred fold the force of yesterday's energy. No wonder his emotions run riot. Seated here in the silent darkness among his roses, he is the lone observer of this tremendous cosmic event—the witness of a mystery which no man has fathomed.

The kitchen door swings wide. A stream of light from within flows across the lawn to the telescope. A girlish treble calls: "Hey, Dad, you goin' to the movies?"

Tomorrow's paper will tell of the gowns worn at the Vandercliff wedding—but there will be no mention of this magnificent gesture on the part of the Creator.

OBSERVING variable stars is the job of a trained amateur astronomer. The word "amateur" means one who does a thing because of his love for it. It is often wrongly applied to a fumbler. I have never known an astronomer—man or woman—who was not an amateur. If it so happened that astronomy was also his vocation, his professionalism was quite a secondary matter. What more natural than to find a brotherhood of interest among astronomers, such as exists perhaps in no other branch of science. Quite likely it was this fraternal instinct that, 20 years ago, brought together the late Edward C. Pickering, Director of the Harvard College Observatory, and William Tyler Olcott, an amateur telescopist of Norwich, Connecticut. Pickering, the professional, had a job for amateurs. Olcott, the amateur, was looking for a chance to aid science. Pickering became the "Big Brother" of all variable star lovers. Olcott became the founder of the "American Association of Variable Star Observers."

In was in 1911 that this Connecticut attorney began to enlist the services of other amateurs in the great game of estimating the brightness of the long period variable stars. In that year, seven men formed an Association, and began work. At the end of three years there were about 20 members. Today the Association numbers about 300 men and women in 23 countries of the world.

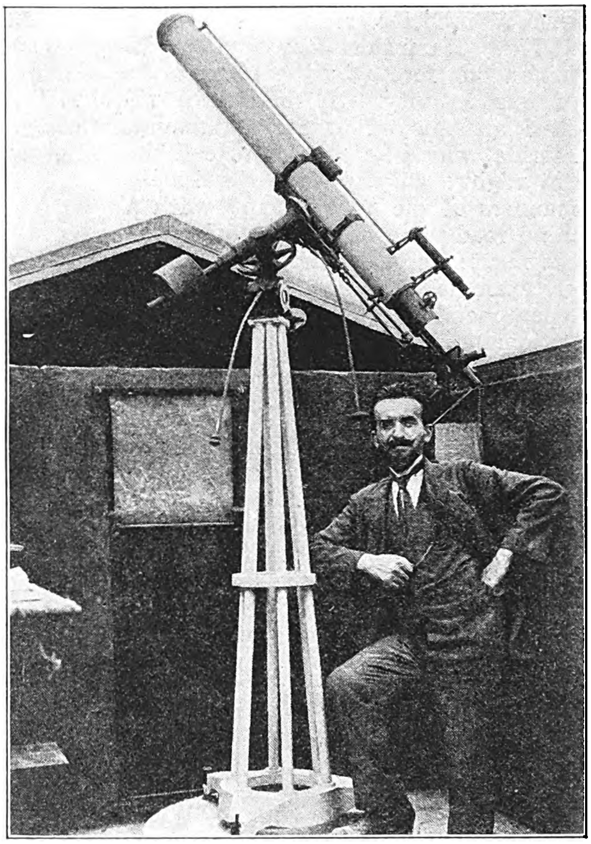
The fact that some of the stars are not constant, is the "touch of nature" that has "made kin" of hundreds of people all over the world—people whose vocations are almost as varied in character as are the stars themselves. Among the great amateurs of the country who make astronomy a profession, and who form the solid background and support of the Association, are several famous men, who, though listed as Honorary Members, are active in the extreme. Upon the shoulders of Dr. Harlow Shapley, Director of the Harvard College Observatory—"the man who remeasured the universe"—fell the cloak of that "Big Brother" who was our original inspiration. Professor S. A. Mitchell, the genial Director of the Leander McCormick Observatory—"the man who made a thousand parallaxes"—is devoting himself to the great task of revising our charts; redetermining our fainter magnitudes by the aid of his 26-inch telescope, in Virginia. Professor Ernest W. Brown, of the Yale Observatory, found that the earth and moon were out of step, and set certain members of our Association "marking time" for this pair. Largely through the efforts of this group, he has recently determined that the earth is the culprit—being out of rating to the extent of one second in a hundred years. This friend and companion of ours never misses a meeting of the "A.A.V.S.O."

BUT most of the variable star observers make of astronomy an avocation. There is Leslie Peltier, for example, whose home on the farm lands near Delphos, Ohio, is many miles from a railway. As a boy he would take his little two-inch glass out into the fields, then make his reports of the brighter variables regularly to the Harvard Observatory. Long since he graduated to a six-inch instrument, and for years was the outstanding "ace" among "A.A.V.S.O." observers. Incidentally, Peltier is the discoverer of two comets, one of which is Comet 1930a, the first to be found this year.

Speaking of comets, the second discovery of the year—1930b—was made also by another member of the "A.A.V.S.O.," Max Beyer of Hamburg, Germany. Though a true amateur, and a major contributor to the Association's reports, he is the publisher of the well known Beyer-Graff Star Atlas which so many of us use.

In the little town of Faenza, Italy, the town whose distinctive pottery gave to the world the name "faience"—lived the postal clerk, G. B. Lacchini. With what ardor he loved the stars and with what great facility he observed the changes in the variables, his long record of faithful service, preserved at the Harvard Observatory, will attest. The authorities at Rome, recognizing his rare ability, have recently taken him from the postal service and made him a member of the staff of the Royal Observatory of Catania, thus granting his heart's desire to devote his life wholly to the stars. His little family moved from their home in the north, to far away Sicily. From the shadow of Mount Etna, his charming daughter, Bianca Rosa, sends me occasional verses in excellent English. Today Lacchini contributes more observations to the "A.A.V.S.O." than any other member.

Lacchini and I had corresponded for a dozen years or more. Then one memorable day in 1926, we met—in Faenza. It was the first time that Lacchini had ever seen a member of the organization which he had served so faithfully, and for so many years. It was a day to be marked with a white stone. On that occasion, too, I met those fine protégés of Lacchini—Benini and Ancarani—who have remained in Faenza to carry on the work he began. Together with one Gallanti, they have organized the "Osservatorio Urania Lamonia," where, with an eight-inch reflector, the property of the "A.A.V.S.O.," they are doing faithful work for the Association.



The topnotch observer of the "American" Association of Variable Star Observers is an Italian, Lacchini, who lives near Mount Etna

Variable star observers commune at Faenza. Left to right: Benini, Pickering, Lacchini, and Ancarini. The organization is international

In the city of Seattle, Washington, lives another man of Italian birth, D. F. Brocchi, an engineer and draftsman for the Northern Pacific Railroad. He too employs his talents making master charts for variable star observation. Later he checks these with the sky by the use of 10- and 12-inch telescopes of his own making. Lacchini and Brocchi and I have for years been responsible for the chart work of the "A.A.V.S.O." Lacchini and Brocchi have never met. Brocchi and I have never met. We are separated from each other by thousands of miles—yet what chums we have become, and what fun we are having, through this common interest.

For many years the head of the "Baron de Hirsch Trade School" in New York City was J. Ernest G. Yalden—the sage of Leonia, New Jersey, whom his friends have affectionately dubbed the "Baron." This tall, bearded genius, with the heart of a boy and the brain of a philosopher, resigned his post some time ago to devote himself entirely to the study of time and the stars. His versatility is astounding—yachtsman, navigator, mathematician, architect, astronomer, and outstanding authority on the ancient art of sun-dialing. He is chief advisor to the Association on observatory construction, and is Chairman of the Committee on Lunar Occultations, another of our important activities.

The Rev. Mr. Tilton C. H. Bouton was a minister of the Gospel in a New Hampshire town when he joined our forces in the early years of our activity. He has since retired and moved to St. Petersburg, Florida, which he chooses to call the "Starlight" City. With the kindly manners of the "old school," with a mind ready and able to grapple with the mysteries of Nature, he has been an example of dependability to his fellow members. He varies his observational and lens-making activities by collecting china and building bows and arrows of rare excellence.

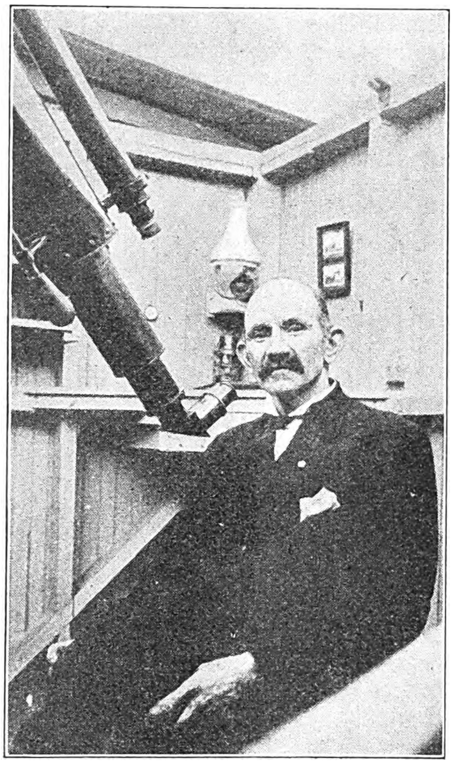
IN 1927 the Association sustained a great loss in the death of its President, Dr. Charles A. Godfrey, a leading physician of Bridgeport, Connecticut. What volumes could be written about his career. He had no means to buy a telescope when as a country boy the stars beckoned to him, so he made his own mirrors and mounted them too.

Another whose memory shall ever be green in the minds and hearts of his fellow members, was Charles Y. McAteer, of Pittsburgh, one of the seven original members of our Association. During his busy, happy life, he spent many hours out of every 24 at the throttle of a Pennsylvania Railroad locomotive. A rack in the side of his cab held a Bible and a star atlas—the only guides he knew or required. Finishing his trip when the night was half spent, he would hurry with his telescope out under the stars, there to observe variables until dawn and sleep broke his vigil. "Mac" was a rough diamond—but of the first water. The great in science were proud to call him friend.

Today, there are Arthur Butler of the New York Stock Exchange; George Waldo of the press; Ernest Jones of the insurance world; Charles Elmer, the court reporter—but space precludes an extended category.

Strange to say, among the 30-odd women who grace the membership of our Association, by far the greater number have chosen astronomy for their vocation. Among the latter who play a prominent part in its affairs, is Professor Anne S. Young, Director of the Mount Holyoke College Observatory, one of our past presidents, and now the editor of our publications.

The president of the Association, at this time, is Dr. Alice H. Farnsworth, also of the Mount Holyoke Observatory, while our vice-president is Professor Harriet W. Bigelow of the Smith College Observatory. Mrs. Margaret Mayall, and Miss Helen B. Sawyer, both of the Harvard staff, are curators of our charts. Dr. Caroline E. Furness, Director of the Vassar College Observatory and author of that splendid treatise, "An Introduction to the Study of Variable Stars," and her assistant Miss Alberta Hawes, are both ardent supporters of the Association and active in its affairs. Equally so, is Dr. Leah Allen, Director of the Hood College Observatory of Frederick, Maryland, and Miss Margaret Harwood, Director of the Maria Mitchell Observatory, on Nantucket Island.



Charles Y. McAteer, one of the seven original members, was a locomotive engineman—"a rough diamond, first water," was "Mac"

Outstanding among the non-professional members is Miss Helen M. Swartz, of South Norwalk, Connecticut, whose devotion to the Association is unquestioned. In Haverford, Pennsylvania, lives Mrs. Otto Haas. Despite the care and responsibilities of rearing her family and attending to her domestic duties, she contributes regularly to our observational records. Still another housewife who devotes her available time faithfully to "A.A.V.S.O." affairs, is Mrs. Mary E. Morris, of Nantucket, Massachusetts.

To our meetings in the spring and fall, come these men and women. Overlords and underlings of big business, professors and students, housewives and teachers, all forgetful for the time being of their daily occupations, they meet on common ground to consider subjects of common interest—to revel in the exchange of thought with kindred spirits. It is at these meetings that Leon Campbell, member of the Harvard staff, and dean of the variable star fraternity, discusses the results of our work. As recording secretary of the "A.A.V.S.O.," it is he who prepares our observations for monthly publication in *Popular Astronomy.*

The dinners with which these meetings invariably close are occasions to be remembered. Thereat we descend from heights of pure research to frolic and fellowship. Woe be to him who tries to hide his pet foible under a bushel of dignity; some one will find him out and exploit his weakness either in verse or song. After every such affair, we return to our familiar stars with a better appreciation of the value of team work.

WHAT a satisfaction it is to know that, because of the far-flung membership of the "A.A.V.S.O.," we are enabled to "spell" one another around the world. Perhaps Peltier of Ohio may be watching for a suspected change in the light of some puzzling star; as daylight ends his vigil, and the shadow retreats westward, he knows that there is a long night ahead in faraway Japan where Sigeru Kanda of Tokyo, or Teiju Kanamori of Naganoken, may mount guard over the same field of stars. When the hours of their stewardship have passed, Chandra of Jessore, India, brings his glass to play upon the sky. Later still the charge may fall to Ehric Liner of Konstanz, Germany, or to A. N. Brown of London. Thus when night again falls upon America, we may feel assured that the sun has not thwarted us.

But, despite this pretty system and these widely separated stations, the Association needs more workers. There are hosts of long period variables and never enough observers to follow all their caprices. We will gladly lead the amateur telescopist into the pleasant and profitable pastures of the variable stars. Through personal contact, by correspondence, or by the aid of literature and charts, we will instruct him in our methods and impress upon him the great assistance which his subsequent service will afford to science. Then, when he has acquired the knack of finding the star fields and estimating the brightness of the stars, and has assured us of his intention actively to co-operate with us, we will welcome him to membership in this happy fraternity of ours.

The very hope of adding one jot to the sum total of accumulated knowledge, seems sufficient reason for anyone to devote time and energy in the pursuit of truth. Perhaps another urge may lie, however, in the response of an eminent man of science when asked why he had given his life to research:—"Because it's so much fun."

OUR POINT OF VIEW

Glenn Hammond Curtiss

THE news of the untimely death of Glenn H. Curtiss at the age of 52, on July 23, came as a shock not only to the aviation world, of which he was one of the few outstanding pioneers, but to the world in general. Inventor, pilot, and manufacturer, he was in turn a bicycle racer and repairer, a motorcycle manufacturer, the first man to make scheduled airplane flights, and finally, an airplane manufacturer. He contributed more to the development of heavier-than-air flight than any other man, and much of America's success in building planes during the war was due to his genius.

After winning many trophies in bicycle racing, Mr. Curtiss made a 10-mile motorcycle record that stood for 16 years. Next he built a motor for an airship, the flight of which was so successful that the government ordered a dirigible. When this was built in 1905, it passed all tests and became Army Dirigible 1. Together with Alexander Graham Bell, he formed, in 1907, the Aerial Experiment Association and built the *Red Wing* which cracked up on its first flight of nearly 319 feet, the first public airplane flight in America. On May 22, 1908, Curtiss flew his second plane, *White Wing,* a distance of 1017 feet and landed safely.

The first previously announced flight in America was made by Curtiss when, on July 4, 1908, he won the first leg of the SCIENTIFIC AMERICAN Trophy by a flight of one kilometer in the now famous *June Bug.* His attempt to take off from the water in the *June Bug,* refitted with pontoons, was unsuccessful but the attempt led to the development of the flying boat which he perfected in 1912.

The second leg of the SCIENTIFIC AMERICAN Trophy was won by Curtiss in the first exhibition flight in America at Hempstead Plains, Long Island. This flight covered 24.7 miles. Then on May 29, 1910, came his greatest triumph: a successful flight down the Hudson River from Albany to New York City by which he won the *World* prize and the third leg of the SCIENTIFIC AMERICAN Trophy, the latter then becoming his permanent possession.

As a builder of planes, Curtiss designed and produced many machines of distinctive design and developed many types of aeronautical motors. In recent years, however, he had relinquished all active interest in the aviation companies that bear his name.

It will be impossible ever to calculate the debt which the world owes to Glenn H. Curtiss but it is an assured fact that aviation will place him forever on the pedestal beside the Wright brothers and Langley. While the world pays tribute to the energy and versatility of the man, SCIENTIFIC AMERICAN, because of its close touch with him during the early skeptical days of aviation, feels that it has suffered a distinct, almost personal loss.

Helping the Deaf

THE almost overwhelming noises of our great cities and of our industrial plants are said to be causing a large increase in the number of the cases of deafness. And it is now understood that deafness frequently tends to cause a mental slowing up and, in some cases, does cause a positive dullness.

The importance, therefore, of the efforts of the Chicago League for the Hard of Hearing to encourage installation of hearing aids on certain seats of churches, theaters, and other large auditoriums so that deafened people may hear and enjoy sermons, music, entertainment, or whatever program is being given, can readily be realized. There are in this country, the Hearing Aids Committee of the above-mentioned organization says, 10,000,000 deafened people, 300,000 of whom are in Chicago. Most of these people have ceased to attend church, cannot enjoy the drama or educational talks, and, since the advent of talking movies, are denied even the pleasure formerly afforded by silent movies. The Committee is backed, in this work, by prominent Chicago organizations.

We wish the League a full measure of success. Theirs is a splendid undertaking and we hope it will be followed in other cities. The world of the person who is hard of hearing is narrow and dreary indeed, and we who have our hearing should extend to him, as much as possible, the means of enjoying the entertainment and cultural programs which so often satiate us.

Before the Accident

DESPITE the disastrous nature of the World War, *The Travelers Standard* voices the opinion that it served a great purpose. It showed how exceedingly horrible a modern war can be and turned men's minds more definitely toward the prevention of future wars. Similarly, the sinking of the *Titanic,* with the loss of 1500 lives, was, it is pointed out, a beneficent disaster because it brought the realization that additional marine safeguards and an ice patrol of the North Atlantic were needed.

In industry, the thousands of safety inventions and devices—mechanical guards over moving machine parts, goggles and masks for workmen, safety valves, protective clothing, and so on—were all born of human agony and sorrow. Someone had to suffer before foremen, plant superintendents, and executives could realize the hazards of old methods.

It is a puzzling and unfortunate fact that foresight, in the matter of industrial safety, has been and is lacking as a rule. The workman has had inculcated in him the spirit of efficiency so that he takes an interest in his work, but he has not yet fully felt the need of accident prevention measures and devices. Working on machinery that is well-protected, he often removes safety devices in the belief, apparently, that he can do his work faster or with less effort.

Some plants are making great advances in safety. In these, workmen are taught the meaning of accident prevention measures and are encouraged to look ahead and devise safer methods of doing the things they do every day. But the toll in fatalities and injuries is still far too great. If the human equation is to blame, then change it by an intelligent educational campaign. The result will be safety before, not after, the accident.

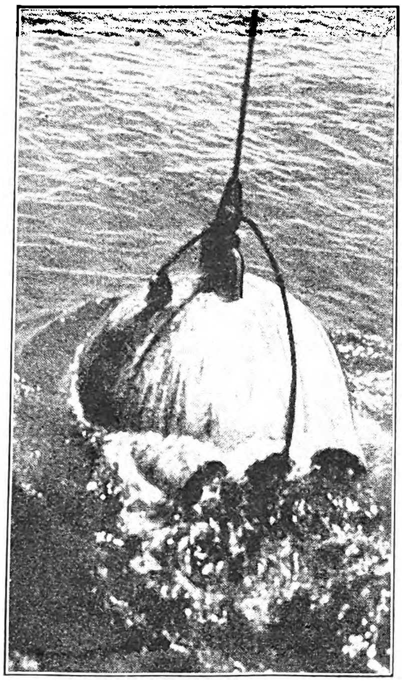
International Affairs

THE THREE POWER NAVAL PACT

PRESIDENT HOOVER won a decisive victory in the prompt and almost unanimous ratification of the naval pact by the Senate. We believe the Senate reflected the public opinion of the country in their action; nevertheless the outcome is a personal triumph for the President, and coming at the close of a Congressional session where his leadership had been several times repudiated, it must have been gratifying. We believe the President deserves all the prestige he has gained by his patient and tactful handling of this difficult problem.

At the same time we entirely understand and sympathize with the patriotic motives that inspired the small group of Senators, ably led by Hale and Johnson, who unsuccessfully opposed the ratification. There is no gainsaying the facts they brought out

(*Please turn to page* 328)



The "bathosphere" emerging from a quarter of a mile dive. Note the cannon-like eyes

A 1400-foot Dive

By OTIS BARTON

THE 13th expedition of the Department of Tropical Research of the New York Zoological Society under the direction of Dr. William Beebe has had a very successful season in Bermuda and our knowledge of undersea life has been greatly enlarged by the use of the "bathosphere," designed by the writer and Mr. J. H. J. Butler. This spherical steel diving chamber or tank is a single steel casting fabricated by a firm specializing in hydraulic machinery. The first casting weighed five tons, and proved too heavy for Dr. Beebe's winch. This casting was therefore junked and another "bathosphere" weighing 5000 pounds was substituted. It is four feet nine inches in diameter and its walls are more than an inch and a half in thickness to resist the enormous pressure that is found at great ocean depths.

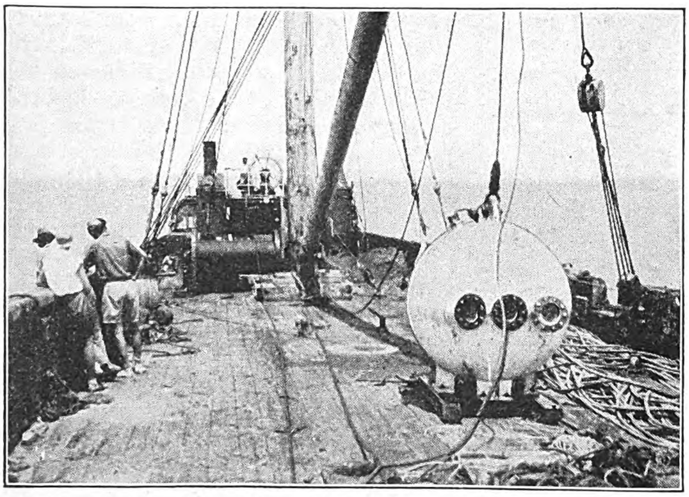
Access to the sphere is gained by a 400-pound door in the rear. It is secured with ten large bolts. In the center of the door is a wing-bolt plug which can be quickly screwed in or out. The door has a circular metal gasket which fits into a shallow groove. This joint, when packed with a little white lead, was entirely waterproof at a test submersion of 2400 feet.

THE windows in front are cylinders of fused quartz eight inches in diameter and three inches thick. They are a special product of the General Electric Company and are fitted into cannon-like projections in the front of the sphere. The joint is secured by a paper gasket and with white lead, and a light steel frame is bolted over the front of each window. In all we had five quartz windows. The first was chipped in an attempt to grind it into its seat. The second gave way under an internal pressure test of 1250 pounds to the square inch. It seems probable that the frame in front was bent and that the resulting shearing strains broke the glass. The third was broken when the frame bolts were tightened unevenly. The remaining two, however, have never leaked a drop, have withstood the pressure under test at 2400 feet, and will no doubt stand much more. We were obliged to seal the third projection with a steel plug.

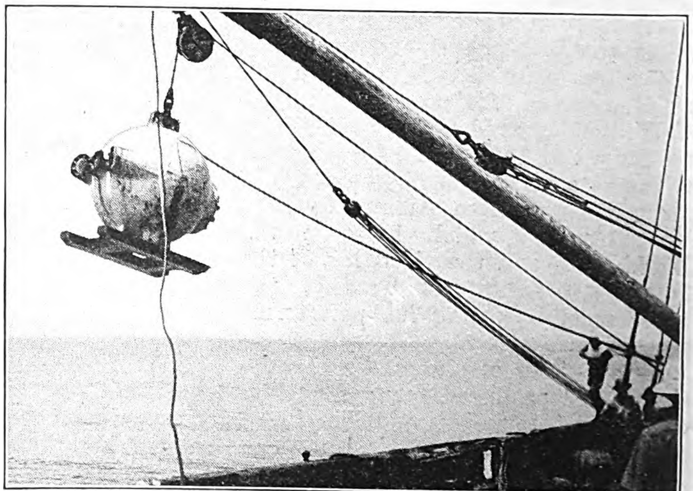
The electric cable was specially made. It is one and one tenth inches in diameter and has heavy rubber insulation. Inside are two conductors for the lights and two for the telephone. The cable passes through a stuffing box in the top of the tank and is squeezed up by two glands, one on the outside of, and the other within, the sphere. The glands proved entirely waterproof under all pressures we encountered, but the higher ocean pressures caused the electric cable to slip in through the stuffing box. It was this which turned us back at 1426 feet. Eventually we succeeded in jamming the cable with friction tape.

The two largest conductors passed to a 150-watt spot light in the right forward projection. At depths of over 700 feet the beam of light could be seen passing through the water. When more illumination was desired, it was simply necessary for the divers to direct the deck crew, by telephone, to speed up the generator. The light was turned out by the divers when they wished to observe the effects of the natural submarine illumination. To facilitate these observations the entire interior of the sphere was painted black. All observations taken in the depths were recorded by the deck crew.

THE breathing apparatus employed was designed by Dr. Alvan Barach of New York. Clamped to the wall of the sphere were two oxygen tanks, either of which would take Dr. Barach's special valve. We set this valve to allow two quarts of oxygen per minute to escape for the two divers. At this rate, one tank lasted



The "bathosphere" on the deck showing the "eyes." The winch and the steam boilers are at the left and Dr. Beebe (hatless) may be seen looking over the rail



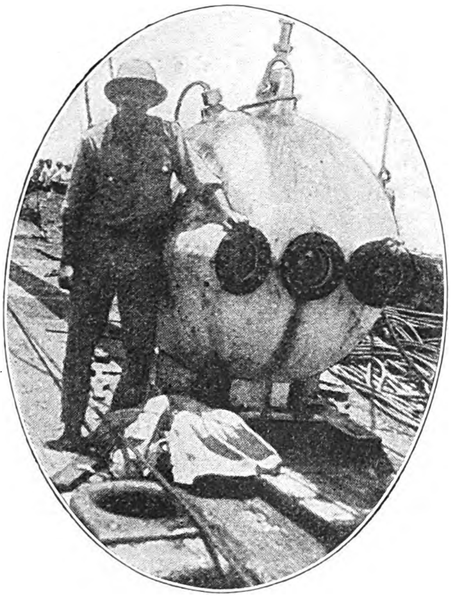
The "bathosphere" is swinging outboard for the dive. Note the skids and the electric cable which carries all the wires for the telephone and electric lights about three hours. Above each tank was a wire mesh tray. One contained soda lime, which took up the carbon dioxide. The other held calcium chloride which absorbed the moisture in the air. Palm leaf fans kept air in circulation. During our deepest dive of 1426 feet we were comfortable and cool, although we were inside more than an hour and a half. The physiological balance was excellent, although after a long dive there was a slight excess of pressure. This we noticed on our ears when the central plug was unscrewed upon reaching the surface.

We always entered the sphere head first, wriggling our way through the narrow manhole. There were no cushions on the floor, for these might hide some of our small implements or obscure leaking drops of water. Our bodies, however, fitted comfortably against the rounded steel walls. The door was put in place with a small hoist. The pounding down of the ten bolts and central ring bolt plug created a fearful racket in the interior. The jarring, however, never seemed to affect the quartz windows.

THE "take-off" always felt smooth, like that of a dirigible. In the air the "bathosphere" swung like a hammock. At times we almost began to feel seasick. Once in the water, however, all was well. We were steady and cool and only knew when we were being lowered by the jerking of the steel cable.

For lowering the ball, we used Dr. Beebe's five-ton winch and special large reel. To operate these, we installed two boilers on the after part of the long deck of our 130-foot lighter, which had once been H. M. S. *Ready*. The lighter was in turn towed by the tug *Gladisfen*, of the New York Zoological Society. This equipment was used on the Arcturus expedition, as were also the three six-ton sheaves. One of these was bolted to the deck about 60 feet in front of the reel, which was amidships. From this the cable returned to the second block close to the mainmast and then passed to the third at the end of the heavy boom.

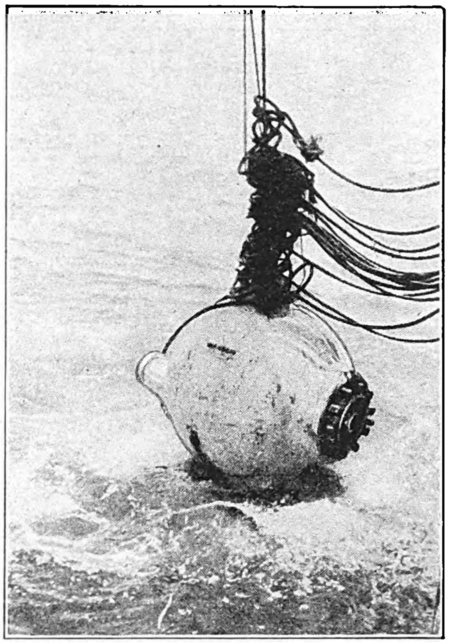
The cable was a special seven-eights-inch steel-center non-spinning type, 3500 feet long, capable of sustaining 29 tons. The amount of cable paid out was tallied by a special meter wheel from the *Arcturus*, as well as by a system of ribbons tied around the cable.



Two of the three windows are closed by heavy three-inch quartz plates

The comparatively light electric cable was let out by hand, and attached at intervals of not more than 200 feet to the steel one. This was done at first with brass clamps, but later it was found better to tie the cables together with lengths of rope about a yard in length, since these took up much of the twisting. The winch was stopped while the tie was made.

Several problems were naturally encountered in these operations. Perhaps the greatest trouble was caused by the twisting of the rubber hose about the steel cable. When twisting was bad we would tie up loops every 200 feet in a loose coil, through the center of which the steel cable continued to operate. Finally, however, we succeeded in getting out as much as 2000 feet without twisting.

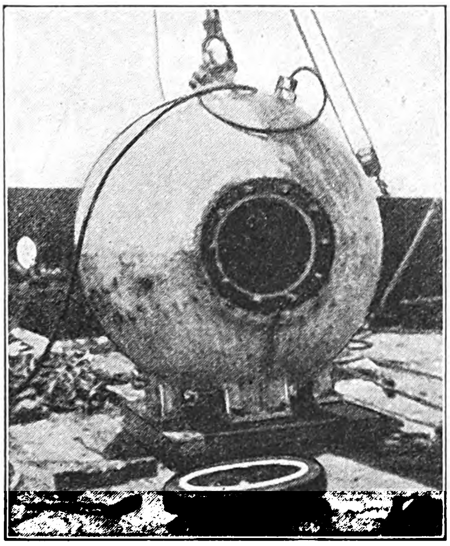


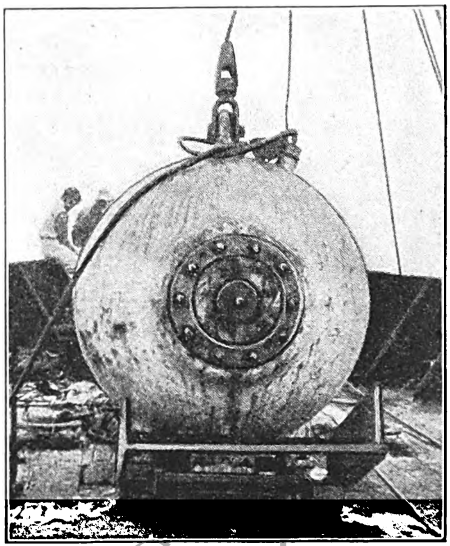
Tangle of steel and electric cables on the first test dive of 2000 feet

Besides taking observations at great depths in the open ocean, we tried towing the tank along under the vessel, endeavoring to keep the bottom in sight and not to run into any ledges, which rise up quite suddenly in these waters. In this work we nailed a wooden rudder on the rear end of each skid, by which the windows were kept always to the front in the direction of motion. A brace of fish hooks was also attached on a frame outside the window. These proved very sensitive indicators of the currents.

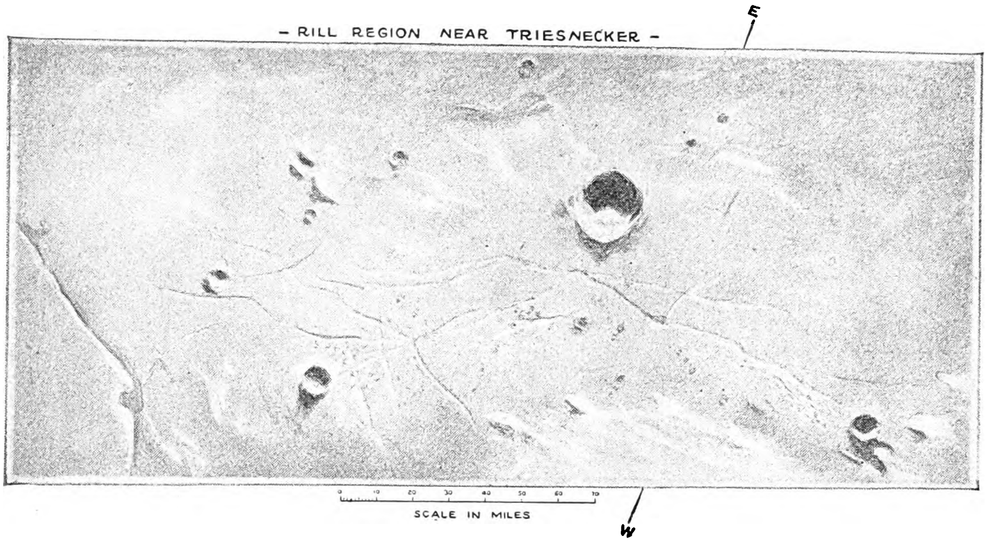
It is with this outfit that we hope next season to study the contours of the bottom down to 500 feet and also to make dives in the open ocean of 2000 feet. The margin of safety seems entirely satisfactory.

Besides the use of the "bathosphere," intensive trawling with meter nets was done, as well as some bottom dredging with the aid of the five-ton *Arcturus* winch. One of the chief objects of the expedition is to determine the continuity of fish life which connects the mid-water zone of one hundred fathoms with that of the ocean's floor two miles down. The expedition has been rendered possible by the generosity of two members of the Society's board, Mr. Harrison Williams and Mr. Mortimer L. Schiff.





After the divers enter the sphere and the four-hundred-pound door is fastened with ten bolts, they are ready to start for "Davy Jones's Locker"



Rill region near the lunar crater called Triesnecker. The drawing extends across about one eighth of the moon's diameter. Lunar "rills" are deep, narrow, crooked depressions, resembling valleys

Moonscapes

A Letter from RUSSELL W. PORTER

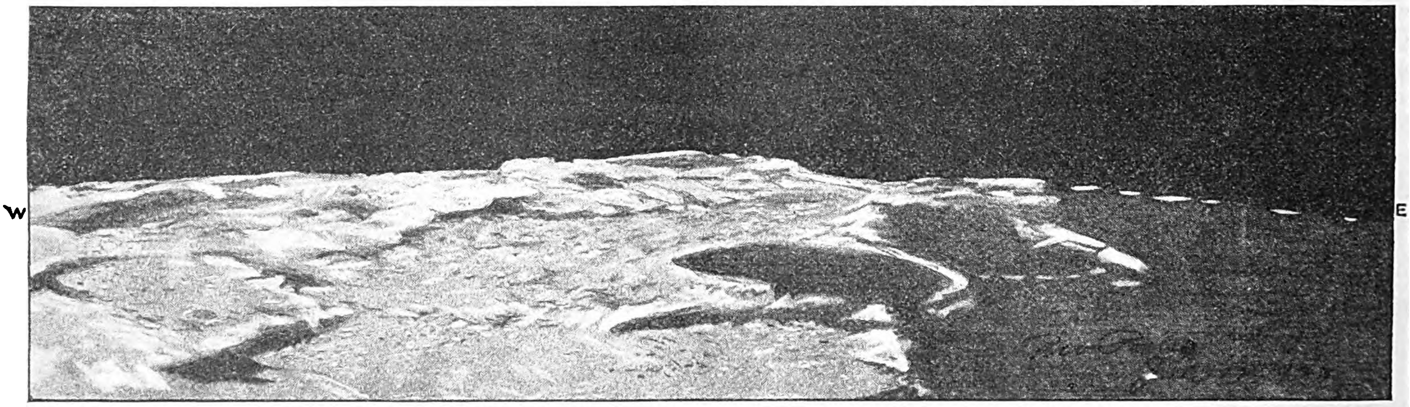
Optical Associate, Jones and Lamson Machine Company; Associate in Optics and Instrument Design, California Institute of Technology; Contributing Editor

ONE of my red letter days came at Mount Wilson when it was suggested by the astronomers that I try my hand at drawing details of the moon's surface—details which are too small to be recorded on photographs. Previous work of this kind, done some years before, together with a facility in using a pencil, made it seem likely that, provided the seeing was good, I would be able to transfer to paper certain lunar objects or markings which would be of value and serve as a kind of standard of seeing.

Unfortunately, the nights allocated to me turned out to be accompanied by relatively poor seeing—from 1 to 3 on the familiar Harvard scale of 10. Therefore these three moonscapes have no particular scientific value, but fall into the category of interesting sketches. Nevertheless, the thrill I got at the eyepiece of the 60-inch telescope during the few hours available will live with me for many a day.

The instrument itself, which I first sketched by daylight [see page 248—*Ed.*], is one of the largest of reflectors, and is greatly beloved by the astronomers. To me, as I sketched the monster taking his afternoon nap, bathed in the dim light that filtered through the shutters of the observatory dome, it seemed to possess a certain sort of personified austerity. If the term "noble" can be ascribed to an inanimate object, I would clothe the wholesome design of the 60-inch reflector with the attribute of nobility.

The moon's image was formed at the Cassegrainian focus near the lower end of the telescope tube, and that night was viewed through a low-powered eyepiece. With the help of the mechanician, Mr. Jones, and the night assistant, Mr. Krisler, my drawing board was fastened with clamps and brackets to the right of and near to the eyepiece, and after many trials was adjusted in such a position that it gave the maximum of comfort and convenience for drawing with my right hand while constantly shifting the eye from the eyepiece to the drawing. A

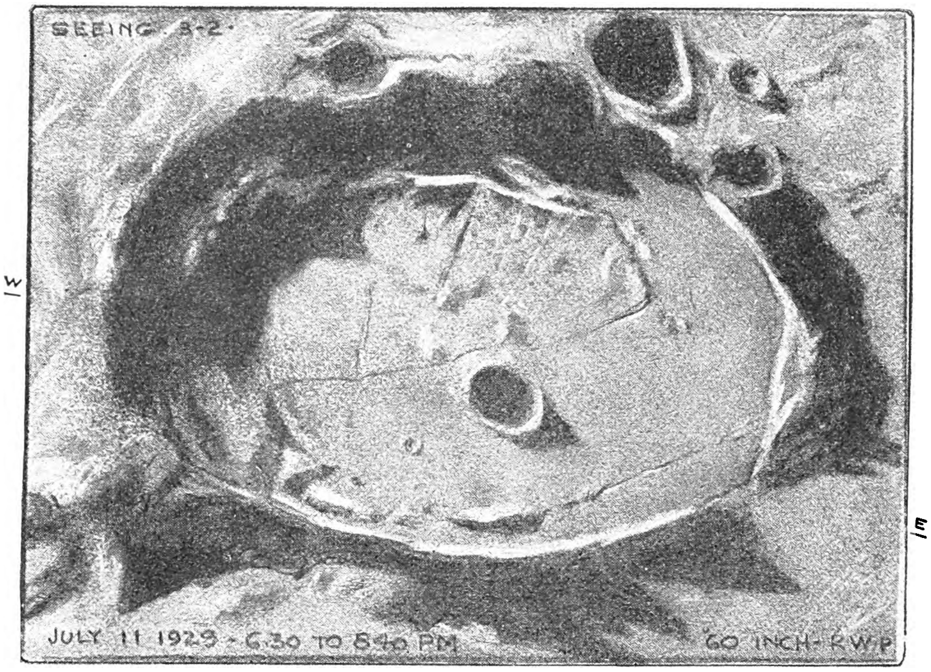


Region around the moon's north pole, showing the craters of Meton and Euctemon. All of the moon's craters are named and thousands of astronomers, professional and amateur, carry the moon's map as vividly in mind as the map of their own city or state. For many years these "selenographers" have concentrated regularly on systematic programs of observation of certain craters and some, notably Professor W. H. Pickering of Jamaica, believe there are small regular changes due not alone to the gradual shifting of lights and shadows. If these changes are objective their cause and nature are unknown.

The moon's temperature range recently has been worked out experimentally by the astronomers Pettit and Nicholson of Mount Wilson Observatory. They state that "the temperature rises from that of liquid air at sunrise to the boiling point of water at noon; returns as the sun becomes lower in the lunar sky, and hovers near that of liquid air during the next fortnight"—that is, during the long lunar night. Even in the lunar day the temperature of the craters shown above is only about 60 below the Fahrenheit zero, because these craters lie where the sun's rays barely graze them; that is, near the moon's limb

lamp bulb clamped to the board, and shielded from the eye, illuminated the paper in such a way as to approximate in intensity the brightness of the image of the moon itself. The drawing paper used was prepared beforehand by rubbing upon it the powdered dust of a soft pencil lead, until an even gray tone covered its surface. Areas darker than this medium tone were then filled in at the eyepiece, while the brighter areas were picked out with an eraser.

The first attempt was made when the moon was in the last quarter. The telescope was in use by others until 2 A.M. and the drawing was actually commenced about 3 o'clock. After exploring the moon's surface along the terminator, where the shadows model the lunar features to best advantage, I picked out an area near the crater Triesnecker, traversed by a network of cracks known as "rills."



The crater of Posidonius. Several smaller craters appear near the crater's rim and a system of cracks covers the floor. Note shadow of peak, near center

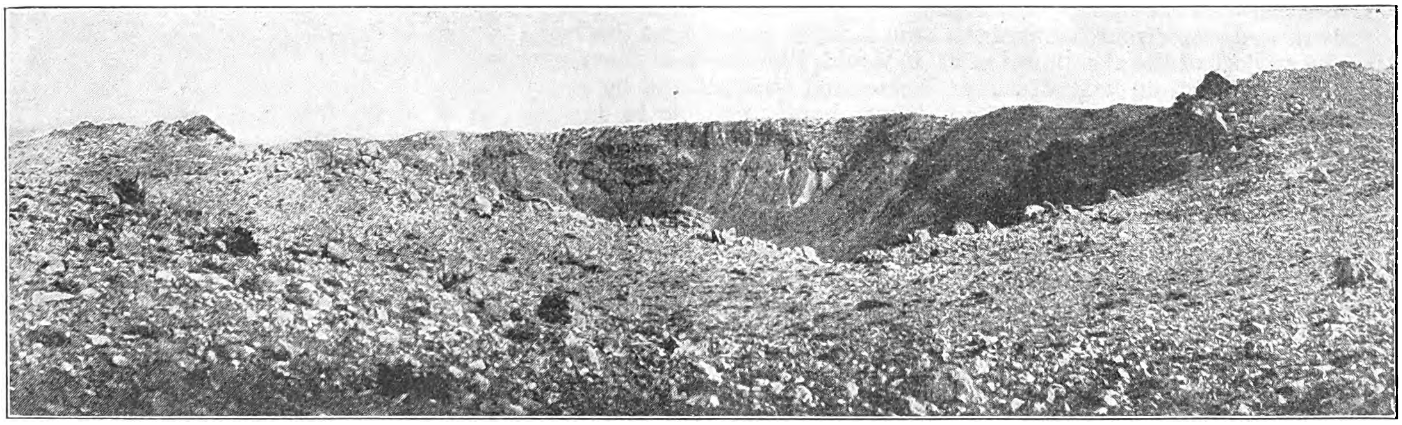
MY time was all too short, for daylight put a stop to the sketching at 5 o'clock. But in moments of better seeing there came fugitive glimpses of minute detail almost too elusive to catch and record. Thousands of tiny craterlets appeared, quite generally distributed over the plains, down the crater slopes and filling the bottoms of the rills. They could not have been far from the order of a few hundred feet in magnitude. These craterlets seem to be typical of the moon's surface.

The other two drawings were made when the moon was in the first quarter. The seeing conditions here were no better than before, although intervals of steady air revealed the great wealth of fine detail so rarely to be caught. Some time I hope to have the privilege of pursuing them further under better conditions, and finally capturing them.

I have been fortunate—or unfortunate—enough to have spent several years in the north polar regions, within a few hundred miles of the pole. These recent nights with the moon vividly recalled the trackless wastes of arctic snow and ice, because of the similarity of the desolate and dead moonscape to our arctic regions.

Through the eyepiece of the 60-inch telescope the moon seems very near, somewhat as though looking down upon it from an airplane. Recently I have seen the moving pictures of the south polar regions, brought back by Admiral Byrd's Antarctic Expedition, and here again the likeness to parts of the moon's surface was recalled. I refer more particularly to those lunar features called "seas," immense undulating plains, slightly crumpled, with here and there apparent cracks running at random—all under dazzling sunlight.

Not long after my final night with the moon I drove through the monotonous deserts of Arizona. A feature lying some seven miles off the trail to the south caught my eye and the car was brought to an abrupt stop. There, for all the world, was a "moon crater," transported to our own earth. Within an hour we were on its rim, looking down into that hole nearly a mile wide and some 500 feet deep. It was the famed Meteor Crater, its origin attributed by astronomers to impact from some celestial wanderer. While I do not advocate the impact theory of lunar craters, a startling likeness to them became apparent when I first saw the profile of Meteor Crater looming out of the desert haze.



Meteor Crater, Arizona, which resembles some of the lunar craters. Professor Henry Norris Russell says: "The evidence appears very strong that this crater has been produced within modern times, geologically speaking, by the impact of a great mass of meteoric material . . ." (Russell, Dugan and Stewart's Astronomy). This also is the point of view of virtually all men of science. On the other hand the majority of astronomers lean, tentatively, toward the volcanic theory of the lunar craters, while a minority hold the meteoric bombardment theory. There is much to be said on both sides. The argument is summarized by Professor Charles P. Olivier in his work entitled "Meteors." He points out that the strongest argument for the meteoric hypothesis of lunar craters is the great difficulties which confront the volcanic hypothesis. The fact that many of the craters overlap, strongly suggests their meteoric origin. On the other hand, the distribution of the craters ought to be fairly uniform if they are of meteoric origin, and it is not uniform. Acres of ink have been spilled in astronomical journals but the question still may be considered wide open. A committee of astronomers and geologists is studing it

same, but, knowing that the seniors have at one time been juniors, I very much doubt whether the seniors are deceived. But it just has to be done. After the inspection is over, the dirt is put back where it belongs and if you look closely, you will find it. It can not be thrown overboard and on an inspection morning the incinerator just can not burn it all.

It seems that I have had the job of keeping a ship clean for a long time; even before that I had some part of it to look after. I have had battleships for over four years and I know the job fairly well—just fairly well at that.

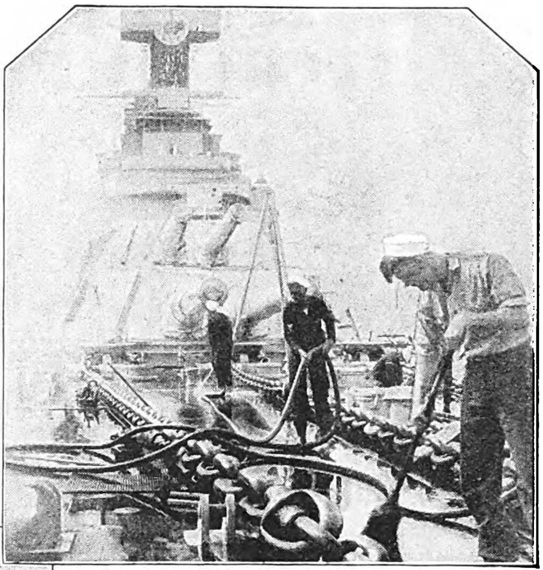
A few months ago a woman from the middle west came up to me and asked how a ship could be kept so clean. I felt inclined to talk to her and tell her something about it. Usually I duck out of this if I can, but she explained that she was from an inland state where such a thing as a ship had never been and wanted me to tell her how it was done. After I had talked with her for awhile, she became enthused; she thought I should write it up for others to read. It seems a very dull thing to write about—especially after having just published an article about battleships and not one word about dirt.

BATTLESHIPS do get dirty! They have to be gone over most thoroughly each week from stem to stern and from keel to truck. Beside this, many men are engaged in cleaning up very nearly all the time. In a way a ship reminds me of a baby. You clean and polish him up most thoroughly and you dress him up in spotless linens and then you put him down on the floor. If it so happens that you burn coal and have a scuttle full in the house anywhere, that is where you will find him all smudged up with coal. When you get your ship all dolled up, if you happen to be a coal burner, you will then coal ship. If you happen to burn oil it may be lots worse; you may get a cloud of oil half way up the boat deck when a line carries away.

When coming in from a long sea trip, the gangways are cleaned before going over the side

Then we always have the recruit. You watch him. As he walks along the deck he exudes dirt. First he surreptitiously drops a cigarette butt on deck against a stanchion; 10 feet farther on he drops a candy wrapper; after a few moments he shakes out his pockets. After this he starts in to collect more odds and ends which he tries to distribute about the decks with impartiality. He doesn't mean any harm.

One man is chipping a bit of rusty paint-work when one of the aviators turns on the engine of a 200 horsepower motor—the "prop" does the rest. The rust goes far and wide while the ever-moving feet of hundreds of men pick it up and mix it with grease from half a hundred different places while the finely ground dust from the hardwood decks swirls about and collects on the paint work, mixed with the sulfur-soot that comes out from the stacks in clouds when the tubes in the great oil-burning boilers are blown.



The anchor, coming up from Davy Jones' locker, brings up mud from the bottom. The anchor and its chain must be scrubbed clean

The human element is comparable with the mechanical. One of the greatest causes of troublesome dirt is the endless preparation and serving of food. Again the recruit, of whom a large percent of the crew is composed, drops his food far and wide. After a meal, the decks look as if they had never been cleaned up. But as the sailor makes the dirt, he also has to clean it up, so for an hour after meals you see him cleaning up. The dirt he picks up is dumped in the slop box if at anchor, or overboard through the slop chute if under weigh.

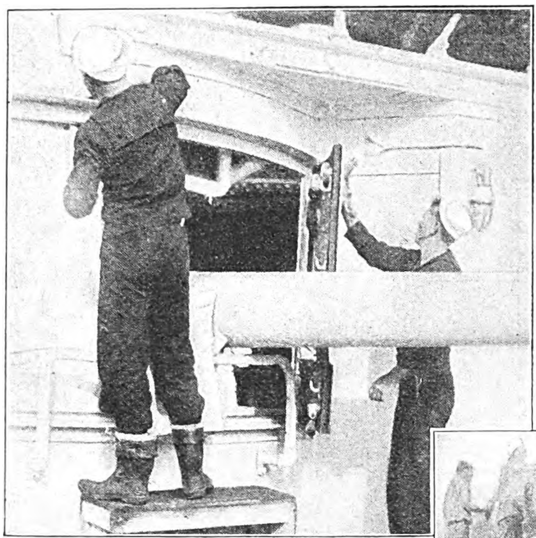
It is a curious thing, but the slop box has a name all out of keeping with its real contents. It is called the "honey box"! It holds around 1600 pounds and is filled, much more than filled, each day. It is no small matter to get rid of the refuse in the honey box of a large ship. A great many times it has to be loaded on one of the work-boats and carried out to sea and dumped, otherwise bathing beaches might suffer if located in the near vicinity, not to mention the breaking of harbor regulations that prohibit throwing refuse overboard.

It is an art to keep the vicinity of the honey box clean; I never have for any length of time. Five minutes after everything has been cleaned up, along comes more slop, and there you are.

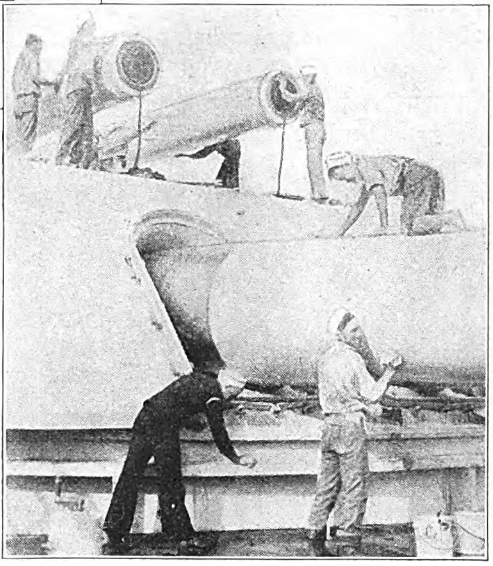
A BATTLESHIP—any ship—uses much food. Each month we take on about 100 tons on a certain day that is set aside for that purpose. A list of these stores reads like an inventory of a wholesale grocer's combined with a meat packing plant. Each and every box, crate, bag, or frozen piece of meat that comes on board brings its full quota of dirt.

We usually finish taking on stores by noon; then, if my friend from that inland state could see us, she would hastily depart and her report to the folk back home would do us very little good. However, we do not take visitors on board during that time, except in rare and urgent cases.

When the ship is got under weigh, the huge links of the chain leave the bottom where they are deeply imbedded in mud and bring some of it up with them, as do the great 10-ton anchors. The chain is washed off with fire hose under pressure, but, mud gets in just the same. I handle the anchors and when I leave the fo'c'sle, it is usually a messy, muddy place: mud, dirty water, and torn up paint work. The boys then go to work and clean it all up again. We average around a



Target practice with the big guns means another cleaning job—and a big one at that. Here sailors are seen scrubbing muzzles, barrels, and turrets of guns after firing



hundred of these evolutions each year.

We go out on the target range and after much practice, the actual firing takes place. After firing half a dozen salvos from a battery of eight 16-inch rifles, the ship is all dirty again—and this time she *is* dirty. Not only that, but everything breakable is broken from the concussion, which now brings us around to the seemingly everlasting task of cleaning up once more.

It is said that there is never a time when someone is not painting something on board a battleship. I think this is so on any ship. It is painted and very soon it is scrubbed off—and then painted again. Thus the battle against dirt goes on day after day.

Someone is always busy painting somewhere aboard a battleship

The ship is so large that one man, even in a supervisory capacity, could do very little with it, so the ship is divided into many parts and even these parts are again sub-divided among the men who belong to that part of the ship. Each man then has a very definite part to play in the morning watch when the decks are wet down and the scrubbing begins. Some are detailed to scrub the decks, some scrub paintwork, while still others scrub canvas and look after boats and the endless pieces of gear that go to make a big ship comfortable as well as efficient. Someone is detailed to look after everything.

The amount of soap, soap powder, scrubbers, polish, and other equipment that I serve out on a certain day each week looks like the beginning of hostilities on cleaning gear. I have a weekly issue of cleaning gear, a monthly issue, and also a quarterly issue. One can easily see that soap would be issued weekly; scrubbers and such, monthly; while some items like scrubber handles and scrapers would last for the quarter. However, there is an endless demand for all sorts of gear, no matter how much is served out. It is very little trouble to keep the ship looking pretty and nice if you can get enough cleaning gear and paint.

One issue of cleaning gear is made on Thursday. This is for general cleaning and is made on that day because the following day is Friday which with us is "Field Day"; that means that insofar as possible the day is given over to cleaning and tidying up the ship for captain's inspection, which comes on Saturday forenoon.

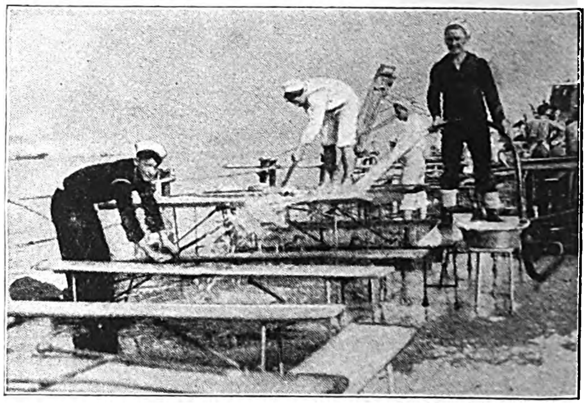
On that day the boys are given 450 pounds of soap; 144 boxes of soap powder; 100 cans of metal polish; 200 sheets of emery cloth; 100 pounds of rags, and a like amount of cotton waste; 50 pounds of air-slaked lime; and one ton of sand! At six o'clock the next morning the boys turn to and spend the entire morning and part of the afternoon in the rather pleasant task of cleaning ship. We still use the holystone on the decks, but I do not believe the boys like that any too well.

There are a good many things about cleaning a ship and keeping it clean without ruining other things as you go along. For example, if you scrub canvas or expensive fire hose while there is sand on the deck, the fabric will very soon be cut to pieces, yet it requires constant supervision to prevent this. One man will be painting aloft; almost invariably if not cautioned, he will spill much of it on the decks below. All of this has to be painfully scraped off. Every spot on the deck—and in the course of a week there are thousands—has to be removed. Lime is used to paint grease spots with good effect, but to complete the job the deck has to be gone over with sand and a holystone.

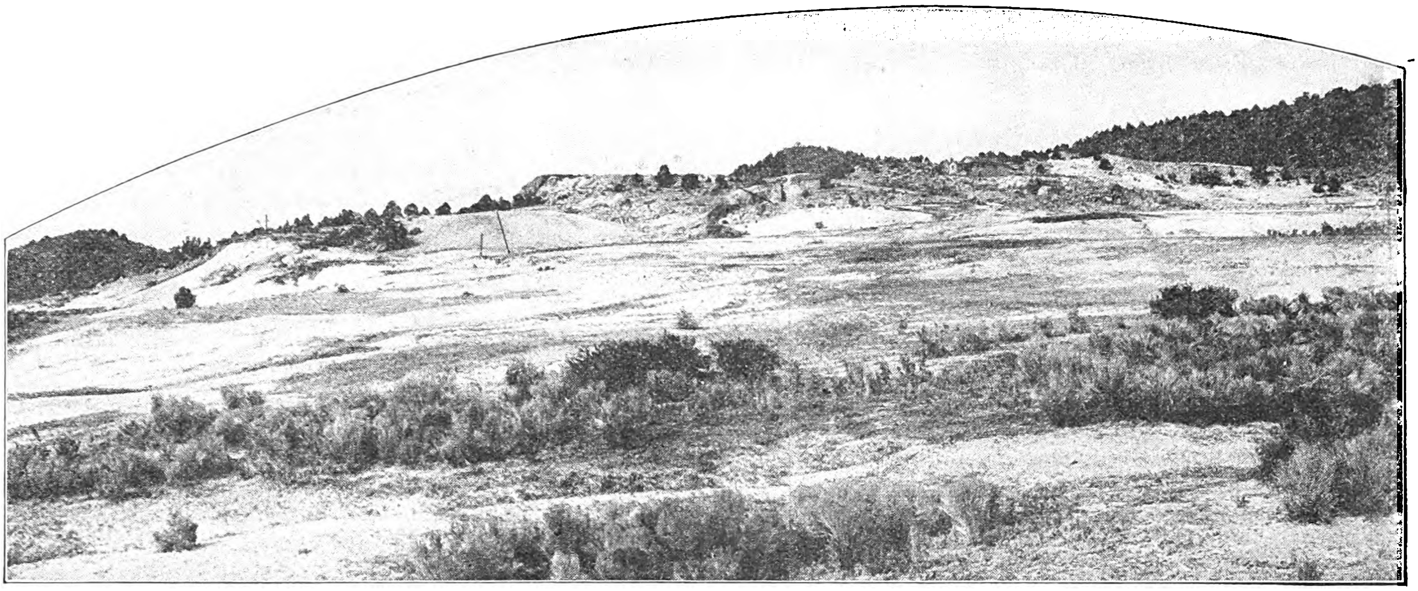
The modern appliances are great inventions, yet each one adds just so much dirt to a ship. The airplane, for example, one would say, surely could bring no dirt! But such is not the case. It is one of the worst offenders. It spatters oil and grease far and wide. Then, due to the fact that to operate the catapults all the stanchions have to come down, much paint work is torn up. This brings not only paint chippings but rust as well.

The ships' boats looking so trim and neat that you see running between the ship and the shore: surely they can bring no dirt. Once again you are wrong, for when I hoist them in—and that is another job I have—they just drip crude oil. After they are hoisted in, kerosene is used by the bucketful to wipe off the sides. Later, the small barnacles are scraped off and some of this is tracked to all parts of the ship.

ON Saturday morning after inspection, usually the ship is open to visitors and they come by the score from every state in the union. The ship is found to be so clean that one is led to believe that it just came that way—probably out of a band-box. Now when I go home—but I guess I'd better not tell anything about that.



Mess benches and tables are brought upon deck, scrubbed, and rinsed with salt water

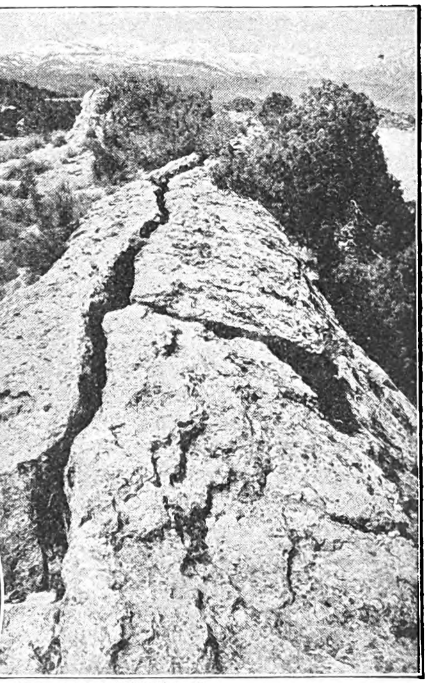


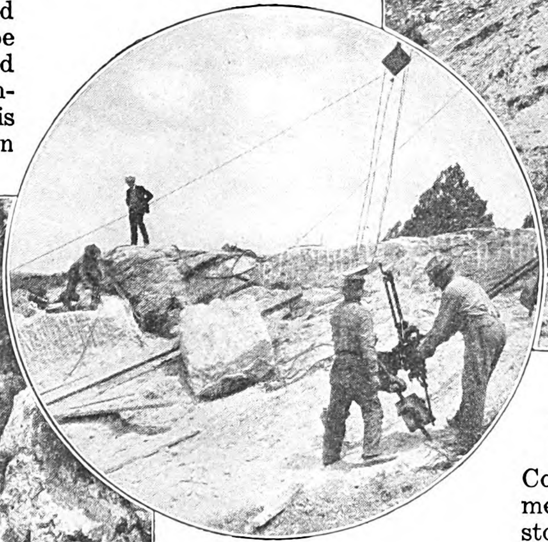
A great hill of travertine formed by the flow of hot mineral water

Stone From Hot Mineral Springs

ONE of the oldest building stones with which we are acquainted is travertine. The name is derived from Tivoli, near Rome, where much of Rome's building stone was obtained. Many of the well-known buildings of antiquity were built of travertine faced with marble. Its employment largely depended upon its softness and excellent wearing qualities. Travertine is found as a deposit of calcium carbonate from hot springs, although there is also a silicous type. The cavities which add so much to the beauty of the stone are partly due to the decay of mosses and other vegetable matter.

In 1854 miners prospecting for gold in Mono County, California, found a deposit of stone they called "moss agate" and later it was called marble. It was afterward found to be travertine and the earthquake and fire in San Francisco in 1906 demonstrated the sterling qualities of this building material. The deposit in Mono County is being developed by the California Red Travertine Company of Los Angeles. Modern methods of quarrying are used. The stone when first taken out saws freely and takes a high polish. Some of the stone varies from clear white to gray, cream, and pale yellow. In other sections where the ascending waters have passed through a deposit of metallic oxides, the stone is handsomely banded with other colors. The red travertine is especially beautiful. The designs are largely dependent on the lichens which have grown up along the borders of spring pools and which have been replaced by stone in the course of time.





Photos courtesy Californians, Inc.

Upper Right: The water from hot springs has caused a great crack in one of the ridges of travertine in Mono County, California. *Circle:* Some ivory-toned stone of the Roman type being quarried. *Left:* A travertine deposit from which much stone has already been cut. Waters of the hot mineral springs still bubble through crevices. The color of travertine varies from white to very dark red

Can We Signal to the Planets?

By JOHN THOMSON, M.A., B.Sc., Ph.D.
Lecturer in Physics in the University of Reading, England

FROM time to time during the last 50 years suggestions have been made for sending a message to a neighboring planet. In general these suggestions have been scientifically worthless, but for all that the possibility merits consideration. At the lowest estimate a general airing of the question seems to be required, while an accurate statement of the problem and its difficulties is the first step towards any attack which may be made upon it.

The question divides itself naturally into three parts. First, can we send a signal through space so that it may be detected on a companion world? Second, in the event of our being able to do so, is there any possibility of the signal being received and understood? Third, having regard to our answers to the previous questions, what signal would we send?

Courtesy American Museum of Natural History

Mars as seen from its outer satellite Deimos. A painting by the astronomical artist Howard Russell Butler. Based on composite evidence.

TO illustrate the difficulties involved, let us consider the possibility of utilizing some form of televisor. In the May "Discovery," (London) mention was made of this means of signaling, and the conclusion rightly reached was that "the prospects of finding planetary neighbors equipped with the necessary apparatus are remote." The complete televisor consists of a transmitter and receiver. The signal propagated through space is, of course, an electro-magnetic disturbance, but this disturbance is obtained at the transmitter from light signals by a series of ingenious energy transformations. Similarly, the receiver, working on the same wavelength, must be able to transform back the electro-magnetic impulse into light signals. Such a process is very complicated and presupposes a vast amount of technical apparatus. But, as will be shown later, in communicating with another planet it is not permissable to assume the existence of any equipment similar to that which we use. The best we can hope for is that our planetary neighbors are aware of the existence of the electro-magnetic spectrum and possess some means of detecting electro-magnetic impulses.

There is another objection to visual signaling, of an even more fundamental nature. It is probable that the possible inhabitants of another planet react in some way to light signals; this appears to be a necessity for intelligent life. To suppose, however, that this reaction corresponds to our own visual sensations is pure speculation. Assuming that a television receiver existed on the planet under consideration, the picture formed on the screen would in all probability convey nothing to the inhabitants. Hence a scientific approach to the problem demands a form of signal much simpler and more fundamental.

Since we are attempting to communicate from the earth to another planet, and between them no material medium exists, it is at once evident that we must utilize as our signal some form of radiation which is transmitted by a vacuum. This is practically equivalent to saying that we must use some part of the electro-magnetic spectrum. But even a casual examination of the problem is sufficient to indicate that our choice of such radiation is extremely limited.

The mere fact that the solid earth is surrounded by an atmosphere capable of absorbing all radiation to a greater or lesser degree makes our choice a difficult one, while the problem of producing radiation of intensity sufficient to be detected some millions of miles away so far adds to this difficulty that we shall be fortunate to find any type of signal suitable for our purpose. Atmospheric absorption immediately rules out of consideration radiation of short wavelength, since X rays and ultra-violet rays are strongly absorbed by gases. Light and heat radiation do not suffer in this way, but these, as we shall see, are useless for a very different reason. Hertzian waves have been carefully studied in recent years so far as their propagation around the earth is concerned, and it is to such radiation that we must look most hopefully.

FIGURE 1 indicates the relative positions of the earth, Venus, Mars, and the sun when conditions would apparently be most favorable for communication between the three planets. The figure corresponds to what is known as an "opposition" of Mars and an "inferior conjunction" of Venus. It is at such an epoch that these two planets are nearest to the earth. Mars is then on the meridian approximately at midnight, while Venus is (along with the sun) on the meridian at midday. It is instructive to notice that under these conditions the appearance of Venus from the earth is similar to the appearance of the earth from Mars, while the appearance of Mars from the earth is similar to the appearance of the earth from Venus. It is useful to realize the point of view of the possible recipients of our signal.

Now we can not hope in signaling to compete with the sun. If the sun is sending out radiation similar to the one we might choose, then our signal will go undetected. A consideration of Figure 1 will make this perfectly clear. But the sun is continually radiating light and heat, and therefore these signals, as has been stated, may be left out of consideration.

It is obvious then that our attention must be limited to a consideration of Hertzian waves, the type of radiation propagated from a broadcasting station. At the very outset, however, we meet with a serious difficulty. Various writers on wireless communication have described it as "signaling through space," and so far as space is interplanetary, this is just what a broadcasting station does not do. One of the chief reasons why Hertzian waves have become an important means of communication over long distances is that the transmitted signals are confined to a comparatively narrow layer of space in the immediate vicinity of the earth. The signals broadcast do not spread out in all directions; they travel around the earth, practically never rising beyond the limits of the atmosphere.

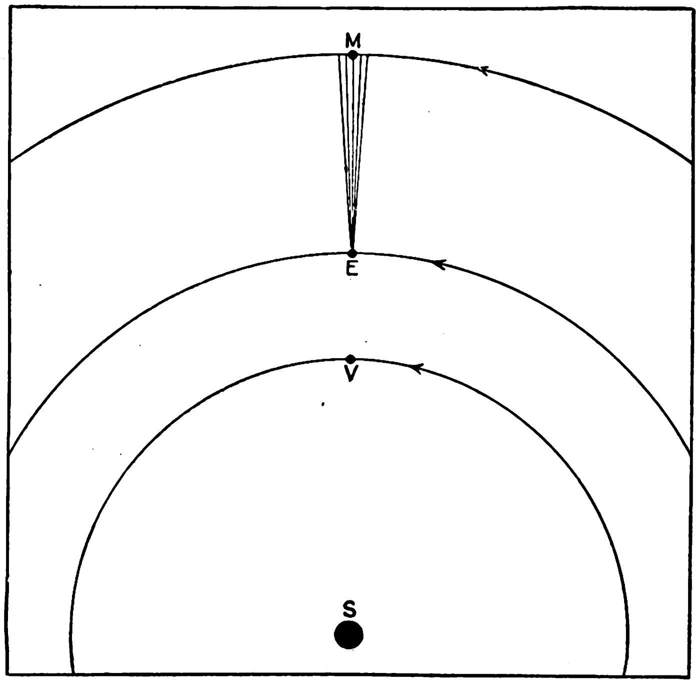


Figure 1: **Optimum conditions for interplanetary signaling between Mars (M), the earth (E), and Venus (V), when all three approach nearest together**

FIGURE 2 gives a rough representation of the path of a "wireless" ray from a radio transmitter T. The ray may move upward toward a layer of ionized gas known as the "Heaviside layer," but there it is bent downward again toward the earth. A straight beam from the transmitter parallel to the horizon is indicated by the dotted line. It will be seen that the latter could not possibly be detected at any distance from the station, as it would be lost in the upper atmosphere.

This bending of Hertzian waves due to refraction (or possibly in some cases to reflection) is of inestimable value in wireless signaling, and accounts for the remarkably long distances traversed by waves over the surface of the earth, but from the point of view of interplanetary communication the Heaviside layer is an unmitigated nuisance, cutting us off, as it does, from outer space. All Hertzian waves are not, however, equally affected in this way, the bending of the ray varying considerably with its wavelength, and hence it may be possible to find some band of waves which may escape to outer space. Recent experiments appear to suggest that short waves are less bent than long waves, and this is in agreement with the most important theory of the effect. It is probably impossible to produce Hertzian radiation which will traverse the atmosphere in an even approximately straight line, but if the wavelength is sufficiently short, there is a reasonable expectation that the deviation of the ray will be comparatively unimportant. Such radiation has a wavelength of less than ten meters.

Attacking the problem from another point of view, an alternative solution is indicated. Theoretically the use of waves of length greater than 10,000 meters should also obviate absorption and refraction in a layer of ionized gas.

Two possible bands of radiation would therefore appear to be suitable for the penetration of the earth's atmosphere, and we have now to determine which band is more suitable for our purpose in other ways. The question of the intensity of the signal decides, as we shall see, in favor of the short waves. Incidentally, it is useful to note, before we leave this part of the subject, that any radiation which can penetrate our atmosphere will be suitable to penetrate the atmosphere of the receiving planet.

We have said that it is preferable to use a radiation of short wavelength. This arises from the fact that in any attempt to signal over a distance of millions of miles some form of beam is necessary, since, if the radiation were distributed uniformly in all directions a negligible fraction would reach the planet. Now the concentration of Hertzian waves in the form of a beam necessitates the use of a reasonably short wavelength in order that the focusing may be efficient. Hence this is sufficient to decide between the rival claims put forward above.

Having decided on the type of radiation to be used, all that remains is to ask whether a signal of intensity sufficient to be detected can be sent. The answer to this question must necessarily be speculative, for, in the first place, we are not acquainted with any receiving apparatus which the other planet may possess. The signal emitted by our transmitter will suffer attenuation because of two factors. First, the spreading of the beam will decrease its energy per unit area. Secondly, the atmosphere of the earth and the other planet will be the cause of a certain amount of absorption. The spreading of the beam is an unfortunate necessity. By modern methods the pencil of rays could be made very fine indeed, and spreading (except that due to dispersion) could be avoided. But our aim at the planet can not but be very rough, and hence a very fine beam would be almost sure to be lost in space. In Figure 1 a pencil of rays is drawn from the earth to Mars. The pencil shown diverges much more than would be necessary, but in any case its cross-sectional area on arriving at the orbit of the outer planet would require to be at least 1,000,000,000 square miles, in order that there should be a reasonable probability of the planet coming within it.

THE sending of a very powerful short-wave signal is not, however, a very serious matter. Even assuming that the requisite intensity could not be obtained at our present stage of development, the problem is merely one of technique. The wireless engineers are quite capable of producing as intense a beam as we may require when the need for it should arise. The directing of the beam, making allowance for refraction in the upper atmosphere, would be much more difficult.

Assuming then that we are able to send a signal, what can be said of the probability of its being received? Many writers have discussed the possibility of there being intelligent life on other planets, but it must be borne in mind that the whole subject is purely speculative. It does not follow, however, that our speculations are irrational or idle. The modern physicist deals largely and with great success in probabilities.

From a philosophic standpoint it appears improbable that the earth is the only planet in the solar system which is the abode of intelligent life. Apart from all biological considerations, this makes an appeal to our philosophic instincts; anything else would savour of (Ptolemaic) egoism. Moreover, it is utterly impossible to argue that the other planets are unsuited for intelligent life, as has been done so often. Such an argument is founded on the assumption that protoplasm is an ultimate essential of life, while there is nothing to show that it is not the essential of life modified by terrestrial conditions. Even assuming that Martian or Venusian protoplasm would be identical with the terrestrial substance, there is still no sufficient evidence to state that life is impossible on these planets, and, where life is possible, intelligent life is probable.

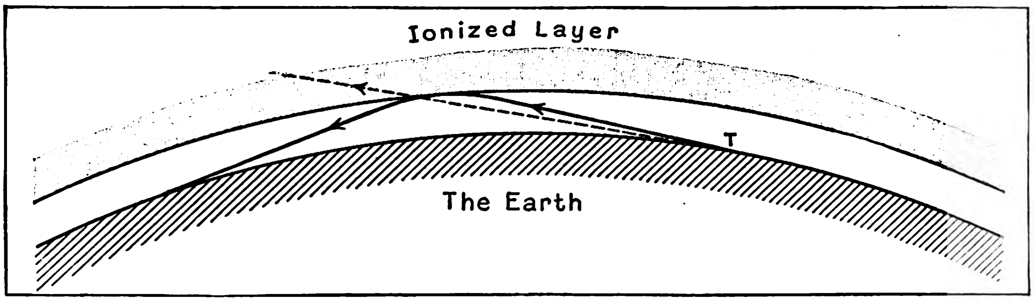


***Figure 2:* The solid line indicates the path of a reflected radio wave from a transmitter located at T. A beam parallel to the horizon is shown by the dotted line**

A more important and less speculative question is whether the intelligent life on another planet would be able to detect and understand the significance of a Hertzian wave signal. We must not transfer our own form of intelligence to Mars or Venus, and assume that natural science has been "studied" by intelligences there. We must remember that intelligent beings existed on the earth for some considerable time before any violent interest was taken by them in the phenomena of nature. However, if we assume on the part of these other beings a speculative and experimental interest in the material universe, then we may legitimately hope for some means of detection of short Hertzian waves.

After all, the mechanism of the universe is not terrestrial, and whatever we may think of our conception of Hertzian waves, the waves themselves are common to all space. The reactions of intelligent life on Venus or Mars to material things must necessarily be different from ours, but the reactions must exist, and they will be reactions to phenomena similar to those we experience.

Obviously, of course, the Martian observer will not "listen-in" by means of the mechanism which we employ, and equally obviously the connotation he may give to the signal is beyond our comprehension. At the very best the evolution of an intelligent life on Mars will have followed quite different lines from our own. The accidents of environment will have produced mental processes of which we can know nothing. Indeed, our very terminology with regard to possible inhabitants of another planet will have a wider meaning than the one which we usually assign to it. How far are we justified, for example, in speaking of the "mental processes" of such beings? Yet it must again be urged that the Martian reactions will be reactions towards phenomena similar to those which we experience.

Finally, we must consider what signal we are to send. Here we encounter difficulties quite different from those already discussed. Speaking generally, our message must abstract from human thought and endeavor something which we consider might be recognized as a message from terrestrial intelligence. It would be useless, for example, sending a message in the English language to a French savant, no matter how intelligent he might be, if he did not understand our tongue.

The only ray of hope is our belief that abstract scientific conceptions have a universal foundation in nature. The earth is the third planet in the solar system. No matter how the non-terrestrial intelligence acts, a sequence of three impulses must convey some notion of the number three. Therefore it might be suggested that a beginning should be made in our communication by sending a systematic series of three distinct impulses. We can form no conception of how the Martian inhabitant thinks "three," but it appears probable that our signal would be of a sufficiently fundamental type to cause the requisite mental reaction. If on any occasion it was discovered that signals on the same wavelength were being received consisting of four impulses, we might have some reason to believe that an answer to our signal was being transmitted from Mars. We might, under these circumstances, describe "three" and "four" as the interplanetary call signs.

It may be objected that the suggested message is too simple, and that surely another, conveying more intelligence, could be devised. An eminent astronomer, discussing the possibility of life on the moon, once suggested a signal to our satellite, taking the form of a drawing on the surface of the earth of the requisite dimensions of a right-angled triangle. He argued that this triangle, being of fundamental importance in geometry, would indicate to the possible inhabitants of the moon the existence of intelligent life on the earth. Leaving out of account the fact that Euclidean geometry is but a first approximation to the geometry of real space, did the astronomer not credit the Lunar intelligence with too terrestrial an origin? To imagine that the right-angled triangle, itself a mathematical abstraction, is common to all space, is surely like blaming an Englishman for not speaking Chinese! No! So far as interplanetary communication is concerned, we are strictly limited in our messages to signals of universal nature.

Now that we have considered the various aspects of the problem, we ought to be in a position to say whether the possibility of communicating with our neighboring planets comes into the realm of practical experiment. With regard to our means of sending a message, we have seen that we can hardly be sure that we possess the necessary equipment for making the attempt. On the other hand, researches at present in progress on the electrical structure of the upper atmosphere ought to provide the knowledge of refraction and absorption of short Hertzian waves which we require.

Assuming that we can send the signal, whether it will be received or not is a matter of speculation, but we can at least be certain that there is no *a priori* reason why it should not. In any case, the only messages which we can send with a reasonable expectation of their conveying the impression of being signals from the earth are of a very simple and uninteresting nature. Yet the possibility can not be dismissed as a scientific fancy. It lies on that borderline of the practicable which so many of our most important inventions and discoveries have but recently crossed.

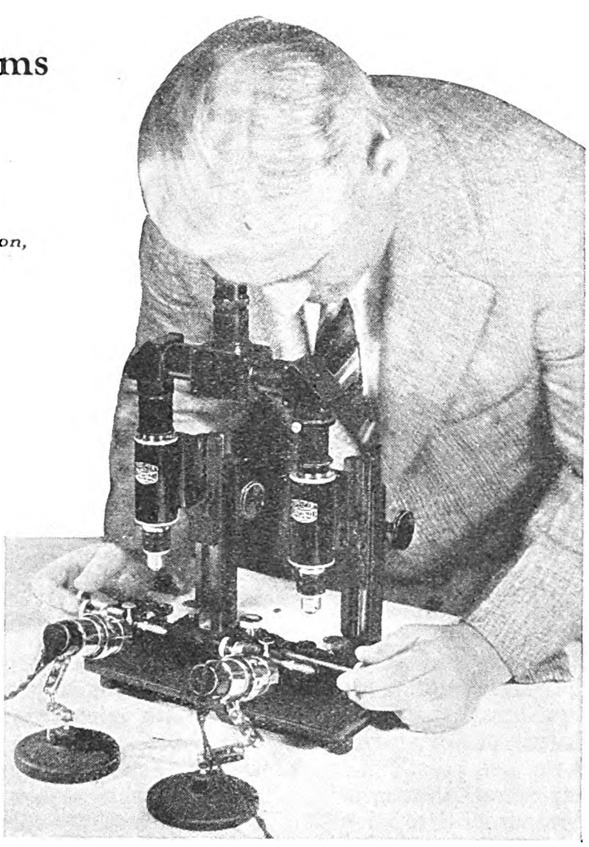
¶ *An interesting Hertzian wave phenomenon was reported in 1928 by the Norwegian physicist Stormer. The radio echo around the earth is a commonplace and requires one seventh of a second, but new echoes, delayed 3 to 15 full seconds, were heard. Possible explanations were: the retardation of velocity either in the Heaviside layer or in the earth; or the reflection of the waves from the moon, from the region of the zodiacal light, or from another and a more distant "Heaviside layer."*—The Editor.

Scientific Criminology

How Bullets and Firearms Are Matched for Identification

By STANLEY F. GORMAN

Lecturer on Bullet and Firearm Identification, Police College, City of New York



The author at work with the comparison microscope examining bullets in the holders

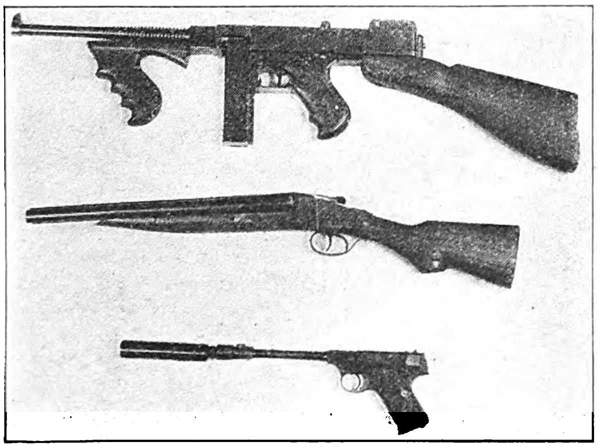
THE most important types of cases a detective has to deal with are homicides, suspicious suicides by means of firearms, suspicious accidental shootings, and assaults by means of firearms during the commission of a crime.

We are all familiar with the fact that, since the war and prohibition, there have been more homicides committed throughout the country by means of firearms than ever before, and it is usual that attempts are made to mislead the detective, either by the perpetrator or witnesses or both, as to the truth regarding the occurrence. It is his duty, however, to obtain facts, present them properly and intelligently, and also to be able to furnish proof of guilt or innocence.

Since the establishment of the New York City Police College by Ex-Police Commissioner Grover A. Whalen, Deputy Chief Inspector John J. O'Connell, the Dean of the Institution, has included a course of instruction in the scientific identification of firearms, shells, and bullets, which, today, is as important as the study of fingerprints. The results of this method of identification are definite and conclusive.

At the scene of a homicide, a suspicious suicide, or an accident where a firearm has been used, the detective is interested in the perpetrator, the witnesses, the surrounding circumstances, finger prints, the fatal bullet, the suspected weapon, and the discharged shell or shells found at the scene of the crime.

It is obvious, of course, that unless a suspected firearm is found, no comparison can be conducted except as pertains to the ammunition. However, with the suspected arm located and the fatal bullet recovered, a comparison microscopic examination and test can be conducted. The results obtained will prove whether or not the fatal bullet issued from the suspected weapon. It must be realized, however, that no identification is possible if the bullet, while passing through the body, comes in contact with bones that cause cuts, grooves, furrows, and so forth, on it, distorting it so completely as to destroy minute important characteristic marks. On the other hand, even if considerable distortion is so caused, but a small side area remains unmutilated, identification can be made. This same condition applies to a bullet which has passed through the victim and has come in contact thereafter with some surface hard enough to mushroom it completely, leaving no portion of the side available for study. If the bullet simply ricochets, however, and only a portion of its surface is flattened or distorted, there will remain sufficient area by which a comparison may be made.



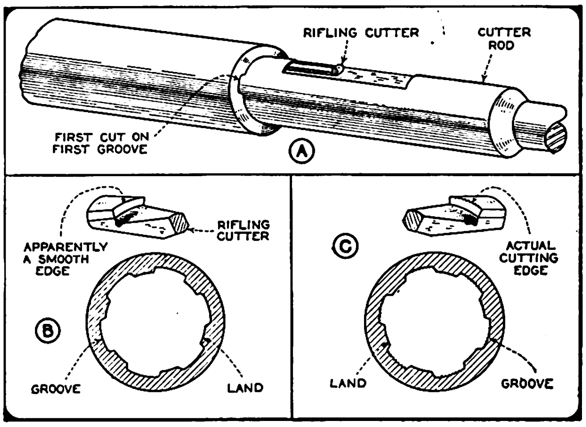
Guns of gangland. ***Top:*** **A Thompson sub-machine gun.** ***Center:*** **A sawed-off shotgun.** ***Bottom:*** **An automatic pistol equipped with a highly effective silencer**

In order to make clear the fundamental principles by which the expert in firearm identification is guided, it will be necessary first to explain in brief the process of gun-barrel manufacture. Here are born the tell-tale marks that are subsequently imprinted on the bullet when it passes through the gun barrel at the time of discharge. These minute marks give to each gun barrel a personality all its own.

In the manufacture of revolver, pistol, and rifle barrels, the first process is stamping out, by the drop-forge system, the gun-barrel "blank," cut off at the desired length. This "blank" is then bored lengthwise with a drill and finished to the proper size with a series of cutters and reamers. The resulting surface is known as the bore.

THE next manufacturing step is to create what is known as the rifling. This is a series of spiral grooves cut in the surface of the bore from end to end of the barrel. These grooves cause the bullet to spin around its longitudinal axis when fired from the gun. This rotating moment serves to make the bullet stable, so that while in flight it will travel nose first. The grooves grip the bullet at the instant of discharge and spin it as the cord spins a top. Just as the top is rendered stable by its spinning action, so is the bullet. In the latter case, however, a forward movement is imparted simultaneously with the start of the spin.

After these grooves have been cut, those sections of the original bore surface that remain between them are known as the lands. The manufacturers, because of their own patterns for this work, will be found to produce arms which differ in widths of lands and grooves. Some have narrow lands and wide grooves, some the opposite, and some have them equal. It will therefore be found that, in guns of a given make, the patterns of land and groove marks made on bullets fired through them will always be the same, and the same marks or patterns will not occur on a bullet fired from a weapon of any other make. In this way we are able to determine, by examination of a fired bullet, the make and type of arm from which it issued. It should be noted here that the lands or high parts of the bore, cut grooves or low marks on the bullet as it passes through. Thus, on a fired bullet, the low marks are made by the lands, while the high marks or rifling pattern are left by the grooves.



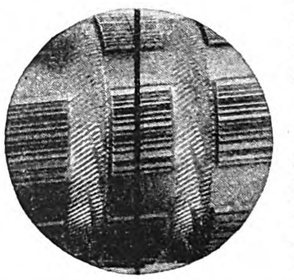
***A:* A rifling cutter starting on the second groove. *B:* How the rifling cutter and rifling should look. *C:* How they are in actuality. All these drawings are exaggerated for clarity**

Every manufacturer or ballistic engineer has his own pattern and formula for the depth and width of the rifling, as well as for the rate or degree of pitch. Different manufacturers use different numbers of grooves; some five and others six. The Colt company uses six, while Smith and Wesson use five grooves in all their arms except their .22 caliber, the automatic, and the .45-1917 model revolver, where they use six. The direction of the rifling in the Smith and Wesson arms runs from left to right and the lands and grooves are of nearly equal width. In the Colt guns the rifling is from right to left; the lands are narrow and the grooves wide. All other domestic manufacturers use five grooves and generally run to the right. In foreign guns will be found a mixture of from four to seven grooves running in either direction, frequently in arms of one make.

WHEN considering in detail the rifling or spiral grooves on the inner surface of the barrel, it must be remembered that the physical structure of any piece of metal is not the same throughout. The consistency of the metal varies at intervals; therefore it will be found that in no two gun barrels will the physical structure be identical throughout the bore. This fact has considerable effect on the tool which cuts the grooves, known as the "rifling cutter." These implements are made of the hardest of tool steel, in two styles. One is made in the form of a hook and is known as a "hook cutter." The other is made in a drawn out S shape and is known as a "scrape cutter."

The cutting edge of one of these tools, when it starts its first groove, is as sharp as a razor. To continue with this analogy: It is well known that after having shaved one side of the face with a razor, it frequently is necessary to strop the blade before shaving the other side. The blade has become dull, due to the action on the fine edge of the hair on the face. This action has in reality changed the shape of the edge. The microscope discloses the fact that a razor edge has teeth similar to that of a saw, although they are invisible to the naked eye. Stropping lines up these "teeth," while use forces them out of alignment: a dull blade results.

The action on a rifling cutter edge is similar. One can appreciate, then, as the rifling cutter is drawn through the barrel, while the barrel is rotated to give a spiral path to the groove, with the cutter so regulated as to cut $^1/_3$ of $^1/_{1000}$ of an inch from the interior of the bore surface on the first draw, that, considering the hard fine steel edge cutting away a hard steel surface, there is considerable wearing of the cutter edge in one stroke, during which it cannot be "stropped." So the rifling cutter edge is continuously changing its shape and, therefore, the pattern of scratches it leaves behind. The minute teeth on the fine edge are wearing down, chipping off in places, and the edge is scratching its ever changing pattern on the inner surface of the steel barrel.

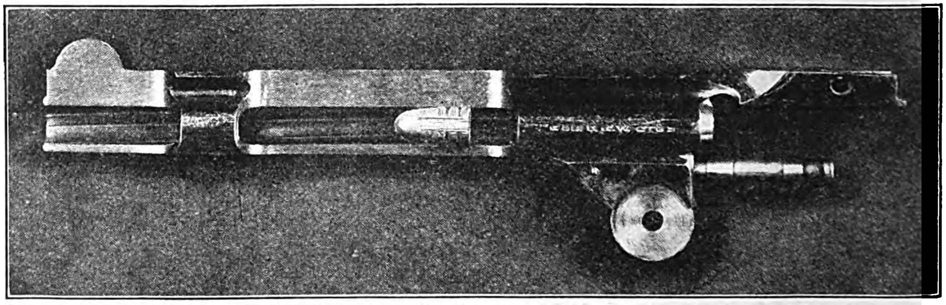


How two bullets look when viewed through the comparison microscope. The markings on the fatal and test bullets correspond

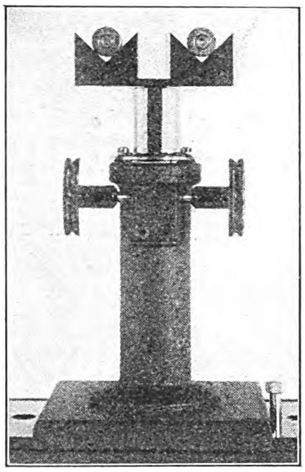
Another source of tell-tale bore markings is to be found in the slivers of steel that have been removed by the cutter and are constantly twirling around ahead of the cutter within the barrel. They not only create their scratch marks, but they also leave behind marks of "fractures" at the point where the steel sliver breaks from the interior barrel surface. Here another analogy may be drawn. When planing a piece of wood, a thin sliver is removed by the blade of the plane. This sliver eventually breaks from the wood body and leaves a plainly visible scar or "fracture" mark. A similar action takes place within the gun barrel. Considering all these facts, it can readily be appreciated how accurate it is to say that no two gun barrels are alike; and furthermore, that no two groove marks are identically the same in any one gun barrel.

TO the naked eye the interior surface of a gun barrel appears smooth, but by examination with the microscope it is possible to detect, examine, and compare these minute tell-tale marks which have been passed on to the surface of the bullet as it is being forced through the barrel under a pressure of from 8000 to 16,000 pounds to the square inch. This tremendous pressure behind the bullet expands it, pressing it against the inner barrel surface, so that it takes on every minute scratch mark of that surface. Some of these scratch marks, seen under the microscope, are more pronounced than others; one line may be faint at one end and come up stronger at the other; the more the gun is used the more pronounced the scratches become.

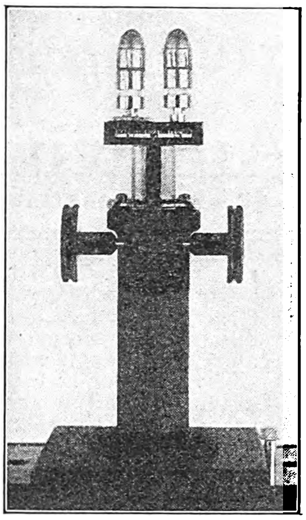
If any particular minute defect exists in the barrel or any rust marks are present, the gun's individuality becomes more pronounced and the marks of identification on the



Cut-away view of a revolver barrel, showing rifling. In the barrel has been placed a bullet, on which are seen the "finger prints" made by the bore



A new instrument designed by the author for holding and manipulating bullets and shells while being photographed. The views show the two different stages that are used



bullet become more positive. It will be noted that those marks imprinted on the bullet as it enters the barrel at the breech end are changed as the bullet progresses through, and it is the marks that are imprinted on the bullet by the last few millimeters of the barrel that serve as the identification card of the gun.

In the case of shell-head identification, the marks made by the firing pin and breech face are the "finger-prints" which must be followed. In the manufacture of the component parts of guns, the same change in the conditions of tools mentioned above gives a starting point for an identification method. If a series of seemingly identical parts, delivered consecutively from the same machine, are examined under the microscope, it will be found that each one differs in some respect from all of the others. The constantly changing tool marks or scratches on the firing pin and breech face are imprinted on the primer as it rebounds at discharge. It is possible to make identification of shell-heads in shot-gun cases in this manner, but because of the smooth bore of the barrel, nothing can be done with the pellets of shot discharged from this type of gun.

IN cases where automatic pistols are used, comparisons can be made of extractor hook marks and ejector rod marks, as well as the breech face marks on shell heads. This same method is used in determining what type of gun discharged a .45 caliber automatic cartridge, which could have been used in a 1917 model Smith and Wesson revolver, a Colt automatic pistol, or a Thompson sub-machine gun.

The method of identification consists of comparing the minute characteristic markings on the questioned or fatal bullet or shell with the markings on a test bullet or shell fired through or by the suspected gun. The bullet fired through a suspected weapon is caught in cotton waste so as not to distort it or cause any foreign marks to be imprinted on it other than those caused by the condition of the interior of the gun barrel.

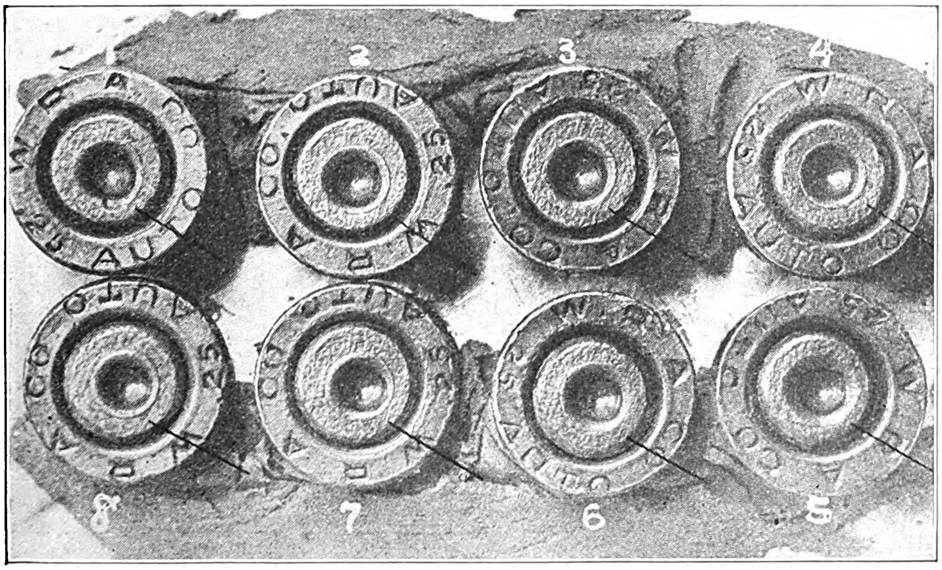
There are today a few experts who make identification in a logical and precise manner but there are also many so-called experts who recognize no limitations, no standards, and no equipment as essential in this field.

In the examination and comparison of fatal bullets and shells fired from suspected weapons, the most important instrument, which is today generally recognized as essential for satisfactory work in this field, is the "comparison microscope" which may be described as a specially designed compound microscope fitted with a comparison eyepiece, in which two bullets or shells can be examined at the same time. With such a microscope the fatal bullet and a test bullet fired from the suspected barrel are placed under the lens systems as shown in the photograph. Their images are fused into one by the arrangement of prisms in the comparison eyepiece. The result is a composite image, one half of which is contributed by the fatal bullet and one half by the test bullet. When the bullets are set in the microscope, they can be rotated independently or simultaneously by means of the mechanical stage.

One bullet is now held stationary, while the other is rotated so as to make various areas of its surface join against the area of the bullet which remains fixed in view. If both bullets are from arms of the same caliber and make, each land and groove mark on the rotating bullet, as it passes a land or groove mark on the non-rotating bullet, will fuse with it as to width and angle of pitch. If the bullets be from the same arm, not only will land and groove edges fuse, and angles be identical, but certain finer scratches from the lands and grooves, mentioned above, will, in some one given position, fuse also. Having located this position, the two bullets are revolved together, whereupon fusion of these fine lines, as well as of groove edges, will take place all around the circumference. Shell-heads are examined in the same way for tool scratch marks left by the breech block as above mentioned.

THE bullets having been examined microscopically and found to match, pictures are taken of both test and fatal specimens. These pictures are so arranged as to enable court and jury clearly to comprehend the result.

There are three pictures taken of the fatal bullet and two of the test bullet. These are arranged side by side in folder form, pasted together on the reverse side, in the following manner. From left to right, number one and two are pictures of fatal and test bullets, respectively; number three and four are pictures of the fatal bullet. The other picture of the test bullet is cut through the short diameter. The lower half is superimposed over the lower half of picture number three, of the fatal bullet, and the upper half over the upper half of picture number four, also of the fatal bullet. The fine lines or striations will match and prove identification.



A row of fatal shells and a row of test shells placed side by side in an accurately bored steel block for purposes of comparison and photography

My Experience in Amateur Telescope Making

By CLYDE W. TOMBAUGH

CLYDE W. TOMBAUGH, author of the accompanying account and the immediate discoverer of Pluto the new planet, "graduated" into professional astronomical work from amateur telescope making, as have several others up to the present time. Until he won a position at Lowell Observatory, Tombaugh was an obscure amateur, one of the 6500 of our readers who have gone in for this fascinating scientific hobby. For some reason he previously had not sent to this magazine a description of the failures and successes in his telescope building, and therefore was wholly unknown to the editors. Acting on a "hunch," when the newspapers stated that Tombaugh "had made telescopes," we found his name in the 1926 records as a purchaser of the SCIENTIFIC AMERICAN instruction book, "Amateur Telescope Making," and invited him to describe his efforts for publication.

Tombaugh's success is a refutation of the assertion, sometimes made, that the layman's worthy work stands little chance of notice by professional men of science. Here we have a plain young man, a farmer, without scientific connection. He makes several telescopes, studies, and wins a position at a noted astronomical institution—all without the least "pull" or preferment. Within three months his name is on every press wire, every cable. If that isn't romance, what is?

IN February, 1926, I began work on my first telescope, an eight-inch reflector, as that was the only way for one of very limited means to possess an instrument of moderate power. The work was new and unfamiliar and mistakes were made; for example, cementing a disk of wood of equal size to the back of the speculum. Another mistake was the flimsy equatorial mounting constructed, which teetered violently with the least wind. The tube was a square box seven feet long, made of four boards nailed together. The telescope was kept out-of-doors and these boards warped sadly in spite of their previous treatment with hot linseed oil and paint. Figuring the mirror was unsuccessful, also the silvering. The return of farm work forbade any further work on the mirror that season.

ABOUT this time, April, 1926, I learned that the SCIENTIFIC AMERICAN had published the book "Amateur Telescope Making," and immediately sent for a copy with the intention of "trying it again" the next winter. The eight-inch telescope was used occasionally during the summer and autumn, though its performance was disappointing. It would stand only the magnification of a two-inch eyepiece, 42 diameters.

A concrete cave (outside cellar) was built on the farm in the late autumn and this was seen to be a fine place to make mirrors because the temperature would remain constant. Work was kept up feverishly to doctor the figure on the eight-inch so that Mars could be observed while near the earth. Nothing but failure resulted, due to the fact that the glass disk was too thin. It showed signs of flexure.

A relative now wanted me to make a seven-inch reflector for him. Here was an opportunity to try fresh glass and to profit from the mistakes made on the eight-inch. Armed now with the book "Amateur Telescope Making," the second project bid fair to be a success, but the first disk cracked while heating it to cement a handle on the back. Another disk was ordered immediately.

The grinding proceeded very satisfactorily and soon was done. The mirror was ground to a focus of 58½ inches. Some scratching was encountered in the polishing, and fine grinding again was resorted to twice to remove the scratches. Upon investigation, the source of the mischief was found to be some grit which had become mixed in the rouge. Polishing was resumed, followed by figuring. "Hyperbolae," "turned-down edge," and "zones" gave trouble and several laps were made in correcting these errors. Finally the mirror was parabolized successfully, placed in the tube and tried on celestial objects for several nights. Views of the moon with a quarter-inch eyepiece were good—much to my joy. Accordingly the mirror was sent away for silvering.

THE tube of the telescope was made of number 22-gage galvanized iron, reinforced by a ring of strap iron at each end, riveted on the inside. A one-inch right-angled prism was used for a diagonal. The telescope was finished just in time, before the annual return of farm work intervened.

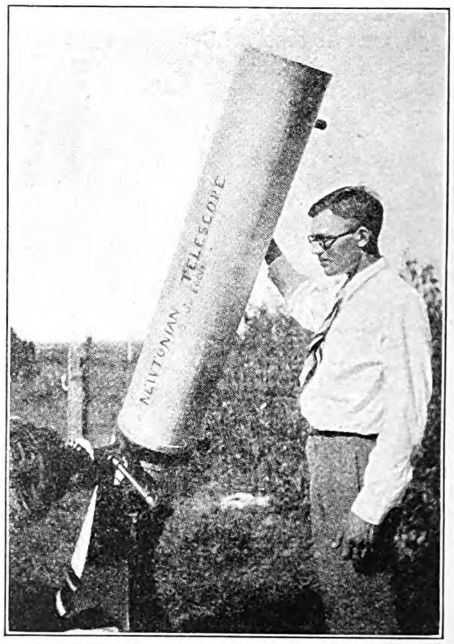
In May, 1927, I set out to enjoy the fruits of my labor. The telescope outstripped anything I had previously looked through. Views of the moon and planets with high powers were splendid. With low powers star fields and clusters were most beautiful. From time to time neighbors came to enjoy a look.

One rainy day in August the telescope was packed and shipped to my uncle. I had become so attached to the instrument that I felt the loss keenly.

Soon afterward I ordered disks of glass to build a nine-inch reflector for myself. During a rainy spell in September the rough grinding was done and several weeks later the subsequent work was resumed. A total of 24 hours were required for the grinding process, including careful washing of stand and tools between grades. An 80-inch focal length was aimed at, which later was found to be three-fourths of an inch less. All the grinding and polishing were done by hand. I did not have the time, money, nor inclination to build a machine for these operations. No wooden handle was ever cemented to the back of the speculum.

MY five-year-old brother took keen interest in the project and begged to help. I let him renew the charges of carborundum and water. This saved me the trouble of laying the speculum down and picking it up each time. His enthusiasm and willingness were a source of great joy and inspiration to his big brother.

My father assisted me most generously with the mounting. Ingeniously he fashioned a neat and sturdy one according to my plans from parts of old farm machinery, using only the

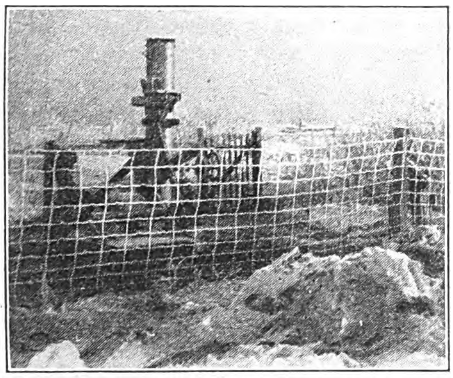


The author standing beside his nine-inch home-made reflecting telescope described in this article tools found in the average farmer's repair shop. Later the performance of the mounting was found to be most gratifying, even when using a power of 400 diameters. The worm-screw slow motion in right ascension, and the turning of the polar axis in its bearings, were uniform and smooth.

The declination axis was cut from one-inch shafting taken from an old straw-spreader. A hardened steel shaft from an old Buick car served for the polar axis. The worm-wheel was made from a spark lever arc of an old car, by carefully filing the notches until they became teeth. The worm-wheel arc is readily clamped to the polar axis for slow motion.

The mounting is of the German type. My father and I forged the yoke from tough, heavy wrought iron. The upper end of the polar axis was threaded and screwed tightly into the yoke. Great pains were taken to fix the polar axis at exact right angles to the declination bearings, the latter being cleanly bored with a hand drill-press, and then treated with fine emery cloth. The polar axis bearings likewise were made with especial care. One could not ask for smoother motion. The polar axis bearings are fastened to the base of an old cream separator whose metal base in turn was bolted to a pier of reinforced concrete.

THE telescope tube, seven feet long and 11 inches in diameter, was made of 20-gage galvanized iron, at a tinner's shop, for a sum of six dollars. Later, at home, two strong bands, one at either end, were riveted by my father on the inside of the tube, giving added rigidity and strength. He also made a cell support in the tube and fitted the back of the cell with three adjusting screws for "squaring on" the speculum.



When the telescope is not in use the tube is capped and the instrument is left out of doors in the snow and rain without injury

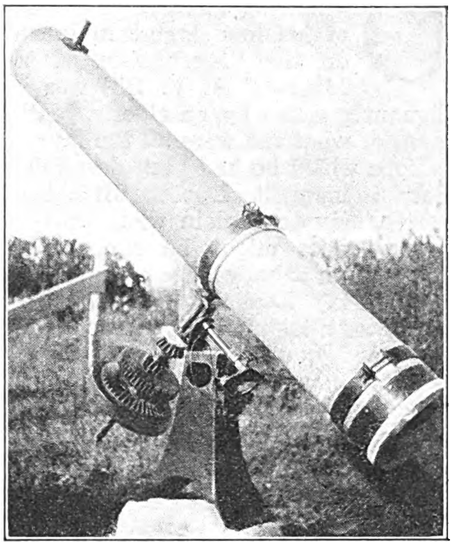
The nine-inch mirror rests on a ten-inch disk of walnut two inches thick, and the wood in turn is joined to a fixed metal disk base by the three adjusting screws. This metal disk fits snugly between a tube reinforcing ring in front and three equidistant arcs of strap iron behind. Three evenly spaced gaps were cut on the circumference of the metal disk. By turning the metal disk so that the three gaps come into a congruous position with the three arcs of support the entire cell with mirror slips out of the lower end of the tube. This arrangement allows quick removal and replacement of the cell with its mirror. Dead-black slate cloth was glued to the inside of the tube with shellac to prevent internal reflection of light.

The arrangement used for fastening the telescope tube onto the declination axis will be quite well understood from the photograph. An iron band two inches wide and one quarter inch thick acts as a slip ring. The grip on the tube may be loosened by the handwheel and the tube rotated into any desired position. An iron block tapering off at either end was riveted to this ring. A hole was bored in the block and tapped, and the end of the declination axis was threaded and screwed tightly into this block. This arrangement proved to be quite rigid as well as convenient.

A SMALL optical flat, three eighths of an inch thick and 1½ by 2 inches, intercepts the light and directs it to the eyepiece. It was mounted so as to permit adjustment, and supported by a thin strip of strap iron extending diametrically across the tube.

Considerable trouble was experienced in figuring the mirror, because of the use of too many long strokes in shaping the first polishing lap which was slow in hardening. The first knife-edge test showed the r^2/R value to be one half inch! Serious complications followed in reducing this, and several laps were made and cut up while correcting various errors. The work, consequently, was greatly prolonged. At last the mirror was parabolized to two thirds the theoretical value, in order to compensate for the rapid fall of temperature at night, which is typical of western Kansas in seasons of good seeing.

The optical performance of the telescope is most gratifying. The "double-double" system of *Epsilon Lyrae* is a favorite test for light-grasp, resolving power, and seeing. The components of the two doubles are $2''.3$ and $3''.0$ apart, respectively. During good seeing these doubles are thrown wide apart, and each spurious disk is very small and clean-cut when using a one fifth inch Ramsden (positive) eyepiece. During moments of extra good seeing arcs of the first diffraction ring are observable, using the full 9-inch aperture. Between E_1 and E_2 are several faint stars. The two stars marked 12.0 and 12.5 magnitudes in Webb's "Celestial Objects for Common Telescopes" were conspicuous. Two fainter stars marked 13.8 and 13.9 magnitudes were just seen and held under favorable conditions. In addition I have seen many very delicate rills and countless craterlets on the Moon. In the autumn of 1928 I was able to observe seasonal changes on Mars and saw a few canals.



Detail of the mounting, made from parts of an old straw spreader, a Buick shaft, cream separator, and several other pick-me-ups

The making and use of my nine-inch telescope has been a source of great pleasure to me, and the entire cost in money, excepting for the eyepieces, amounted to 36 dollars.

The entire telescope, excepting the eyepieces, is left out-of-doors in my "telescope garden." When not in use the tube is held in a vertical position, a tin cap is placed over the end, and a solid dummy eyepiece is substituted for the eyepiece. Thus closed, the tube is practically air-tight. The telescope has withstood the onslaughts of blizzards, driving rains, hail, and dust-storms without the slightest damage. Yet it can be set in operation in two minutes and closed up in five minutes, thus greatly encouraging observation.

A five-inch single-lens non-achromatic refractor of 6½ feet focal length was also made in the early part of 1928. Of course the color is bad and the definition poor due to diffusion. With a two-inch eyepiece it is fairly satisfactory, however.

The following autumn (1928) a Cassegrainian mirror was ground for the nine-inch. Two five-inch specula with focal lengths of 20 and 75 inches, respectively, were also under construction at that time, but early in January of 1929 I was granted work at the Lowell Observatory, and a little later was assigned to the new 13-inch Lawrence Lowell Telescope to search for "Planet X" (Pluto). Consequently my mirror work came to a close, and these mirrors still are unfinished.

Experiments With "Wonder Creatures"

By FRANK E. LUTZ, A.M., Ph.D.

Curator of Insect Life, American Museum of Natural History

ON inviting questions at the end of his first American lecture on the "Mechanism of the Muscle," A. V. Hill was indignantly asked by an elderly gentleman, of what use were all the investigations which he had been describing. For a moment Doctor Hill tried stumblingly to explain what practical consequences might be expected to follow from a knowledge of how muscles work. Realizing suddenly how thankless a task it was to prove to his indignant questioner that the work he was doing was useful, Doctor Hill turned to him with a smile, and finished,

"To tell you the truth, we don't do it because it is useful, but because it is amusing."

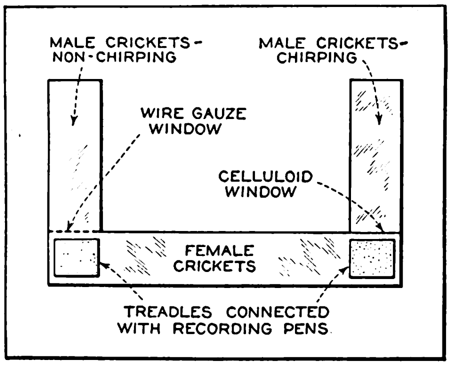
"And if that is not the best reason why a scientist should do his work," says Doctor Hill, "I want to know what is. Would it be any good to ask a mother what practical use her baby is?"

This article is to give you a peep at some of our "babies," glimpses of some of the experiments we have been trying at the American Museum's Station for the Study of Insects in the Harriman State Park and at the private laboratory of Alfred L. Loomis in Tuxedo. They are "babies" in the additional sense that none of them have gone far enough to mature into a definite scientific report.

MOST of the more than half a million different kinds of insects live their lives without a sound that we can hear. A few, however, such as the crickets, katydids, and their relatives, with an originality that is the more striking as we consider the multitude of conservatives, have developed not only rather complicated sound-producing organs, but also apparently satisfactory ears. As is characteristic of insects, they have gone about certain functions in a way and with structures that seem to us strange. An interesting essay could be written on this latter point, telling about such things as that insects take air directly to the blood instead of the rather clumsy human method of taking the blood to inhaled air; and not the least interesting thing about it is that the insects' way seems to work better than our way. An intimation of their success will be found in the last of the experiments discussed in this article.

Several years ago, in reviewing work on insect sounds, I confessed considerable skepticism concerning the utility of these sounds to the sound producers; but the chirping of crickets gave me considerable trouble both then and after the paper was published. The chirping is done by rubbing together highly modified structures on the front wings which seem "made for that purpose." Furthermore, crickets have ears on their front legs, and definite ears are unusual among insects. Since only males chirp (although both sexes have ears) the conclusion has been that the chirping is a sex call.

Having somewhat questioned that conclusion, it seemed only fair that I should test the matter; but watching a female cricket to see if she goes to a chirping male is a time-consuming business and, so, it seemed desirable to invent a machine that would do the job as well or better than we could. Consequently we made an automatic "eavesdropper." It will have to be improved and its first reports are not to be taken too seriously.



The plan of the "automatic eavesdropper" described in the text

A box was made to contain the females. There was a window at each end where two other compartments joined it and here was food and shelter. Each window communicated with separate boxes containing males. One window was covered tightly with thin celluloid that let through the chirps but kept back odors. (Remember that insects have a keen sense of smell and many clearly find their mates by this sense.) The other window was covered with wire gauze that let through the odors and would have let through the chirps also if there had been any in the box with which it communicated. But there were no chirps in that box, because a simple surgical operation on the wings of the males there had completely "dechirped" them without hurting them more than a girl is hurt by having her hair bobbed—and the effect was much the same in so far as they were made more like the opposite sex. The females in the central box could wander about and go to either window. Would they go more often to the one where there were male chirps but no odor, or to the one where there presumably was male odor but certainly no chirps? This is where the automatic eavesdropper comes in.

On the floor of the females' box, just below each window, was a very delicate treadle. When a female came to either window, she stepped on the treadle there and, her weight depressing it, closed an electric switch that completed the circuit through an electromagnet. The magnet drew aside a pen that was otherwise tracing a perfectly straight line on a paper tape moving at a known speed. Each treadle moved its own separate pen. Clearly, all we needed to do was to examine the tape at our leisure and we could tell not only which window was visited but how often the female came, when she came, and how long she stayed.

IN "chirp but no odor *versus* possible odor but no chirp" the females visited the chirp window 290 times and the no-chirp window 307 times. There is practical equality here. When offered a choice between a blank window and one where there were males that could not chirp the score was 170 to 166. Again equality. "Chirp but no odor" won out over "blank" by 63 to 24, but the numbers are rather small and "blank" scored 65 against 48 for a window where there was *both* chirp and possible odor. Males which were offered several of the same choices paid 86 visits to "chirp but no odor" and only 40 to "possible odor but no chirp"; also 80 to "possible odor but no chirp" as contrasted with 44 to a blank window. It seems as though males are more consistently interested in both male chirp and odor than are females, the latter wandering about more or less at random; but that may be a too hasty conclusion.

A few experiments were tried with unmated females whose presumed ears had been removed by the simple expedient of cutting off their front legs. There were 27 visits by these virgins to a window where there were both male chirps and possible male odor and none

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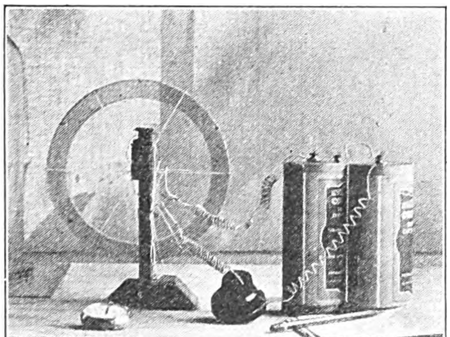
to the other window where there were no males. In another short series of trials where possible odor but no chirps was opposed to chirps but no odor the score was 14 to 11 in favor of odor, but the numbers are too small to be significant. On the other hand, possible odor but no chirps won out over a rival blank window by the rather startling total of 106 to 1.

One of two conclusions is fairly certain: either female crickets do not get wildly excited over the music of possible mates or there is something wrong with the apparatus.

THERE is a very different sort of problem which has greatly interested some physiologists and which may strike rather deeply into the mysteries of animal activities, either muscular or nervous, we are not sure which. For example, Harlow Shapley, an astronomer apparently desirous of improving daylight hours when he could not look at stars, watched ants and noted the speed with which they walked along a path at various temperatures. The warmer it was, the faster they went. A curious thing is that the relation between speed (S_1) at a given temperature (T_1) and the speed (S_2) at another temperature (T_2) closely accords with a complicated formula which represents the speeds of certain chemical reactions at various temperatures:

$$S_2 = S_1 e^{A\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

where e is 2.7183, the base of "natural logarithms," temperatures are measured on the "absolute centigrade" scale ("absolute zero" being about —273° C. or about —459° F.) and A is a constant that is characteristic of the reaction.



Treadmill operated by a cricket. A photo-electric cell recorded the revolutions made by the pedestrian

Some physiologists think that, by a comparison of the "temperature characteristics" of various animal activities (as shown by a curve representing the speeds of these activities at various temperatures) with the "characteristics" of various chemical reactions, we can discover what chemical reactions control these activities. Possibly we can but, at any rate, it is interesting to find out a little more concerning the influence upon insect activities of all the environmental factors, and this seemed to require a new type of apparatus in which the insect could walk straight ahead indefinitely without coming to a wall and in which the environment could be controlled.

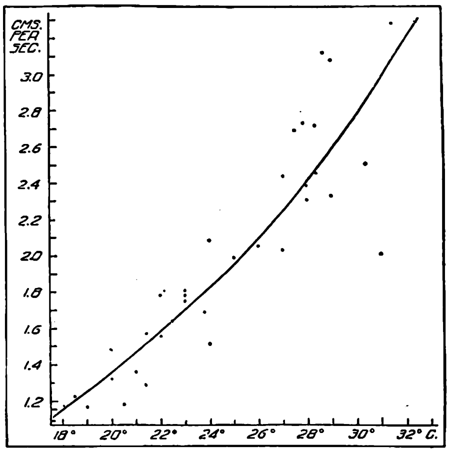
A device something like the wheel in an old-fashioned squirrel cage seemed to be what we wanted, but we wished it to be so delicately balanced and so frictionless that even a tiny fruit-fly would easily turn it. However, if we did away entirely, or almost entirely, with friction, the wheel, once it got started, would go on and on even after the insect had stopped walking. Furthermore, while we were at it, we wanted things fixed so that the wheel would automatically record both the speed and the direction of its turning. As I look back, I do not wonder at the kind, solicitous inquiries of friends concerning the "fly-wheel," and I even forgive the less kind intimations as to "wheels" in my head. The list of failures is a long one, but here is what worked and it is quite simple.

The track where the insect walks is something like an automobile tire with the insect inside of it. It is made of exceedingly thin, transparent celluloid, the "valve" being a tiny, sliding celluloid door for getting the animal in and out. The spokes of the wheel are fine silk threads; the axle, depending on the size of the wheel, is either a needle or the shaft of an almost obsolete thing, a hat pin. Over each end of the axle is an electro-magnet whose strength can be quickly and accurately varied by a rheostat conveniently located in the circuit.

NOW: An insect is put into the wheel, just enough electricity is sent through the magnets to take practically all the weight off of the bearings (a trick suggested to me by Professor R. W. Wood), and the insect can go as rapidly as it pleases but, like Alice and the Red Queen, it never gets anywhere. If it decides to stop, we can decrease the strength of the electric current; this lets the weight press on the bearings and friction stops the wheel.

Since an observer is usually on hand when the apparatus is being used, there really was not much point in having it self-recording but, compared with getting the wheel to work, that was easy, and there is some satisfaction in finishing what one starts out to do. Accordingly, a disk of opaque paper was fitted to the wheel and a series of openings was made in the disk. A photo-electric cell was put back of the disk and a beam of light was directed against its front. Every time an opening passed the beam of light, as the wheel turned, an electric impulse went through the photo-electric cell and worked a pen on a recording tape much as did the cricket treadle already described. The openings were so arranged that the turning wheel "telegraphed" a code message that told exactly what it was doing.

Having the apparatus, there was an obligation to use it and, I confess, this was more like work, although interesting. Not every insect is fit to go in such a wheel. Some sat calmly, as though thinking about something. Others had the will to walk but got tired, for the inside of a freely turning wheel is a trail that has no end. Thus, a yellow-jacket wasp that, in ordinary life, flies much but walks little, started off with an evident intention of getting somewhere in a hurry. For the first 20 minutes it kept steadily going at an average speed of about 9.5 centimeters per second. Then, temperature, light, humidity, and barometric pressure remaining the same, it began slowing up, its average speed in successive five-minute intervals being 8.3; 7.7; 7.4; 7.3; and 6.2 centimeters per second. At the end of the three hours and a half it was still at it but going only 3.9 centimeters per second, having had the longest walk of its life—about two thirds of a mile.



The higher the temperature the faster the milliped walked. "What it all means is another question"

GROUND beetles (Carabidæ) are much more used to walking than are wasps. In fact, they rarely fly. A specimen which Richard Iverson timed for two hours with the wheel in the open laboratory started off with a speed of 5.3 centimeters per second. Its average speeds in 19 of the 20 five-minute intervals for the last hour of the run were: 5.4; 5.3; 5.1; 4.9; 4.8; 5.9; 6.0; 5.9; (Dick took a five-minute rest); 6.0; 6.2; 5.8; 5.7; 6.2; 6.1; 5.5; 5.6; 6.0; 5.2; and 4.3. Apparently it could keep that up longer than we cared to watch and record. Our automatic disk contraption would have been handy in this case.

The creature that best served our purpose was not, strictly speaking, an insect but *Spirobolus marginatus*, the large brown milliped ("thousand-legger") of the late-summer woods. It is heavy enough to turn the wheel without the help of magnets; it is a consistent walker; and there is an absolute fascination in watching the perfect rhythm of those many legs hour after hour. Let us examine the effect of two environmental factors upon its speed of locomotion.

A *Spirobolus* was started off at a temperature of 32.5° C. (90.5°F.); then the box which contained the wheel was gradually cooled to 18° C. (64.4° F.); and finally warmed again to 30° C. This took about four hours and a half, the creature walking most of the time. Distance traveled, together with elapsed time, was electrically recorded on a rapidly moving tape. If you are used to reading graphs, the one on page 271 will clearly tell the story. The dots on the graph indicate the average speed of walking (see left-hand margin) at various temperatures (see bottom margin) and the slightly curved line is that given by the formula noted above when the constants are speed of walking (centimeters per second) equals

$$2.238\, e^{6351 \frac{(\text{Temp.}-300)}{(300 \times \text{Temp.})}}$$

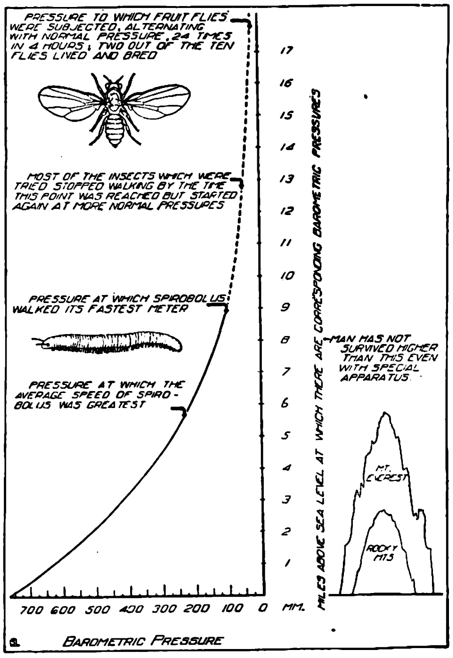
when temperature is given on the "absolute" centigrade scale. It is quite evident that "the warmer, the faster." What it all means is another question.

RATHER more startling experiments, perhaps largely because they were in an almost unexplored field, were the effect of changed air pressures, and this requires a bit of comment on the side. At sea level the air above us weighs so much that it balances the weight of a column of mercury about 760 millimeters high; in other words, the barometric pressure is about 760 millimeters at sea level. As we go up in a balloon (mountains are not high enough for present purposes) the pressure decreases, but not in simple proportion to the altitude. "Sounding balloons," carrying recording barometers but not a human being, have attained about 19 miles above sea level. But even that is not high enough for our present purposes. Since we do not know what the air pressure is 30 miles above sea level, about the best we can do is to take a very simple formula which seems to be "in the direction of the truth" even though it is known to be inaccurate. It is that altitude in miles about equals

$$10.33 \log_{10}\left(\frac{760 \text{ mm.}}{\text{Observed Pressure}}\right)$$

It may be simpler to look at the curve in the drawing above which gives, on the bases of known facts and of this formula, altitudes in miles for various barometric pressures.

For this experiment *Spirobolus* was put in a wheel; the wheel was put in a bell-jar; and air was pumped out of or let into the jar according to whether we wished to decrease or increase the atmospheric pressure. It was absurdly easy to give the creature all of the air-pressure thrills of a super-balloon ride to, say, 15 miles above sea level (air pressure of about 27 millimeters) and return in less than three minutes. Of course, since it is well to investigate one factor at a time, temperature, light, and humidity were kept as nearly constant as possible, and for that reason we can speak here of only the effects of air pressure and decreased oxygen supply.



The effect of decreased barometric pressure on several animals tested. The vertical column of numerals has reference to miles above sea level at which there are corresponding barometric pressures. The insect is a much "tougher" organism than the mammalian primate known as *Homo sapiens*

Suppose a man were being treated in this way. Even if the change were made slowly, his gait would be wobbly and his breathing very labored at a pressure of 400 millimeters of mercury, and the aviator Gray died, whether accidentally or not, when it was about 150 millimeters.

Since we wished to time the speed of walking at various pressures, *Spirobolus* was subjected to graded series of them. Observations were made during the first hour at 740, 500, 400, 300, 250, 200, 150, 100, 75, 50, 40, 30, and about 22 millimeters pressure in succession. In order to have a constant degree of humidity and also to prevent drying of the milliped by excessive evaporation, we had water in the jar and, since the vapor pressure of water at ordinary summer temperature is about 22 millimeters, that was as far as we went, and it seemed far enough for the present. At that, there was practically no air left in the jar. Then we came by rather short stages back to normal; then went to 100 and back to normal; and repeated this "round trip" three more times—all in two hours and a half.

Instead of walking more slowly as the air became rarer, *Spirobolus* increased its speed, all of its many legs functioning in absolute rhythm. This increase kept up on the average until the air was about two thirds gone, corresponding to pressures at an altitude of, say, six or seven miles; then it began to slow on the average and stopped (but not for good) when there was practically no pressure left except that of water-vapor. As a matter of fact, however, the fastest one-meter dash that it did was at an air-pressure of only 105 millimeters (representing, say, an altitude of about nine miles), making the meter in 59 seconds or a rate of about 1.7 centimeters per second. Of what stuff are these creatures made, at any rate?

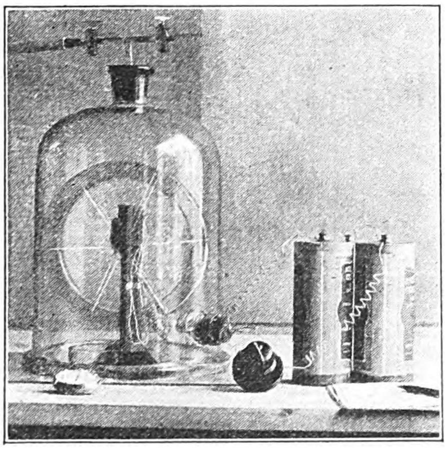
WE are all familiar with the tiny, red-eyed fruit-flies that come about over-ripe bananas and the like. Ten of these flies were put in a bell-jar with water and the air exhausted to the vapor-pressure of water in 90 seconds. The flies stopped moving. Valves in the apparatus were then opened wide and the pressure almost instantly returned to normal. Within four minutes all ten were walking about as though nothing had happened. The same procedure was repeated again and again. After the eighth trial one fly did not walk within seven minutes and I did not wait for him but went on with the one- to three-minute swings from normal to "none" and back again. After the 20th trial only six of the ten stalwarts were walking and I took time out for tea.

After tea we (the flies and I) made four more round trips and then only a male and a female of the original ten were still alive. There seemed no point in pushing the experiment to their death and, besides, I wanted to see if they were really as well and hearty as they seemed to be. So, I put them in a cage with a nice ripe banana, where they started breeding the next day. Careful microscopic examination of their children, grandchildren, and great-grandchildren failed to reveal indications that anything unusual in fruit-fly affairs had happened.

Human endurance would fall so far below that of insects in such a test that no comparison can be made. An express elevator in the Woolworth Building or the dropping of a cage in a deep mine are slow coaches going a short block compared to the ride these flies took 24 times in four hours, but in what follows we tried to reach the limit of even insect endurance—and failed as far as air-pressure is concerned.

It is well known that, in order to produce X rays, the air is almost completely removed from the X-ray tube and then an electric discharge of very high voltage is made to jump the gap between two electrodes in this "vacuum." But the so-called vacuum, while nearly complete, is not entirely so; there are still enough ions left to carry the electricity from one electrode to the other. Furthermore, it is possible, by means of a pump which Mr. Alfred L. Loomis has in his bio-physical laboratory at Tuxedo, to exhaust the tube so completely that the X ray dies out and even 30,000 volts will not force a discharge across the gap. Instead of an air-pressure of about 760 millimeters of mercury, as we have in normal atmosphere at sea level, the pressure now in the tube is of the order of one 10,000th of one millimeter. It is probably lower than the vacuum of interstellar space. What would happen to a "frail" butterfly or bee if subjected to such a vacuum and then suddenly brought back to normal pressures?

THE answer is complicated by a factor already mentioned, one which we found was more important than sudden and great changes in air pressure. This factor is that the pump which removes the air also removes the moisture; and insects which are kept in a pressure much less than the vapor pressure of water would quickly dry up and die of desiccation. Water can not be supplied to them in this apparatus, because some of it would evaporate so quickly that what remains would be frozen to solid ice and, in fact, part of the slowing effect of high vacuum on insects may be due to a marked lowering of their temperature caused by evaporation from their bodies. However, let us see what happened.


The treadmill placed inside a bell jar connected with a vacuum pump

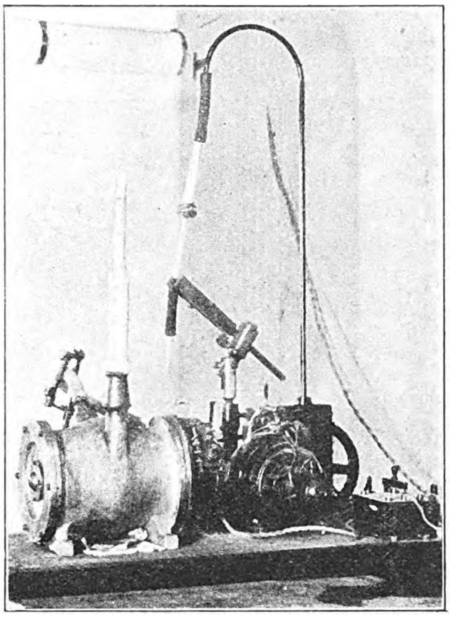
Three small bees belonging to two genera of the sort that live a solitary life, instead of in colonies, two mound-building ants, a beetle related to fireflies, and an immature grasshopper, were put in a tube and the ends of the tube were melted so that it was welded into the apparatus. (Ordinary joints would not hold.) Since moisture would ruin the pump and since moisture was sure to come from the insects, that part of the tube between the insects and the pump was packed in a mixture of solid carbon dioxide and acetone in order to freeze the water out of the air while on its way to the pump.

The pump was started and the next three minutes were busy ones. First the vacuum-tube glow appeared, but before the end of the second minute it had died out, showing that a non-conducting vacuum had been reached. This was held for 60 seconds, a rapidly growing pile of snow in the chilled connection being the moisture sucked out of these "frail" creatures, and then the glass tube was broken at one blow and the insects were returned to normal conditions from their journey into a "complete vacuum." Not one moved then, but two hours later all were active and apparently normal. A little later one of the ants showed some signs of trouble but whether it was due to the vacuum, the drying, or to some more natural cause I do not know. The next day that ant was dead but, when released, the other ant and all of its companions each according to its kind flew, hopped, or walked away.

THE same experiment was tried with a bumble-bee and two kinds of butterflies, except that the insects were in a vacuum of less than one millimeter pressure for four minutes and the extreme of 1/10,000 millimeter was kept up for 90 seconds. In about ten minutes after the tube was broken, instantaneously returning them to normal pressures, the bee and one of the butterflies began to show signs of life. Five minutes later both were walking and the other butterfly was feebly moving its legs and mouth-parts. By the next day the bumble-bee was active as ever but the butterflies had died. Possibly they were unable to withstand the conditions of the experiment, including the excessive drying, and possibly they died from other, more natural causes, but it did not seem necessary to try the experiment again.

There was no longer room for doubt that insects and their near relatives are creatures that can not only exercise vigorously at air-pressures which no man nor any of the animals related to him could survive; creatures that can not only completely recover within a few minutes from sudden and rapidly repeated transfers from normal pressures to almost none and back again; but they are creatures that can survive the most complete vacuum that man can produce with exceptionally perfect apparatus. How do they do it; why can they do it?

All that we can say is that insects seem to be better made than we are. They have invaded almost every bit of the livable world, including hot springs and the highest mountains, the Arctic and the tropics, in water and on water, underground and above ground, in plants and animals and on them. Only the ocean is avoided by them. Their structure and mode of living have stood the test of time practically unchanged since the Carboniferous period. Possibly Maeterlinck was right when he called them "beings so imcomparably better armed and endowed than ourselves, concentrations of energy and activity in which we divine our most mysterious foes, the rivals of our last hours and perhaps our successors." On the other hand, as has been pointed out in "The Friendly Insects" (*Natural History*, Vol. XXVI, p. 147), relatively few kinds of insects seriously injure us and we owe much to many kinds. Possibly, with increased knowledge of insect habits, we may be able to swing the balance still more in our favor.


The high vacuum pump at the Loomis Laboratory. See the text

WHAT good are such experiments as these? Possibly collecting interesting information about the masterpieces of Creation is of no greater value than collecting human masterpieces of art; and possibly writing about Nature is no more useful than writing music; but, until some one is wise enough to be able to predict the worth of any bit of pure (as contrasted with "applied") science, we can at least say that it "amuses" those who do it and interests many who read about it. "Pure" science is science which has not yet been applied.

The Largest American-Made Telescope Mirror

READERS who are devoted to to science and the arts doubtless will recall that, in January, 1928, much publicity was accorded by the scientific and daily press to the successful casting of a two-ton disk of optical glass at the United States Bureau of Standards in Washington.

This disk, 71 inches in diameter and 12½ inches thick, had been poured in May of the previous year. The glass reached the mold at 2500 degrees Fahrenheit, was securely covered (the mold itself was in an insulated pit beneath the floor) and permitted to cool within a week to 1100 degrees Fahrenheit. It was held at that temperature four days, then cooled 4½ degrees per day until it reached 860 degrees, was held at constant temperature 45 days for annealing, and then allowed very gradually to cool to outside temperature, which required 130 days.

Only then might the covering be removed to ascertain whether the disk were broken and worthless or perfect. Dramatic moment! Some wag said that, as the decisive time approached, some of the anxious spectators nearly died of heart failure, but the disk came out uncracked. This was the first large American telescope disk ever cast and its successful completion rightly put a feather in the cap of the Bureau of Standards, particularly of Dr. A. N. Finn, the glass technologist at the Bureau. Optical tests for strains and symmetry of annealing indicated that the disk was optically as well as physically a success, and the whole proceeding thus constituted the beginning of a sort of declaration of American optical independence.

The disk was shipped to J. W. Fecker of Pittsburgh, the successor to the late John A. Brashear whose fame as a maker of large telescope mirrors is a tradition. The sequence of six recent progress photographs reproduced in the present pages was kindly furnished by Mr. Fecker, who with his men has done the further work which they show.

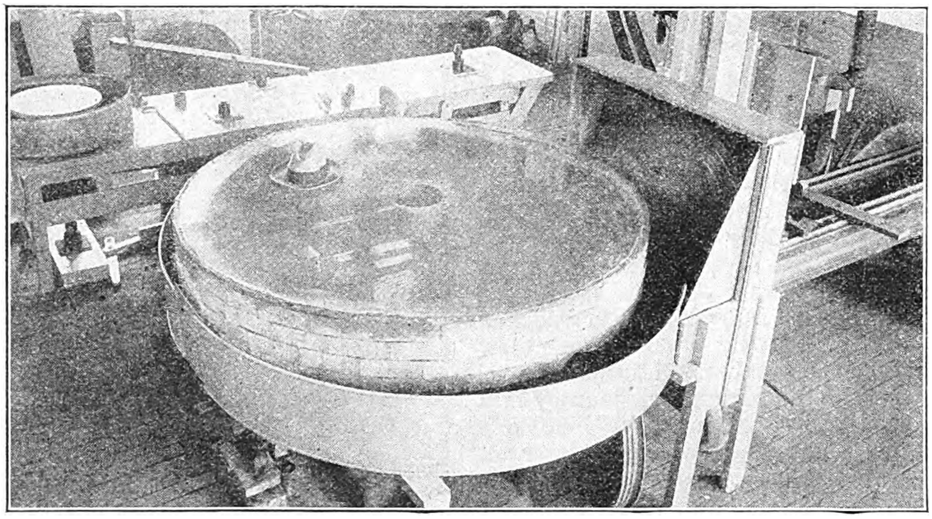


Figure 1, Above: **The raw glass disk of the 69-inch mirror. The geometrical pattern on its edge is due to the bricks of the underground mold**

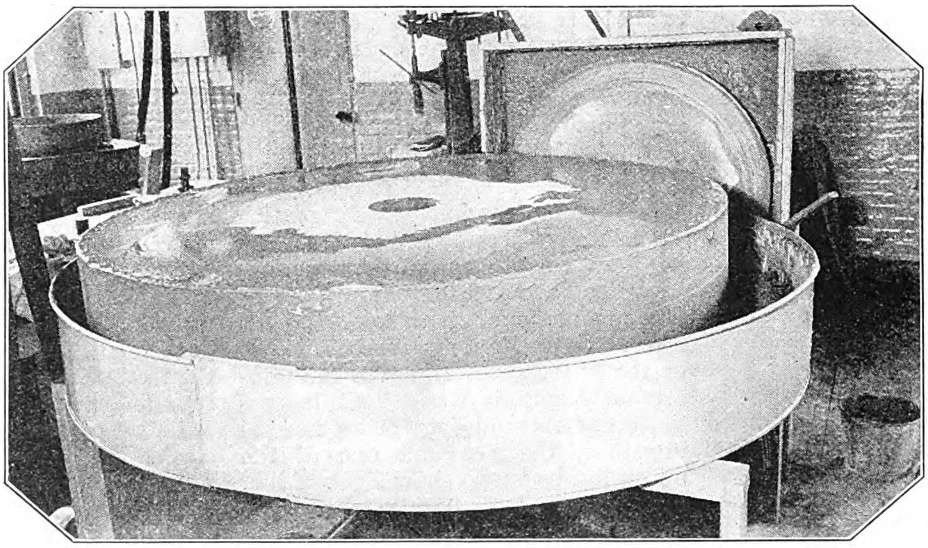
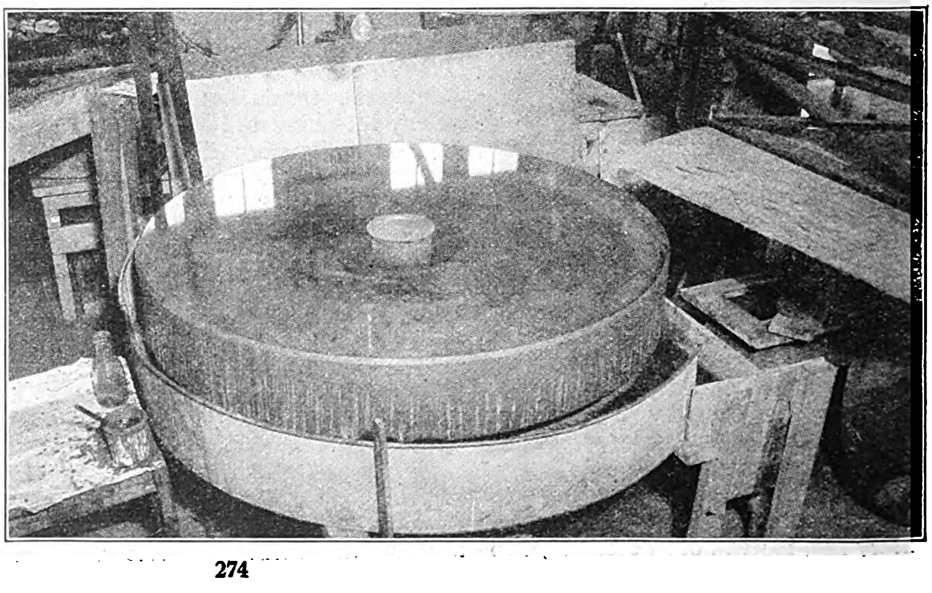


Figure 2, Right: **Rough grinding the edge with water and emery (note pot at right, on the floor) as the disk is slowly revolved**

Figure 3, Below: **The edge has been ground and the back surface ground and polished approximately flat. The disk is ready to be turned over and ground to thickness, preparatory to grinding the concave curve in the reverse side**



In Figure 2 the glass is slowly revolving while a disk of iron bears steadily against its edge, with wet abrasive doing the work of removing the irregularities. Figures 3 and 4 are sufficiently explained in the legends. In Figure 5 the disk, now reduced to $9\frac{5}{16}$ inches thick, has been ground to a concave (approximately spherical) curve having a depth of 0.95 inch, and less than one thousandth of an inch will be removed in all subsequent operations.

Apparently, then, the job is about complete. But is it? "In its present state," Mr. Fecker writes, "the mirror is about 20 percent completed." It is this last thousandth of an inch which contains most of the real grief in making a telescope mirror.

Even a thousandth of an inch is an extremely rough, coarse measurement in this work and a millionth of an inch is much closer to Mr. Fecker's final criterion of perfection. The degree of accuracy required by the purchaser in this case was one tenth of a wavelength of yellow light, or one 500,000th of an inch. In large work of this kind it is the practice to work within a specified tolerance, such as this, but Mr. Fecker carries the refinement to a still higher degree of accuracy. This final process, call "figuring," usually requires endless hours of the most skilled retouching, all performed underground in a constant temperature.

It is hoped that some time in 1931 the finished mirror will be functioning in the large telescope at Ohio Wesleyan University, which was made possible by the life savings of the late Hiram Mills Perkins and his wife Caroline Barkdal Perkins, the donors.—*A. G. I.*

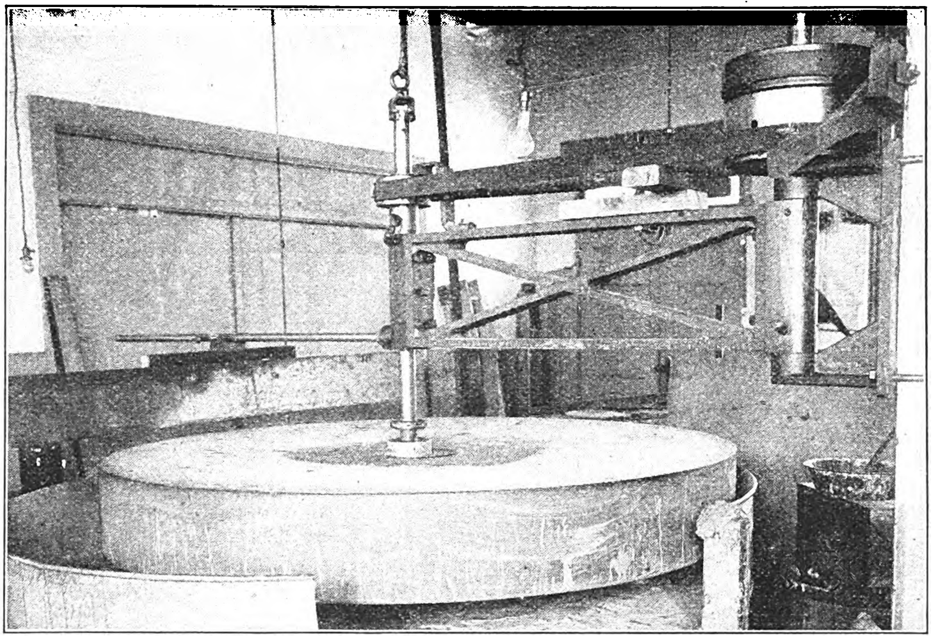


Figure 4, Above: **Grinding the hole true and concentric with the periphery of the mirror. As the disk slowly rotates the vertical, adjustable (note arm), revolving tool, belt driven, enlarges the hole**

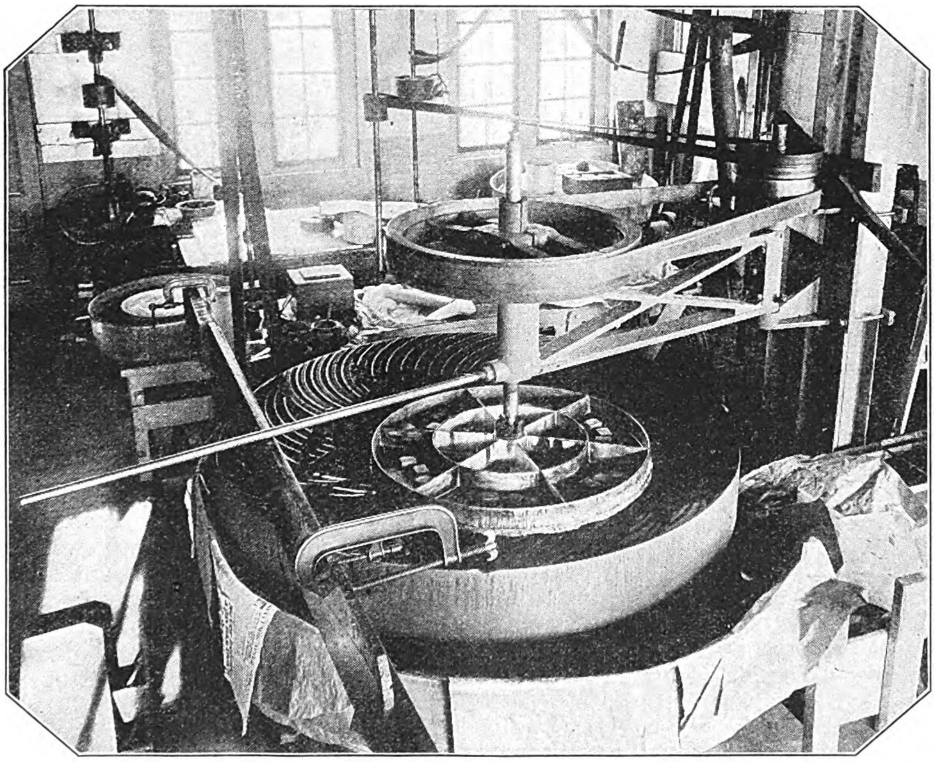


Figure 5, Left: **Polishing the concave surface of the mirror, using a pitch polisher and rouge abrasive. This brings the mirror to approximate spherical form ready for final delicate correction**

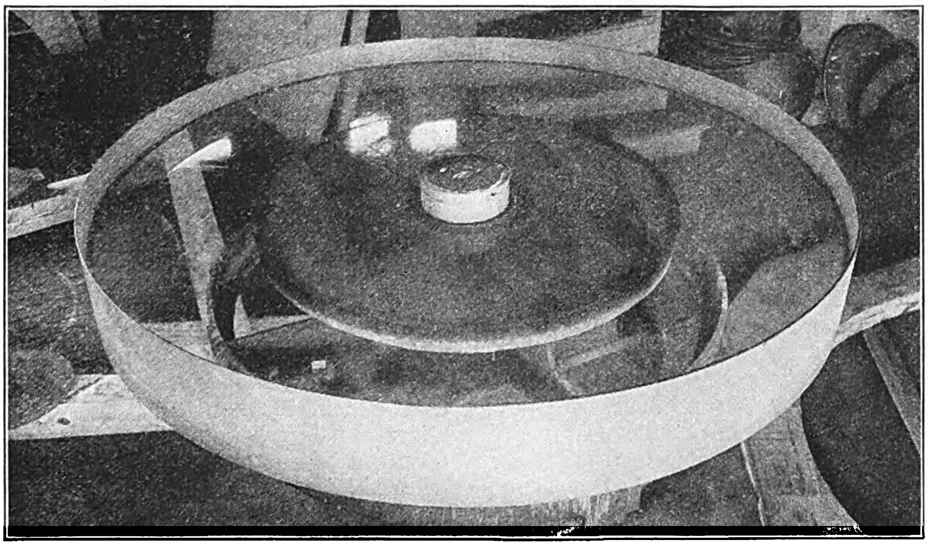
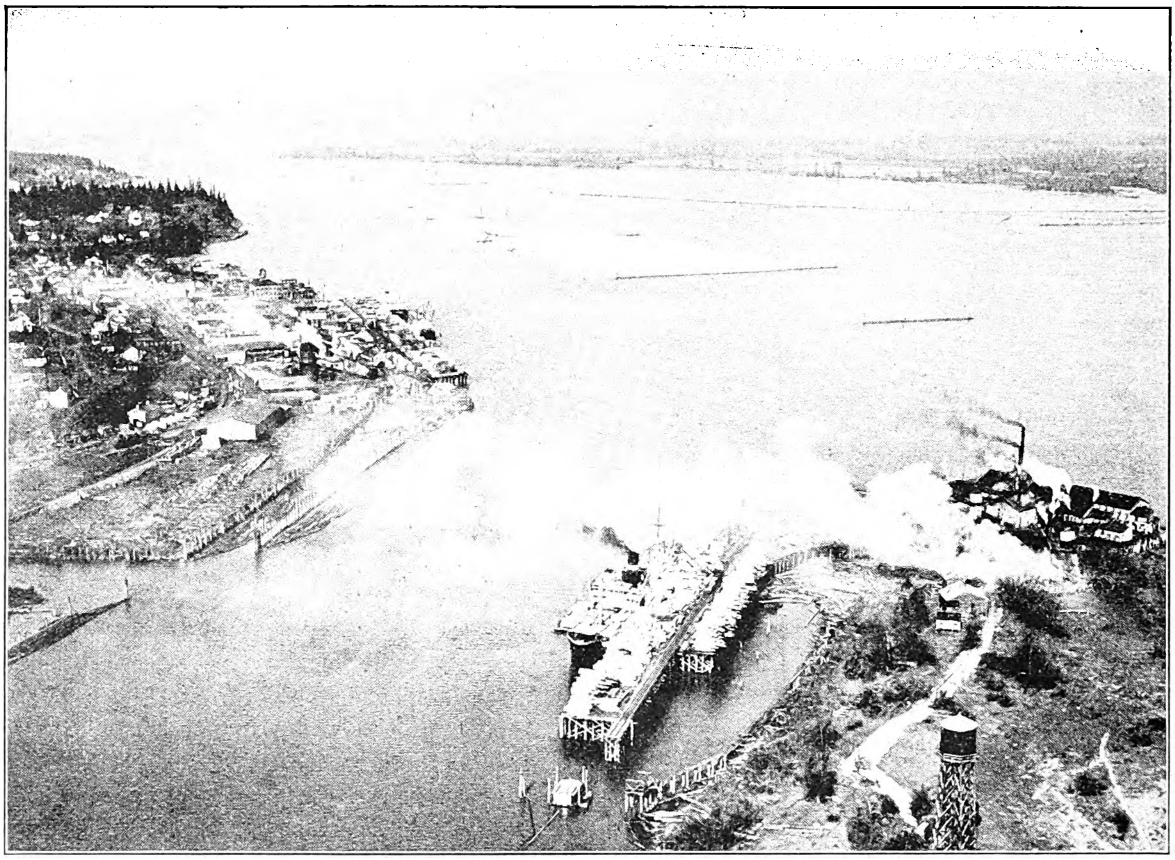


Figure 6, Below: **Ground and polished on both sides, ready to be put into its metal backing or "cell," removed to another machine in the constant temperature room underground and given final correction or "figuring"**



View of St. Helens, at left, showing a group of mid-stream diversion dykes which formed a deep-water channel at St. Helens where once broad marshes prevented ships from landing

The Development of the Columbia River

By CHARLES F. A. MANN

AFTER over a half century of incessant effort by the citizens of Multnomah County and Portland, Oregon, assisted by United States Army Engineers, toward the establishment of a deep channel in the 110-mile stretch of the Columbia River that lies between Oregon's famous port and the Pacific at Astoria, the final and most important chapter of all is about to be written down—that of scraping off the last five feet of river bottom in the present 30 by 300-foot channel, in order that a deep-water canal 35 feet deep and 500 feet wide will be a stable part of the Columbia River.

Word reached residents along the lower Columbia late in 1929 that the Board of Army Engineers had approved and recommended the project to Congress, involving an initial expenditure of only 1,366,000 dollars with an annual maintenance charge of 665,000 dollars. Five feet does not seem much, but when one realizes that 85 percent of all imports of the Pacific Coast ports move in ships of greater draft than can be cared for in the present 30-foot channel, the importance is at once appreciated. Portland, together with its neighboring Columbia River ports of Vancouver, Washington; St. Helens and Rainier, Oregon; Kalama and Longview, Washington, draining vast quantities of lumber, paper, pulp, and fruit into the markets of the world—presents the paradox of a great seaport being able to export but do little importing.

THE Columbia River ranks as one of the great rivers of the world, draining some 300,000 square miles of territory in seven states and British Columbia, which is a region of heavy precipitation. It flows from glacial headwaters in the remote Columbia ice fields in north central British Columbia for 1200 miles to the Pacific.

Because of its gigantic proportions, the development of the Columbia for power and navigation, and use of its waters for irrigation, has been very slow. The great interior stretches of the river flow through vast, sparsely inhabited arid plains and past weird rocky cliffs where once countless lava flows and uplifts tore gashes and even changed the course of the river entirely. There is approximately 8,000,000 horsepower of primary and double that amount of secondary, or summer hydroelectric power available in the Columbia River. Only in the fall of 1929 were plans made for the first power plant ever to be placed on the river. It will be a 100,000 horsepower plant at Priest Rapids, in central Washington.

Because of its glacial origin, the Columbia carries vast quantities of sharp sand in its waters. In addition to this, when the hot summer sun melts the glaciers in the Columbia ice fields each year, the river floods with unusual rapidity, raising the level from 20 to 75 feet in various parts of its course. With a normal flow of about 70,000 cubic feet per second the river rises at certain times to a maximum of 1,400,000 cubic feet per second. Thus two great problems confront engineers who set out to conquer the river: silting and flooding in peculiar combination.

Scarcely 30 miles above Portland—140 miles inland from the ocean—the Columbia takes its last plunge over the Bridge of the Gods practically to tidewater. From there on, the river, known as the Lower Columbia, changes its character. It becomes wide, often sluggish, with shifting channels and innumerable sandbars. Rolling, green hills and fertile river plains in the wide lower river valley form the banks. It is in these quiet waters that the people of Portland and the lesser ports are directly interested.

Long ago navigation on the upper river, above Portland, gave way to the parallel railroad tracks on each bank, which are not affected by floods or silt and need fear no rapids, yet are able to take advantage of the matchless grade through the mountains that never is greater than 0.2 percent all the way from Spokane to Portland. This factor, together with the limitless possibilities of growth in the tributary area of Portland, long ago made one vital factor of great importance to the citizens of Oregon's metropolis: to make the Columbia River into a navigable channel. In final terms their problem was about as follows:

1. To get a deepwater channel to the Pacific.
2. To create a deep harbor in the shallow Willamette River, on the banks of which the city of Portland rises, 12 miles in from the Willamette's confluence with the Columbia.
3. To build two jetties at the mouth of the Columbia in order that the river might carry its silt far to sea, leaving ample depths over the bar at all tides.
4. To keep all bridges high above the Portland harbor and permit nothing but suspension spans with at least 200 feet clearance over the Columbia.

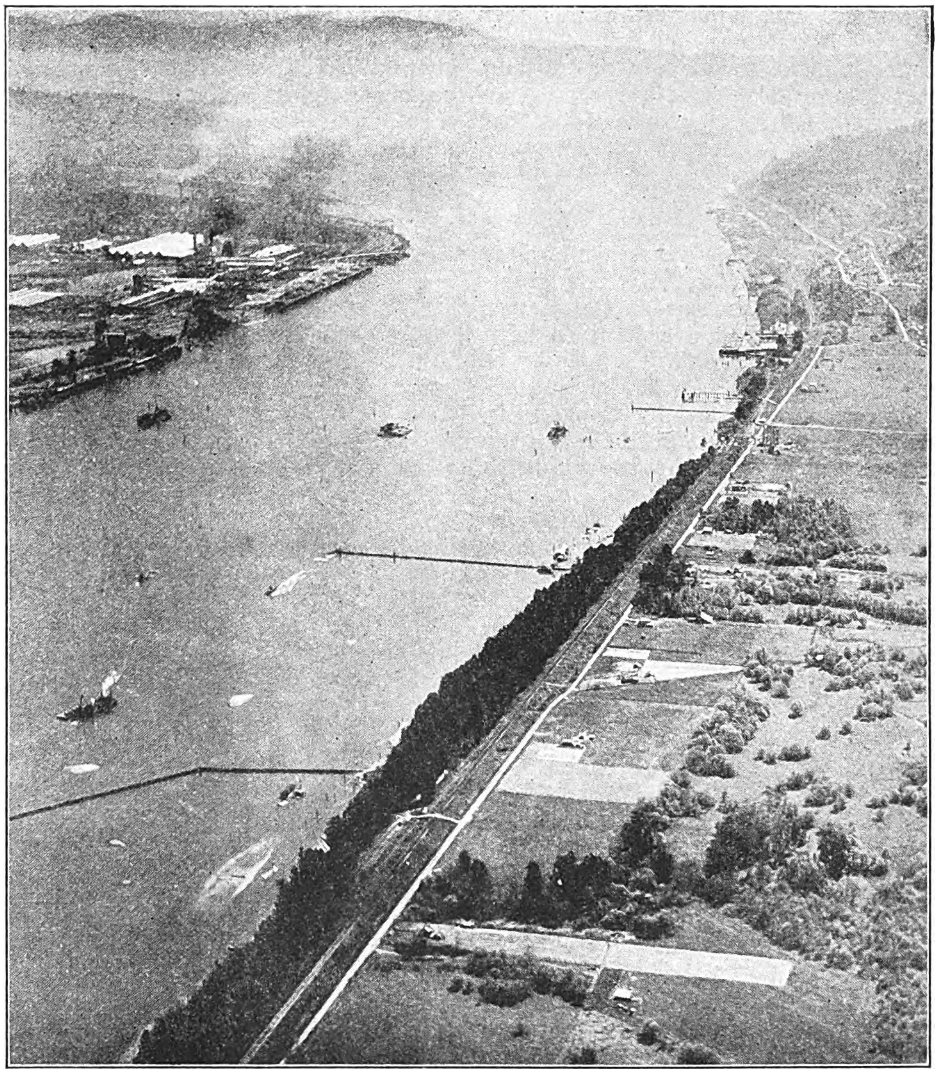
FIRST efforts by Portland citizens to get a deep channel in the Columbia began more than half a century ago. In order to clarify the method of carrying out the long series of river improvements, it is well to divide it into sections. The first section concerns the work of the Engineer Corps, United States Army, which has complete charge of the Columbia from its mouth to its confluence with the Willamette River. The second concerns the work of the citizens of Portland and Multnomah County, that of developing Portland Harbor without financial assistance from the Government through the Port of Portland Commission, and the development of public terminals through the Portland Commission of Public Docks. To the end of 1928, the United States Government had spent about 16,000,000 dollars on the two jetties at the Columbia's mouth, and 11,000,000 dollars on the 100-mile stretch of the Columbia River; the city of Portland had spent approximately 25,000,000 dollars divided about equally between harbor development and a public terminals system.

In the original state of the river, a minimum depth of about 15 feet was found, and around 20 feet at the Columbia Bar at the river's mouth. When work was first started by the Government a half century ago, the first problem to be solved was that of making the river scour its own bed free over the bar. The original plan for these jetties was first approved by the Government in 1884, but it was not until a quarter of a century later that they were finished. The south jetty is seven miles long and the north jetty two and a half. These have effectively changed the channel over the bar to a depth of 46 feet for a width of about 2500 feet and 40 feet for about 7000 feet width at mean low water. The original depths of the river were from 19 to 21 feet over a width of six miles.

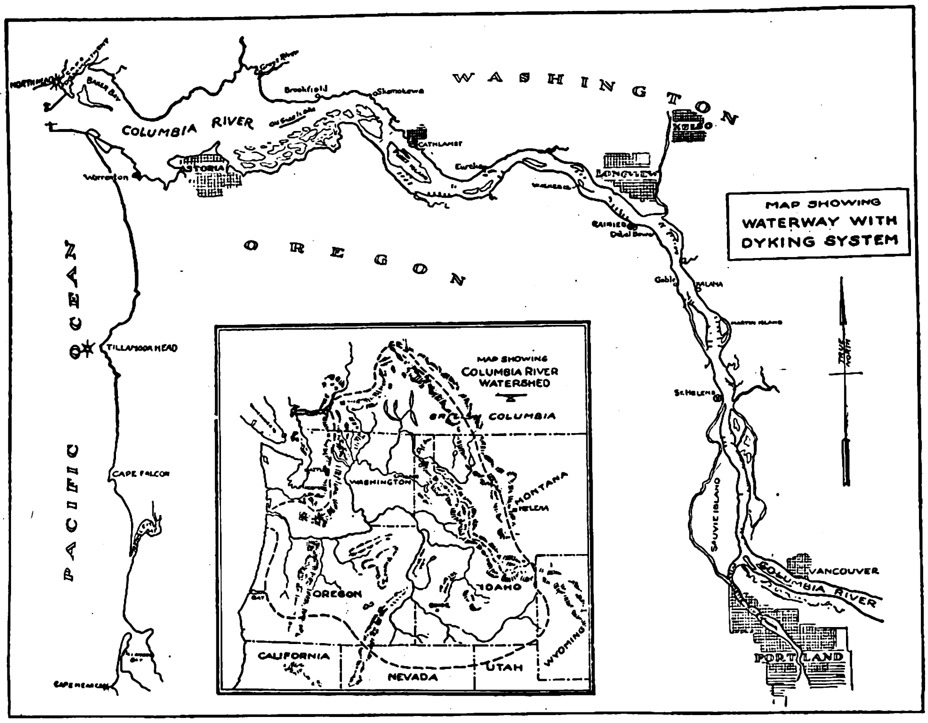
In the 100-mile stretch from Portland to Astoria, the Columbia develops shoals in about 25 places after the annual freshet in June. These are known as bars and, between them, deep pockets of safe water are found. So regular are these bars that year after year they are found in exactly the same places and after being measured are attacked by dredges and pumped away.

Ever since the long line of surveys was begun on the lower Columbia in 1878, the plan has been to make the river scour its own bars free of silt, the deposit of which varies from three to twelve feet each season, in exactly the same way as the big jetties at the mouth do. Accordingly, the primary problems of the Army engineers were reduced to two: dyke construction and supplementary dredging where dykes would not do the job.

BY watching the river closely after each flood, they have found where the shoaling takes place. As a result of this, more than 70 dykes projecting into the river at various angles have been built, which act as a contraction to the stream flow and keep the mass of mud and silt moving along the bottom. Supplementing this, after each flood from June to October, a fleet of dredges attacks the bars and brings them back to normal depth. The Portland Port Commission lends the War Department two dredges for a period of three months each year, the government paying nothing but operating expenses, to assist the regular Army dredges in speedily bringing back the proper depths before the



Three new dykes at Ranier, Oregon, at wide part of river where silting takes place. Notice how sand has been deposited on downstream side of dykes



deep-draft grain ships begin to move in October. This accounts for the abnormal rush to bring the channel back to proper depths that takes place each summer. The Willamette River does not silt in summer, but during heavy rains, it floods vast quantities of mud down from its valleys, which must be removed. Silting in the Columbia amounts to about 5,000,000 cubic yards per year.

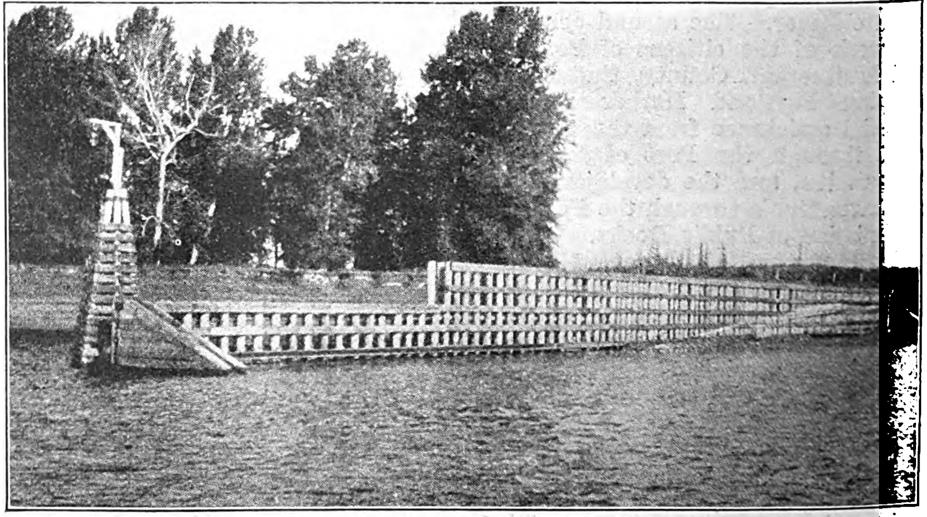
AFTER years of effort, the effect of the permeable dykes has become apparent. The channel is now stabilized and the success of the timber and rock wing dyking system has been proved. The entire project is a part of successive projects for 20, 25, and 30-foot depths approved by Congress in acts of 1892, 1902, 1905, 1913, and the foundation work of the 35-foot depth project about to be started, in 1919. With faster and deeper ships, increased dyking has had to be done to compensate for the increased cross-sectioned flow incident to dyke construction of earlier dates which deepened the channel.

In order to execute the 35-foot project, about 18,000,000 cubic yards of silt will have to be removed. In addition, 18 new dykes will have to be built and 28 extended farther into the river, amounting to 44.7 miles of Columbia channel and 11.5 miles in the Willamette. The annual appropriation of 665,000 dollars will serve to dredge away 7,000,000 cubic yards of silt and to repair dykes.

At Portland, we find the oldest quasi-public organization in the northwest, the Port of Portland Commission, at work with a fleet of four dredges, moving millions of yards of mud out of the Willamette, building its famous Swan Island Airport in the middle of its harbor out of waste silt from its dredges, filling in valuable real estate areas in the harbor, operating drydocks and towboats, and in sole charge of the entire harbor, without governmental aid in any form. Organized in 1891, the Port Commission began dredging away on its harbor, then mainly a muddy puddle between the two halves of the city. One old steam pipeline dredge—the famous *Portland*—worked 30 years at the task. Four others, ending with the 2000 horsepower twin-turbine steam dredge *Tualatin* and the giant *Clackamas*, a 3400 horsepower Diesel-electric dredge of tremendous capacity, were built. The *Clackamas* was the last dredge built by the Commission and, at the time of her building in 1925, was the most powerful in the world. She is capable of moving 20,000 cubic yards per day at a cost of about three cents per yard, and cost 850,000 dollars to build. During the two years in which the Swan Island Channel was changed to the west side of Swan Island and the famous airport built out of the waste from the dredges, the Port Commission dredges moved 39,000,000 cubic yards of material with an over-all cost of about 2,500,000 dollars. The real estate obtained by filling tide lands reduced the net cost of the entire project and gave the Commission an airport, a yacht harbor, and a new channel, all for less than 800,000 dollars! This still ranks as one of the most important dredging projects in the world.

WITH the last and most important step of all about to be taken, that of the 35 by 500 foot channel to the sea, the efforts of 50 years will at last bear their best fruits. Probably no more important piece of engineering has been done in this country than the building of a fine inland seaport on the erratic Columbia. With the hinterland yet comparatively untouched, and an enthusiastic group of boosters besieging Congress for 350,000,000 dollars to irrigate 2,000,000 acres of the Columbia Basin, the waterway will grow in importance as the years pass. Credit for the two big divisions of Columbia River development goes to Colonel G. R. Lukesh, of the Army Engineers at Portland, and James H. Pohlemus, Manager and Chief Engineer of Portland's famous Port Commission.

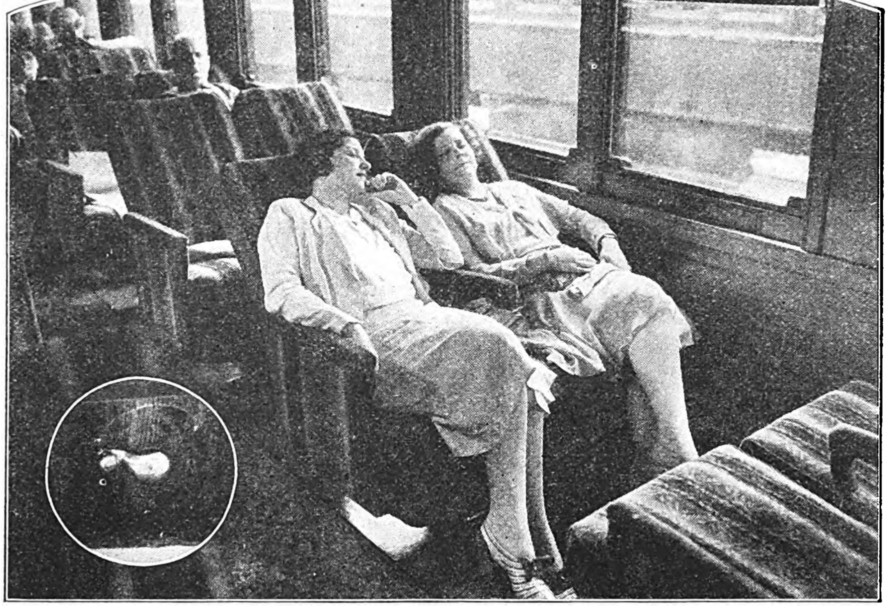
Another phase of the work, although not immediately concerned with channel development, is the vital problem of bridges in which approximately 50,000,000 dollars have been invested. Eight large spans cross the Willamette and two cross the Columbia carrying rail and highway traffic northward from Portland into Washington. A 6,000,000-dollar cantilever span across the Columbia between Longview and Ranier was opened in January, 1930; and a 5,000,000-dollar suspension span has been planned to cross Portland Harbor at St. Johns.


Dyke on Washington shore, showing type of construction. Channel marker on end of dyke on tower. River is low; high-water in June nearly covers the dyke

A Reclining Chair Night Coach

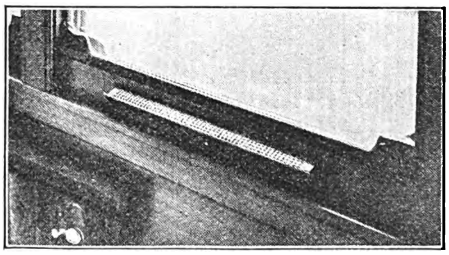
WHEN a person has to travel only part of the night, it hardly pays to take a berth in a sleeping car; some travelers cannot afford even the luxury of an upper berth. To all such, a new type of car has been introduced by the Baltimore & Ohio Railroad Company for their night trains between New York and Washington. These cars were built in the Mount Clare shops, Baltimore, Maryland. "Twin seats" in day coaches are in use on other railroads, but these new cars have many points of novelty.

THE exterior of the car shows no change, but in the interior there are many departures from normal practice. By means of cranks, each seat can be inclined independently. The arm-rests of the reclining seats are of sponge rubber composition, soft and comfortable. The middle armrests are collapsible and disappearing so they can be removed if desired, to allow children to lie down. Foot-rests are also provided, adjusted to the proper angle so that when the seats are in a reclining position, the posture of the occupant is conducive to rest. Thermostatic control is provided on each side of the car to insure even temperature throughout, and in addition there are ceiling and window ventilators. The decorations are plain and the car is finished in "living-room" style. In addition to ceiling lights, small individual night lights are provided so that those who wish to read may do so. There are separate smoking rooms for men and women, with comfortable arm chairs. The great novelty is the lunch room at one end, where simple refreshments can be obtained at all times during the long and wearisome night.

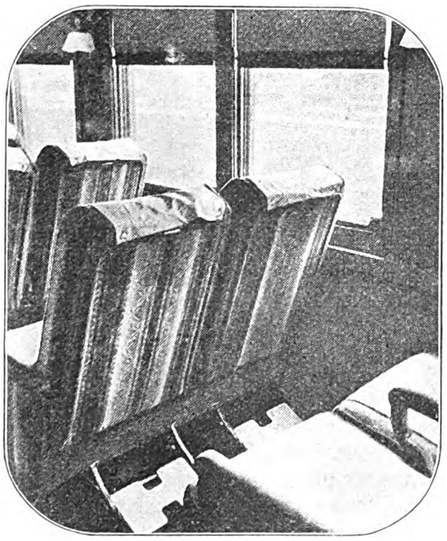


All photos courtesy Baltimore and Ohio Railroad

Each seat can be inclined independently by manipulating the cranks (insert). Windows have ventilators and a night light is on the side wall over every other seat

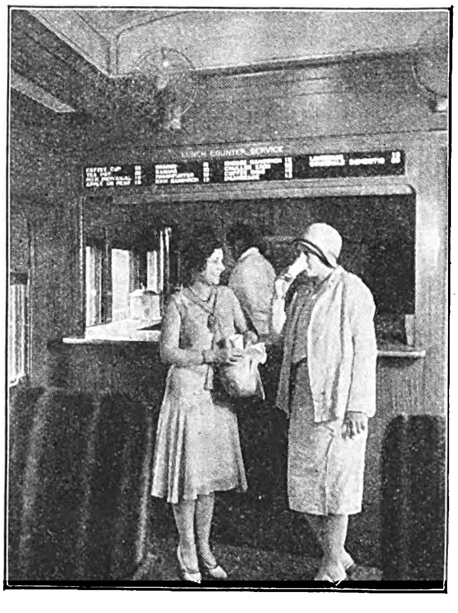


The window ventilator is a novelty. The air filters in through screens which arrest the cinders. Car windows are notoriously obstinate and here is the solution. The chair position crank is seen below

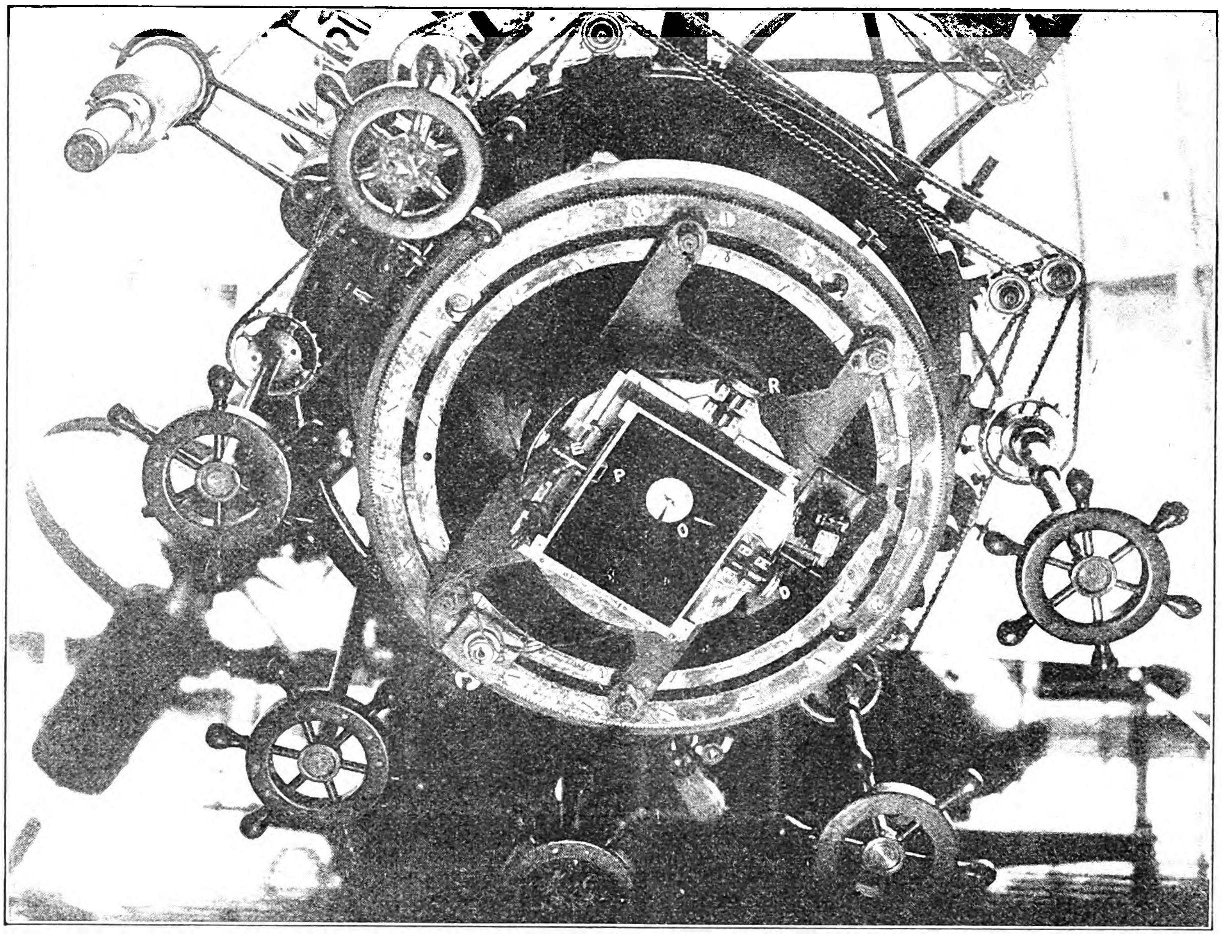


***Above:* The foot rests are adjusted to the proper angle so that when the seats are in a reclining position the posture is most rest producing**

***Left:* Women need no longer "bootleg" smokes, for a comfortable compartment with real chairs is provided for their use**



***Right:* This is not a "diner" or a "broiler" but it is a real lunch counter, where beverages, fruit, and sandwiches can be obtained**



Courtesy Yerkes Observatory; also "Astrophysical Journal" (Vol. 32 page 375)

Figure 1: **Professor Schlesinger's occulting disk or rotating sector invention attached to the 40-inch Yerkes refractor, for use in star distance measurement. The nearly square central object is the 8 by 10 photographic plate holder. O is the disk adjusted to a V-shaped opening (small object at center of disk is an adjusting wingnut.) P is the prism described in the text, and E the guiding eyepiece with crossed spider webs inside. R and D are the two guiding screws**

Measuring the Distance to the Stars

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University

Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

SIR ROBERT BALL, who illuminated his admirable lectures with recurrent flashes of his native Irish wit, used sometimes to say, "Astronomy consists of sitting up all night and doing arithmetic all day." No truer picture of the life of the working astronomer was ever compressed into a sentence. All that need be said in addition is that some astronomers specialize in the sitting up, some on the arithmetic, while some divide their energy between the two.

An excellent example of the third sort of work is found in the measurement of the distances of the stars. This has become in recent times distinctly an American field of work and may well claim our attention for a few moments. The principle involved is the simplest. Look out across the room through a window at the world without, then move your head a few inches from side to side. As you do so the window bars will seem to shift to the right as you move to the left, and *vice versa*. It is exactly such a shift of nearer objects, compared with those at a distance, which we use to measure the distances of the planets and the stars, only we call it by the Greek name of "parallax." Obviously, the nearer one sits to the window the more the window bars will seem to move across the landscape (for the same motion of one's head) and, if one can measure the apparent shift, the simplest sort of geometry gives their distance. Exactly the same principle is used in the range finders which are so important in military and naval gunnery.

TO apply this principle astronomically we must have two things: a shifting base moving by known distances, and a distant background against which we can measure the parallactic shift. When we are working on the moon or the nearer planets we change our base simply by making observations from different parts of the earth, or by the cheaper process of letting the rotation of our planet carry us around it. When we must deal with the stars we need a far longer base line. Fortunately we have one, provided by the earth's motion in its orbit, which takes us alternately 93,000,000 miles on one side of the sun and on the other, and so gives us a base of double this length. Even with this long base the parallactic shift is measureable only for a small minority of the stars. The rest are so far distant that their displacement is imperceptible.

This is no unmixed evil, for we may employ the multitude of faint stars which cloud the heavens as the background, the standard of reference; which is the other prime necessity of

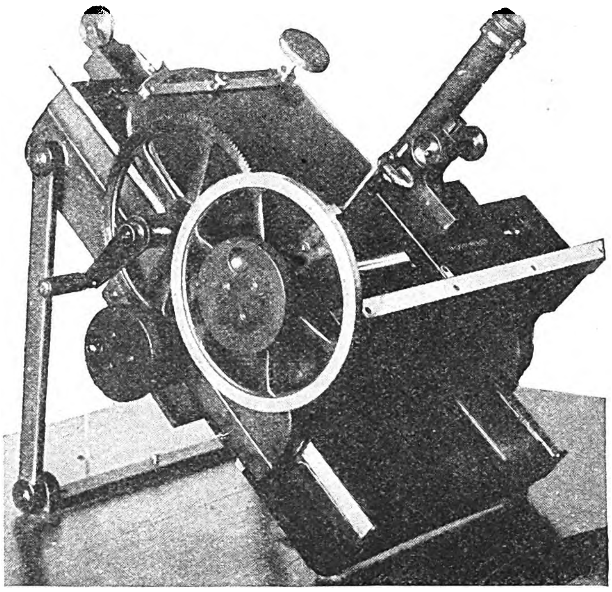


Figure 2, Right: **Gaertner machine for measuring parallax plates. A microscope, movably mounted above the plate on a very accurate, horizontal low-pitch screw, is spotted over the star's image, with the aid of its cross hairs. The accurately divided index head at end of screw facilitates measurement to 1/25,000 inch**

Courtesy Yerkes Observatory

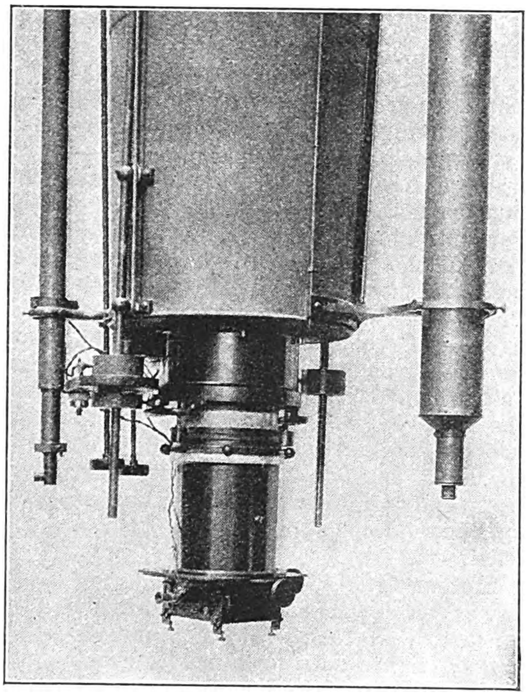


Figure 3, Below: **Double slide plate holder of the 26-inch refractor at Leander McCormick Observatory with which Professor Mitchell's work was performed. Note small guiding eyepiece at left and guiding screws at right**

Courtesy Prof. S. A. Mitchell

the method. Theoretically it is not quite an ideal standard, for even these remote stars must show a small parallactic shift compared with an absolutely fixed background. But, practically, this makes no trouble, for we have means, based largely on the sun's motion in space, of finding the average amount of this tiny shift and can then allow for it.

When it comes to the application of these principles to the actual measurement of star distances we meet with various difficulties. The first is that the stars do not stay still to exhibit their annual shift, but move across the heavens. By extending our observations over two or three years, however, we can easily find out the rate of this "proper motion" for each star and allow for it. More serious is the fact that the shift due to parallax is very small, so that our observations must be extremely accurate. This difficulty again has been fairly well overcome by the use of large telescopes and, above all, by the photographic method of observation.

ONE of the most unexpected discoveries of modern precise astronomy was that it is possible to make more accurate observations with a given telescope by photographing the stars and measuring the positions of their images on the plates than by measuring the stars directly with a micrometer attached to the telescope. Until the thing was actually tried no one had any idea how precisely the photographic film preserves the record of the position of the images which impress themselves upon it. In ordinary modern practice the average error of position of a single star image is less than a 10,000th part of an inch. Considering the vicissitudes through which the gelatine film has gone during the processes of development, fixation, and drying, this is really extraordinary.

However accurately the plate records the positions of the star images, it must be measured under the microscope, employing some form of micrometric device (for example, as in Figure 2), and it may still seem strange that this two-stage process yields better results than does the micrometer directly applied to the telescope. The most probable explanation is that, owing to the irregularities of atmospheric refraction, the star images in the telescope are continually oscillating and dancing about. In visual observation the observer sets his spider thread on the images and catches them at some one moment. The plate automatically averages the effect of the oscillations of the image during the whole length of the exposure (usually several minutes) and thus gains a considerable advantage. When it comes to measuring the positions of several stars in the same field the photograph has the still greater advantage that its record is simultaneous for all, while the visual observations must be successive and are subject to different errors in each case.

Photographs, therefore, have quite ousted all other methods in parallax work, but the observer is only at the beginning of his troubles when he has set up his telescope and got his lenses into proper adjustment. In the first place his instrument should follow the diurnal motion of the stars in the heavens so perfectly that the image of a given star throughout the whole time of the exposure falls exactly on the same spot upon the plate. Even the best driving clocks do not quite meet this severe requirement, and of course they can not follow at all the irregular motions of the images caused by refraction. To meet this need the parallax observer has the plate holder mounted on the telescope in such a way that it can be moved up and down or right and left by two delicate screws. (Figure 1 at D and R; also Figure 3.) Just outside the plate holder and clamped to it is an eyepiece (E, Figure 1), adjustable in such a fashion that the observer may bring into it the image of some faint star. Before he begins his exposure he brings this star on the cross hairs of the eyepiece. Then, watching with the eye of a hawk, he notes the slightest deviation of this image and brings it back by turning one or both of the screws which move plate holder and eyepiece together. An experienced observer in this way may get rid of most of the "errors of guiding" which otherwise might vitiate the positions of his star images. As a result of this care the images will all be small, clean and round. If by any mishap they are not, the plate will be rejected and not measured.

TO get good images, however, we need not only careful guiding but correct exposure. Under-exposed images are gray and diffuse; over-exposed large, fuzzy, and ill-defined—and neither sort can be measured accurately. When the star whose parallax we are seeking is faint, this causes no extra trouble. A trial plate or two shows what length of exposure is necessary to get good images of this "parallax star," and among the other stars which appear on the plate it is practically always possible to find enough of about the same brightness to serve as the "comparison stars" which furnish the requisite background.

But the parallax star may be a bright one—perhaps even Sirius itself—while the only available comparison stars are a hundred or even a thousand

Photo by Dr. James Stokley. Science Service

Professor Frank Schlesinger, Director of Yale Observatory, whose parallax work was done at Yerkes and Allegheny Observatories

times fainter. Obviously, some means must be found to cut down the light of the one without obscuring the others. This is usually done by the aid of an "occulting disk" an inch or so in diameter (Figure 1, O). This consists of two parts which can be set so as to leave a narrow open sector of any desired width from 1 degree to 180, while blocking out the rest of the circumference. This disk is mounted close to the front of the part of the plate where the image of the parallax star falls and is rotated rapidly by a tiny motor or by clockwork. If the opening in the sector covers only 1/50th of the circumference, the parallax star will be given intermittent exposures which will total 1/50th that given the fainter comparison stars which receive a continuous exposure.

WITH this apparatus the image of even a very bright star may be reduced to apparent equality with those of its faint neighbors without losing the advantage resulting from the averaging effect of a large number of exposures under different conditions of trembling of the images. This method has been completely successful, with the result that observations of stars as bright as Sirius made with its aid are found to be as accurate as those of faint stars which do not need it.

Still another danger, and the most subtle, remains. The images of the stars are raised in the heavens by refraction, and more for white stars than for red ones (by the same influence which produces the "green flash" at sunset). If our parallax star and comparison stars are not of the same color (as very often happens) this will shift the one relatively to the other. So long as this spurious shift is always in the same direction and of the same amount it will not trouble the parallax observer, but if it is in different directions at the same time of his different observations it may become confused with the true parallactic shift in such a way as to vitiate his results. To be safe, therefore, he must observe any given star always when it is in the same position in the sky, preferably on the meridian, so that the error due to refraction may always be the same.

When all these precautions are taken, a set of from 12 to 20 photographs made at the proper times during an interval of two or three years, will give a determination of the parallax with the probable error less than 0''.01, which exceeds in precision any other angular measurement.

Parallax work is a strenuous occupation. To get the shift in one direction the stars must be photographed in the evening as soon as it is really dark—which is easy; but every such plate must be matched with one showing the opposite shift taken at some other time of the year and in the morning hours just before dawn. To carry on the careful work of precise "guiding" without a moment's relaxation of the tension through these weary hours is "sitting up" with a vengeance, even if the observer has left the instrument to another worker during the middle of the night and sought a well deserved rest—and it is rarely that the size of an observatory staff permits such a relief.

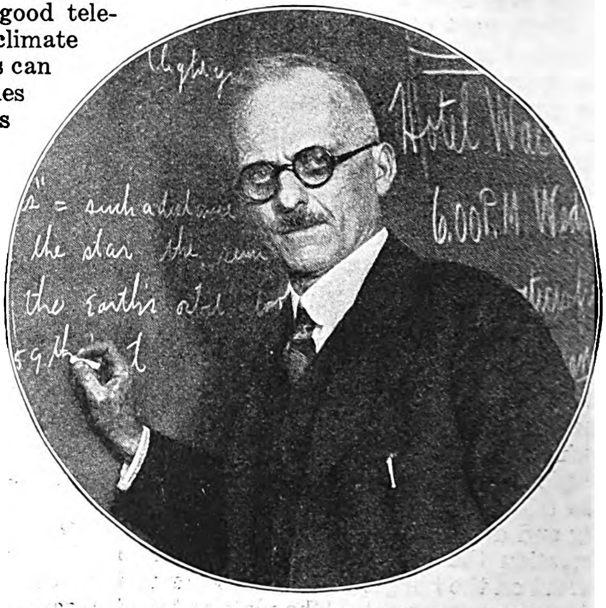
Measuring the plates, after they have been developed and passed as fit for it, is a job for the daytime and for a good light, and consumes a great deal of time. Indeed, one good telescope in a fairly favorable climate and with assiduous observers can secure plates two or three times as fast as these observers could work them up. Fortunately the measurement, like most routine work, can be entrusted to assistants and this is true *a fortiori* of the computations, which are simple but interminable when thousands of plates have to be discussed.

The pioneer of this photographic method was the great Dutch astronomer Kapteyn, who first pointed out the importance of accurate guiding and the way to avoid the errors due to refraction. The methods which are at present employed are mainly due to Schlesinger of Yale, who first used the rotating disk upon bright stars and devised the very convenient methods of calculation which are now employed by almost all workers in the field.

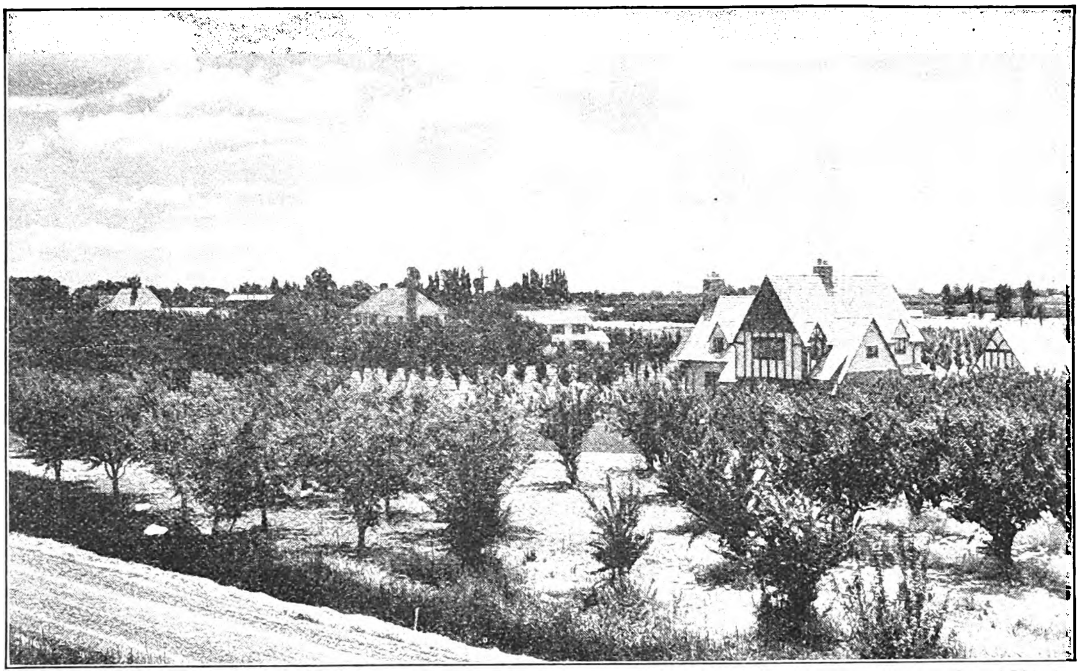
Most of these workers are Americans. First in productivity is Professor Mitchell, Director of the Leander McCormick Observatory of the University of Virginia, who recently has been the guest of his colleagues at other observatories in celebration of his completion of determinations of parallax for no less than a thousand stars! (See page 247.) This record is the more noteworthy since it comes from an observatory possessing a telescope of moderate size, as great instruments now go, and very modest resources. Moreover, the telescope is a visual one and therefore slow in photographic work. Only the persistent devotion for a long term of years of the director and a loyal corps of colleagues could have secured this remarkable result.

NEXT in order comes the Allegheny Observatory where, at first under Professor Schlesinger and later under Professor Curtis, more than 850 parallaxes have been determined. Smaller but very considerable lists, each about 300, have been observed at Mount Wilson, Yerkes, Greenwich, and the Sproul Observatory of Swarthmore College. The promising and almost untouched field of the southern hemisphere is now being worked both at the South African station established for the purpose by Yale under the direction of the veteran Schlesinger and at the Cape Observatory.

Arduous as the work is, and dull as some parts of it may seem to one who merely reads about them, it has a curious fascination.—*At anchor, off Mitylene.*



Dr. H. D. Curtis, Director of Allegheny Observatory at Pittsburgh, who also has measured many star distances and made inventions



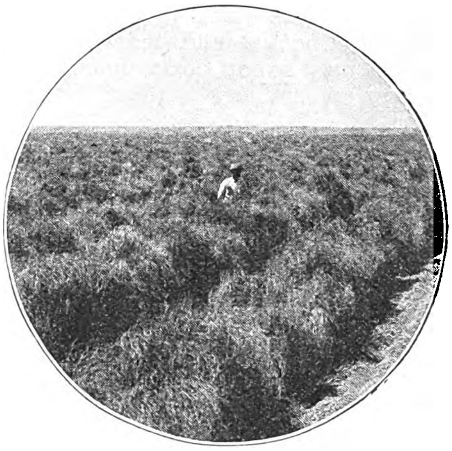
Where once were the worthless tule marshes along the Sacramento River, are now found prosperous farms, luxuriant orchards, and beautiful homes—wealth for everybody everywhere

Courtesy *Pictorial California*

Marsh Delta Lands Become Rich Farms

ONE of the most fertile regions in California is the Delta area (usually called the "Delta lands") in northern California, just a few miles west of Sacramento, the capital city. The tule marshes along the Sacramento River were long considered worthless but have been developed in recent years into most fertile farm and orchard land. Until the engineers constructed levees, drainage canals, pumping plants, and other flood protection, the Sacramento and San Joaquin Rivers spread out over the entire area during annual spring floods, depositing new layers of silt. Water for irrigation now comes from the rivers and the surplus water is drained and pumped back into them. Soil rich with the humus of centuries, abundant water, and a splendid climate all unite to make this one of the most fertile spots in the United States. The crops are very diversified and include asparagus (a 10,000,000 dollar crop). The rivers and paved highways serve to bring all the crops to market or to the great canneries at strategic points.

Gyp corn, a dwarf type, grows to nearly double height—seven feet



Asparagus is a splendid crop in Delta lands, worth $10,000,000

Celery is grown on seven thousand acres in the Delta lands and much of it is crated in the field itself

Cutting asparagus in the irrigated fields. Much of our best canned asparagus comes from this locality

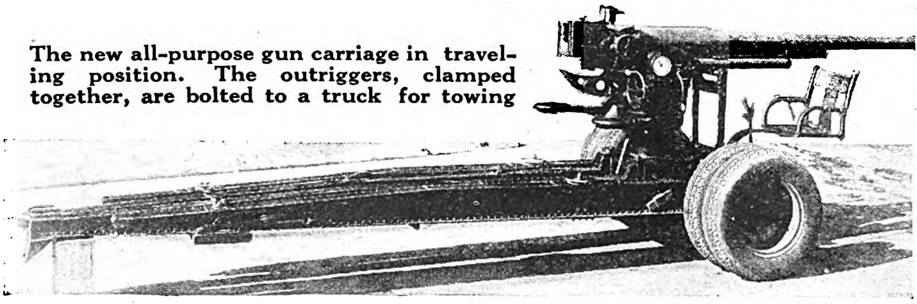
Our Army's New Super-Weapon*

By MAJOR G. M. BARNES

Chief, Design Section, Watertown Arsenal, Watertown, Massachusetts

DEVELOPMENTS during and since the war are tending to render the existing field artillery matériel obsolete. It is a well known fact that new field guns and carriages of the division, corps, and army types have been built since the war which are greatly superior to the war types in that the guns give greater ranges. However, the matter is more serious than that, since none of the war types and few of the post-war types of artillery will meet the new demands which will be required of them in future wars.

High-speed targets in various forms are gradually entering the field of fire of all types of field guns, such as the new high-speed trucks used as prime movers for artillery and for carrying infantry, and tanks having cross-country mobility and speeds heretofore unthought of. But even more menacing than the high-speed tanks and trucks are the many types of aircraft, carrying bombs and machine guns, which may swoop down upon the infantry or artillery without warning.



The new all-purpose gun carriage in traveling position. The outriggers, clamped together, are bolted to a truck for towing

It is well known to all field artillery officers and other officers, and civilians as well, who have given thought to the problem, that the present types of field artillery, as exemplified, for example, by the famous French 75-millimeter gun, are wholly incapable of dealing with these high-speed targets. Few of the carriages for these guns permit sufficient elevation for firing at aerial targets, or have sufficient speed in traversing or elevating.

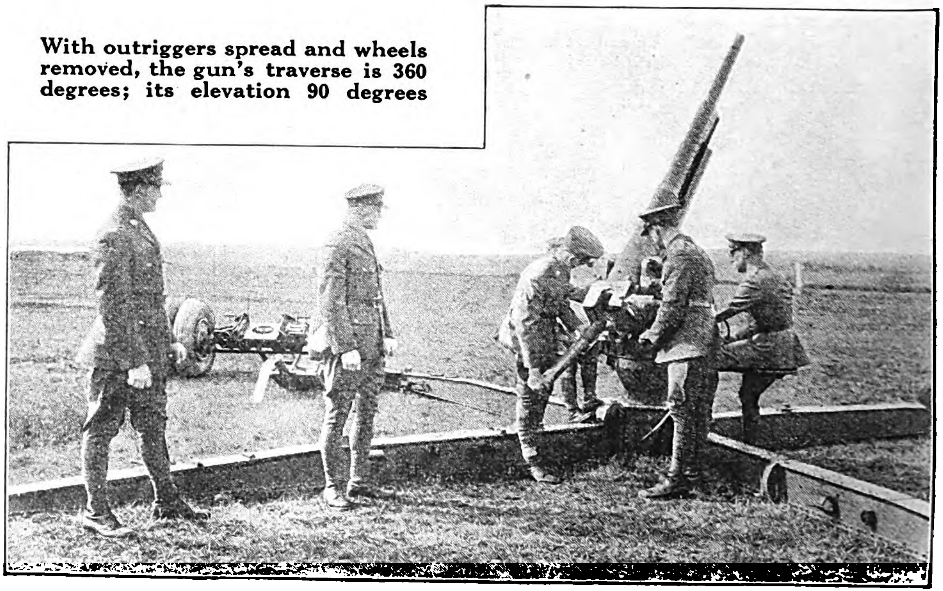
Unfortunately, not only the guns and the carriages but also the fire-control instruments which have been developed for use of field artillery, are wholly unsuitable for use against high-speed moving targets. The fire-control instruments used by a field artillery battery have been developed on the principle of keeping this equipment as light and as simple as possible. Practically all firing data must be computed slowly and laboriously by the personnel of the battery. It will be at once evident that such methods are found lacking when attempting to fire guns continuously at moving targets.

With luck, a battery of divisional guns might destroy a high-speed tank, but there could be no assurance of the same result using the present types of field carriages and fire control. It would be absolutely impossible to bring effective fire upon an airplane traveling at a speed of 100 miles per hour or more, and to attempt it would be purely a waste of ammunition. The present methods of fire control are being adhered to although the increased ranges of the post-war guns necessitate refinements in fire-control instruments and methods.

Furthermore, practically all existing field artillery carriages, up to this time, are defective from the standpoint of modern high-speed transportation in that they cannot be hauled at speeds greater than about 15 miles per hour without seriously damaging the gun carriages and their mechanisms. All the artillery of the World War period was limited in this respect since it had been designed with the idea of using horses or the slow-speed tractors available at that time for tractive forces. Since the war, trucks have been built which are capable of hauling gun carriages at high speed. Commercial development makes it imperative that gun carriages of the future be so constructed that these high speeds can be taken advantage of, not only on good roads, but when the gun carriages are trailed across country.

THESE new conditions, thus briefly outlined, call for field artillery of a new type. The present ideas concerning fire control must be revised and the fire-control equipment of the battery must be augmented so that these batteries can bring effective fire against stationary ground targets, and can also be used effectively both against rapidly moving ground targets and, with equal accuracy and facility, against high-speed targets in the air.

A new type of field-gun carriage which has been developed with the idea of meeting the new requirements referred to above, was completed recently at Watertown Arsenal. This carriage mounts the high velocity 75-millimeter gun (muzzle velocity 2175 foot-seconds) which gives a maximum range of 15,000 yards with a 15-pound



With outriggers spread and wheels removed, the gun's traverse is 360 degrees; its elevation 90 degrees

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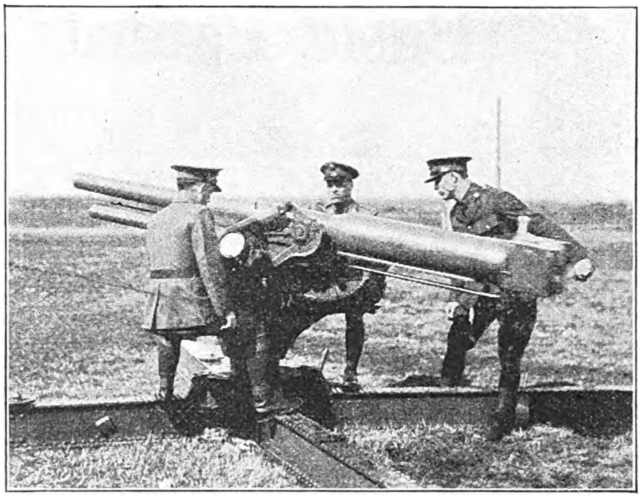
*Reprinted through the courtesy of *Army Ordnance* projectile for high or low altitude.

The new carriage has been equipped with wheels mounting balloon tires and having roller bearings at the hubs. The design is such that either single or dual tires can be mounted. The newly developed puncture-proof inner tubes are used. While the dual wheels and tires increase the weight of the gun carriage about 400 pounds, it is believed that tests will show the advantages of having the additional tire contact area. Furthermore, the two additional wheels and tires may be considered as spares, in which case, if one of the tires were punctured, the vehicle would not have to stop. The increased ground contact area will make it possible for the vehicle to pass through sand and soft mud. The construction is such that the gun carriage proper is carried on the wheels and axle as a spring load.


Firing position of the 75-millimeter gun, 360-degree traverse and 15-degree elevation, in full recoil

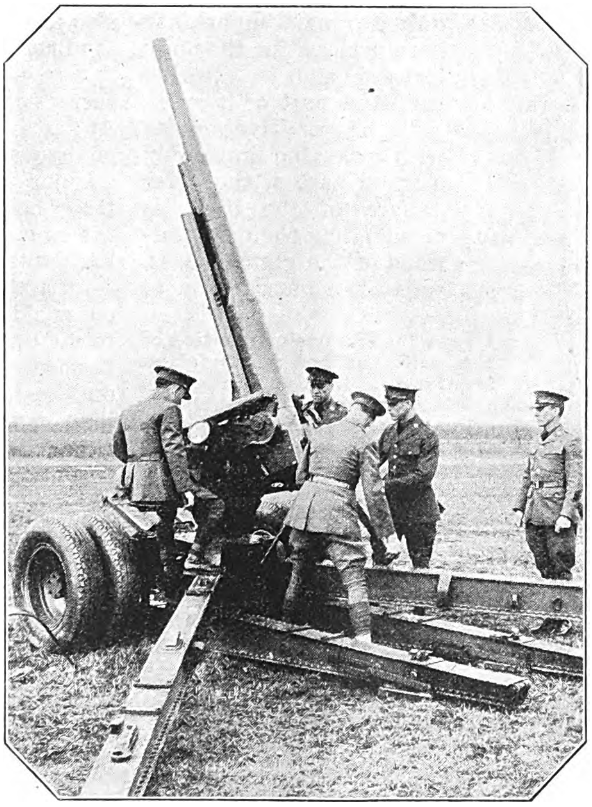
The gun can be fired by opening out the rear trails and supporting the front part of the carriage by means of the two spare trails. Two outriggers with built-in screw jacks are placed on the ground under the carriage pedestal.

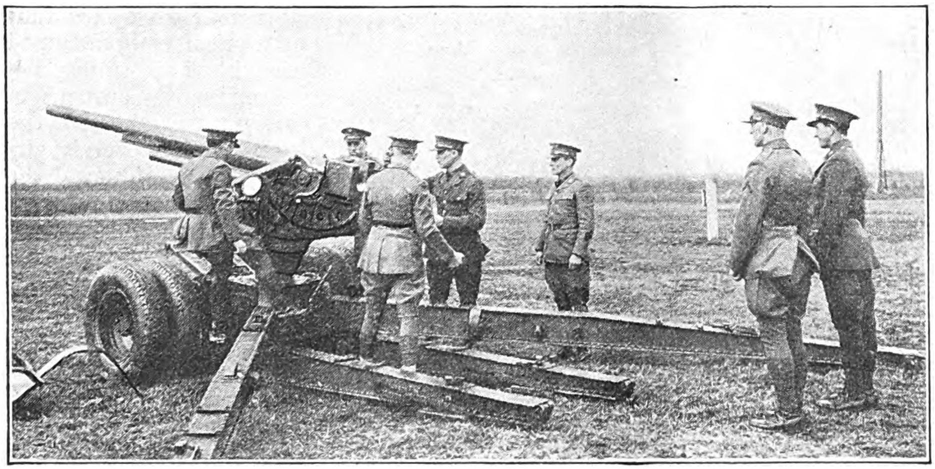
When in place, the screw jacks are tightened against the bottom of the carriage; thus the vertical component of the firing load enters the ground through these two outriggers which serve to protect the balloon tires, roller bearings, and the spring suspension from the firing load. The gun can be fired in this manner through an angle of traverse of 90 degrees and at elevations from 0 degrees to plus 80 degrees.

If all-around fire is desired, the carriage can be put in a second firing position. In this case, the two outriggers are used as levers for raising and lowering the carriage. The wheel and axle assembly can be removed quickly from the pedestal of the gun carriage and the latter lowered to the ground. The two spare outriggers are then put into place to complete the base for the carriage. In this position, the gun can be fired through 360 degrees of traverse and at angles of elevation from 0 degrees to plus 80 degrees.

In arsenal trials, using untrained men, the carriage was put in the first firing position (for 90 degrees traverse) from the traveling position in one minute, and in the second firing position (for 360 degrees traverse) from the traveling position in four minutes.

It is believed that such a gun carriage fully meets the requirements which were outlined at the beginning of this article. The weight of the gun and carriage in the firing position is 5800 pounds, or nearly twice that of the low-velocity 75-millimeter gun carriage of the World War type. However, assuming a four-inch penetration of the tires into the ground, the area of the tires in contact with the ground is 832 square inches as compared with 194.6 square inches for the French 75-millimeter field gun, M 1897, equipped with steel tires, and the ground pressure is 6.9 pounds per square inch as compared with 13.7 pounds per square inch for the French gun. Thus it will be seen that the new carriage will undoubtedly possess greater cross-country mobility than the lighter carriage.




In center of page the mount is arranged for 90-degree traverse and 60-degree elevation for anti-aircraft firing. At bottom of page, the gun has a 90-degree traverse and an elevation of 15 degrees for firing at speedy land targets. In both cases, the balloon tires, the roller bearings, and the springs are protected against shock of recoil by the special type of construction

This low weight for a high velocity, all-around-fire carriage with dual balloon tires, brakes, and spring suspension, is made possible by taking advantage of steels of high physical qualities, of a new welding process which has been developed at Watertown Arsenal, and by making parts of the carriage, where possible, of strong aluminium alloys having one third the weight of steel. This carriage is equipped with the anti-aircraft type of elevating and traversing mechanisms, employing roller bearings throughout. All blacklash is eliminated, making it possible to lay the gun with an accuracy of ½ mil on either elevation or azimuth.

Fitting of fire control equipment to this new gun mount is still in the experimental stage and somewhat too technical for discussion here.

Basic Patents in Evolution—III

By WILLIAM K. GREGORY

Professor of Vertebrate Paleontology, Columbia University. Curator, Departments of Anatomy and Ichthyology, American Museum of Natural History. Member of the National Academy of Sciences

(Concluded from September)

TURNING now to the history of the pelvis and hind limbs, we have already noted that in many respects their origin was similar to that of the pectoral limbs, that is, they first appeared as keels or ridges supported by basal rods and operated by extensions of the segmental muscles of the body-wall (Figure 13). Much later they became paddle-like and finally when bent downward (Figure 14) were able to support the weight of the body and to co-operate with the pectoral limbs in pushing the body forward. But the pelvic limbs and the pelvis itself differed widely in their functional associations with surrounding parts and consequently they acquired conspicuous anatomical differences from the pectoral limbs. In the first place, the pelvis corresponds only to the inner or primary shoulder-girdle and it never had any system of sheathing plates attached to it. Secondly, the pelvis was associated with the lower ends of the digestive tract and of the tubes that discharged either eggs or living young in the female or the sperm of the male (Figure 13).

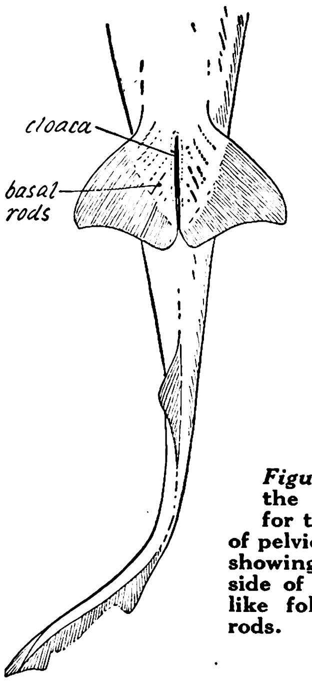


Figure 13: **The basic invention of the pelvis or bony foundation for the hind limbs. Under side of pelvic region of primitive shark, showing the pelvic fins on either side of the cloaca; they are keel-like folds supported by skeletal rods. Drawing from specimen**

THUS the pelvis arose around the cloaca or common opening of the digestive and reproductive tubes and served as a base or platform of the following sets of muscles: first, those that ran forward along the lower surface of the abdomen; second, those that ran backward along the outer and under sides of the tail (Figure 15); third, for a cone-shaped mass of muscles based on the pelvis and converging outward and downward to form the thigh muscles.

The ilium, or upper branch of the pelvis, at first grew upward between the muscles of the back in front and the tail muscles behind. As it grew upward it passed to the outer sides of the ribs, which were at first entirely free from it. Gradually, however, certain of the ribs became tied by connective tissue and ligament to the inner side of the ilium and when this happened an indirect connection was established between the hind limbs and the backbone. Thus the hind limbs soon acquired great importance both in thrusting the body forward and in steering the front part of it.

In the primitive reptiles with sprawling limbs only a small part of the outer surface of the ilium is occupied by the deep portions of the gluteal mass, which ran outward on to the top of the femur. But when the limbs were drawn in toward the sides of the body in the primitive mammals, the gluteal muscles acquired great importance in holding the body upon the femur when the opposite leg was lifted off the ground. Hence, that part of the outer surface of the ilium which gave rise to these muscles became enlarged in accordance with their increasing importance (Figure 14, D, F, G, H, I).

In the early mammals when the knees were drawn forward the ilium also grew forward almost parallel with the backbone (Figure 14, E), to which it was now attached by means of the sacral vertebrae and their ligaments. At first in the mammals the upper part of the ilium was trihedral, that is, triangular in cross-section, its three surfaces being occupied respectively by the muscles of the upper side of the backbone, by the iliacus muscles in front and by the gluteal muscles on the outer side. When the primates began to sit upright (Figure 14, G), resting themselves on their folded-up legs and on the lower ends of the pelvis, the iliac muscles served to check them from falling backward, while the gluteal muscles prevented them from falling forward. Hence with the increased size of these two sets of muscles the blade of the ilium began to grow outward in a transverse plane, the chief successive steps in this broadening process being recorded in the lemurs, monkeys, apes and man (Figure 14, F, G, H, I).

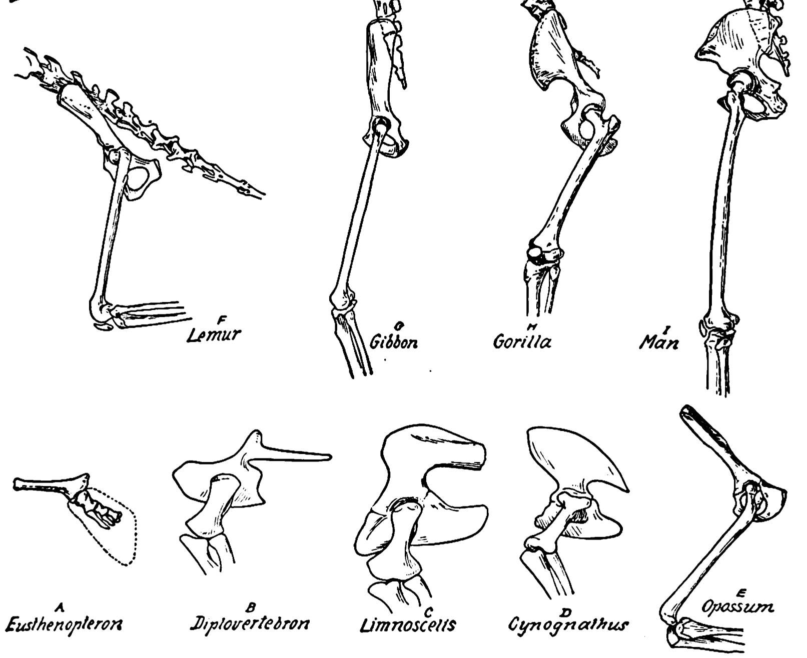


Figure 14: **Series showing progressive outward growth of ilium from fish to man. (A) Lobe-finned ganoid (*Eusthenopteron*) of the Devonian period; (B) *Diplovertebron*, early tetrapod; (C) primitive reptile (*Captorhinus*); (D) advanced mammal-like reptile (*Cynognathus*); (E) primitive mammal (opposum); (F) primitive primate (lemur); (G) gibbon; (H) gorilla; (I) man. This series of drawings was made chiefly from models and specimens in the American Museum of Natural History at New York**

In the first section of this article we saw that in a primitive quadruped the body is slung between two suspension towers, which are the pectoral and pelvic girdles. The gibbon of the East Indies (Figure 16) has succeeded in turning this suspension bridge up at right angles to its original horizontal position and in balancing it on its rear tower, represented by the pelvic girdle. In other words, in the gibbon Nature has already worked out the basic invention for upright or bipedal progression on the ground. This great step in advance is seen first in its viscera, which approach the human type in a number of ways, and, secondly, in the details of construction of its pelvis.

But how did the gibbon learn thus to run on its hind legs? The answer of comparative anatomists is that the first step was the habit of sitting upright and the second was the habit of brachiating, or climbing with the arms raised above the head and the body suspended beneath the branches. The habit of sitting upright, as we have seen, conditioned the first steps in the remodelling of the pelvis, especially the flattening of the ilium in the transverse plane. The habit of brachiating conditioned the extension to and upon the upper border of the ilium of certain muscles of the loins and abdomen, which thus found themselves in a better position to support the viscera, pelvis, and hind limbs when the body was suspended from the arms. But the gibbon is no longer content merely to climb deliberately with his forearms; he makes enormous leaps from one branch to another one in the distance, and in taking off for the leap he can extend his thighs backward so that they may be nearly parallel with the backbone; whereas in a quadruped, with its backbone in the horizontal position, the thigh is but rarely extended so far backward. The result of this habit of the gibbon is that when it comes down on the ground to walk it has no difficulty in extending the thighs downward parallel to the backbone.

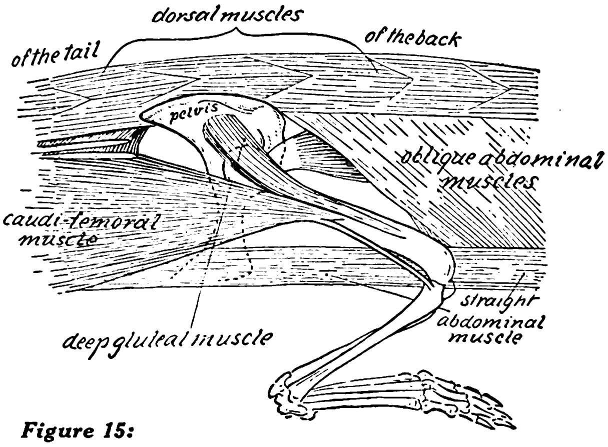


Figure 15:
Pelvic musculature of a crocodile. After Romer, 1923

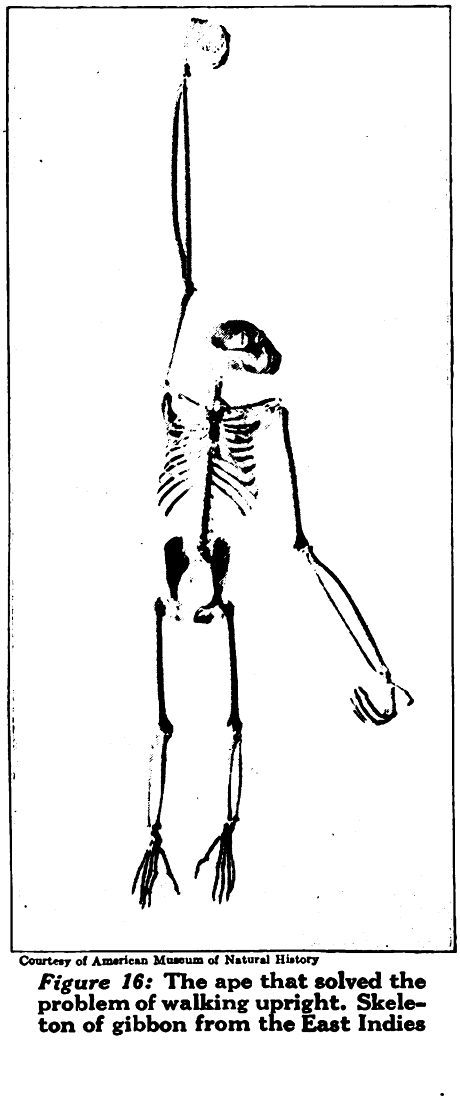

Courtesy of American Museum of Natural History

Figure 16: **The ape that solved the problem of walking upright. Skeleton of gibbon from the East Indies**

But is there any reason to suppose that our own remote ancestors, which from all the evidence of comparative anatomy were admittedly related to the anthropoid stock, learned to walk upright on the ground only after a long course of instruction in brachiating in the trees? The answer is, yes, since the human skeletal and muscular systems, as well as the brain and viscera, still retain abundant traces of a brachiating, arboreal stage that immediately preceded the stage of upright walking on the ground.

In the first place, the entire shoulder-girdle, arm, and hand of man are far more nearly approached by those of the brachiating anthropoid apes than by those of any other known animals living or extinct, and the same is true when we compare the pelvis and hind limbs of the two groups. It is truly surprising that, although the pectoral limb of the anthropoids is chiefly an organ of locomotion, while that of man is used almost exclusively for carrying or manipulating objects, in spite of this great functional difference the anatomical resemblances between the forearm of man and those of the gorilla and the chimpanzee are such as to amount almost to identity, while the differences are limited chiefly to differences in the lengths of the corresponding segments of the hand and arm. Thus the hand of the chimpanzee, for example, is much longer than that of man, at least in proportion to the body size, while its thumb is notably degenerate in size; yet the humerus, radius, and ulna closely resemble those of man and the same is true of the bones and muscles of the hand. These fundamental resemblances between man and anthropoid are well brought out in Figures 17 and 18.

Objection to the derivation of man from brachiating ancestors has been made on the ground that the habit of brachiating in the anthropoids has led to the use of the hands merely as hooks and to the consequent degeneration of the thumb; also that the mobile hand of man with its well developed thumb could never have been derived from a brachiating type. The answer to this line of argument may be sketched* as follows: first, that it is not necessary to attribute to the common ancestors of man and the anthropoids the extreme specializations of either of their descendants—and indeed all the available evidence indicates that while the thumb of the chimpanzee has been reduced, that of man is a progressive structure which has experienced an increase in adjustment with its increased functional importance. Secondly, the evidences of both hand (Figure 17) and foot (Figure 18) indicate that the remote ancestors of man were primates of arboreal habits, with hands and feet more like those of the gorilla and the chimpanzee than like those of ordinary monkeys; also, these are the only known kinds of hands and feet that would work well with the particular forms of shoulder-girdle, arm, pelvis, and hind limb, which upon quite other grounds there is good reason to attribute to the common ancestors of the anthropoids and man.

In short, from the point of view of comparative anatomy, these and many other resemblances between man and the anthropoids are due neither to chance nor to "convergent evolution," because they are too numerous and too detailed. They can mean only that both man and anthropoid have descended from a common ancestral stock which was already brachiating, yet was perhaps somewhat less specialized in this way of climbing than is the chimpanzee.

In conclusion, the chief "basic patents" in the locomotor apparatus in the long ascent from fish to man appear to have been as follows:

(1) The appearance of the striped muscle fiber, under the control of the nervous system. This is the stage attained by many invertebrates.

(2) The building up of these muscle fibers into zigzag muscle segments separated by tough partitions of connective tissue. This is the stage attained by *Amphioxus*.

(3) The assumption of a streamline body-form, propelled by lateral undulations caused by the rhythmic

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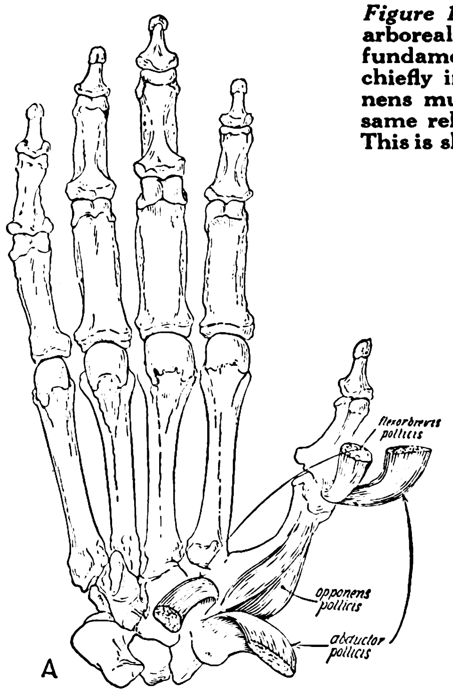
* For a fuller presentation of the evidence, see the author's papers in the Proceeding of the American Philosophical Society, 1926, Vol. LXVI, pp. 439-463; 1928, Vol. LXVII, No. 2, pp. 129-150; No. 4, pp. 339-376.



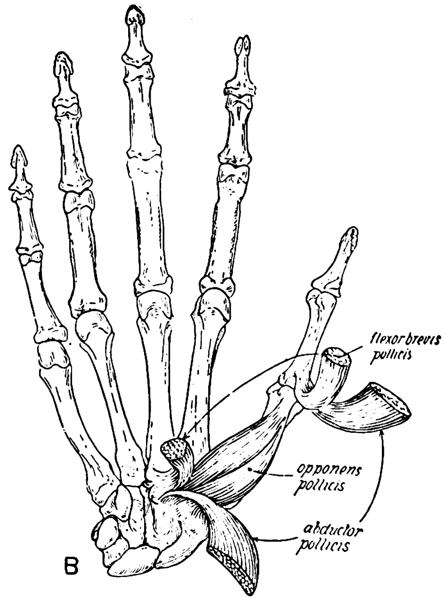


***Figure 17:* The testimony of man's hand as to his arboreal origin. Man's thumb, it will be seen, is fundamentally similar to that of the gorilla, differing chiefly in its relatively greater length. The opponens muscle is present in the gorilla and has the same relations to surrounding muscles as in man. This is shown in the drawings. (From Gregory, 1928)**

contraction of the muscle segments. This is the stage attained by *Amphioxus* and the oldest ostracoderms.

(4) The development of an axial skeletal system laid down at the points of greatest stress at the intersection of the primary and secondary septa, between the muscle masses. This is the stage attained by the shark.

(5) The development of an appendicular skeletal system, beginning in the form of keel-like projections of the body-wall, supported by segmental cartilaginous rods, as in the oldest sharks; from these rods evolve gradually the skeleton of the paired fins, the shoulder-girdle, and the pelvis, successive stages being seen in the different sharks.

(6) The operation of the paired fins by muscles that were originally derived from the segmental muscles of the body-wall but which soon became organized into a definite system consisting of a dorso-medial group above and behind the pectoral paddle, and a ventro-lateral group below and in front of the paddle. A similar system develops simultaneously in the pelvic fins. Different stages in this development may be observed in the sharks, lobe-finned fishes and early amphibians.

(7) The development of freely movable paired paddles with a fan-shaped skeleton from the keel-like ridges already mentioned. Stages of this development are observable in sharks and lobe-finned fishes.

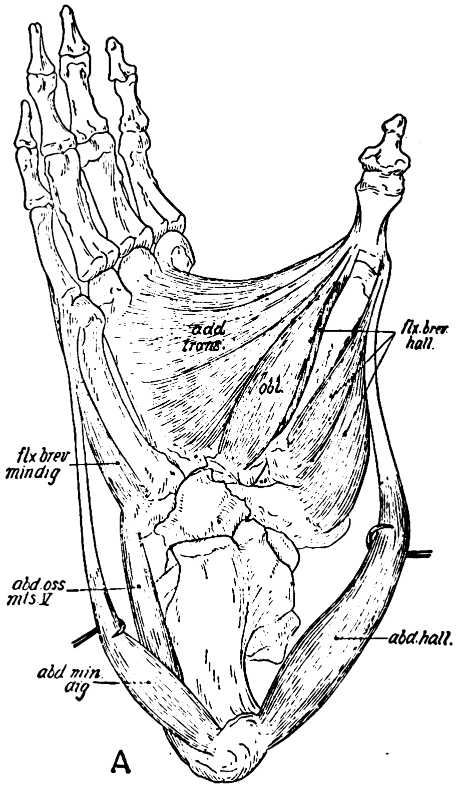
(8) The remodeling of the paired fins and shoulder-girdle of some early lobe-finned fishes after they had "learned" to turn the fins downward and to use them to assist in wriggling along on land.

(9) The development of the "double suspension bridge," by which the weight of the body was supported between one U-shaped and one V-shaped sling made from the pectoral and pelvic girdles respectively. This is the stage of the oldest known tetrapods.

(10) The development of a connection between the V-shaped pelvis and the backbone. This stage was attained by later tetrapods.

(11) The raising of the body off the ground and the drawing inward of the feet, elbows and knees. This stage was initiated in the mammal-like reptiles, perfected in the mammals.

(12) The invasion of the trees and the establishment of the habit of sitting upright. This stage is observable in the lemurs and monkeys.



(13) The development of the habit of brachiating, or climbing with the arms extended above the head and the body suspended from the arms, by which were acquired very many prerequisites for erect, bipedal progression on the ground. This stage is seen in the gibbon.

(14) A marked increase in size of body, which became too heavy for comfortable climbing in the trees, and the gradual abandonment of tree-living in favor of upright, bipedal progression on the ground. This stage is today observable in the gorilla and was with high probability passed through by our own ancestors. The gorilla, however, is now becoming secondarily quadrupedal.

(15) A profound readjustment of the viscera and of many parts of the skeleton to secure more favorable arrangements for supporting the body in the upright position. The early stages in this transformation have already been passed by the gibbon, chimpanzee, and gorilla. The later stages are now observable in man.

Although many details as to the "basic patents" that led up to man's present locomotor apparatus remain to be worked out, it is unlikely that we can be very far off in the foregoing sketch of the main stages, because much consistent evidence of the evolution of the jaws, teeth, skull, brain, and so forth is already on record.

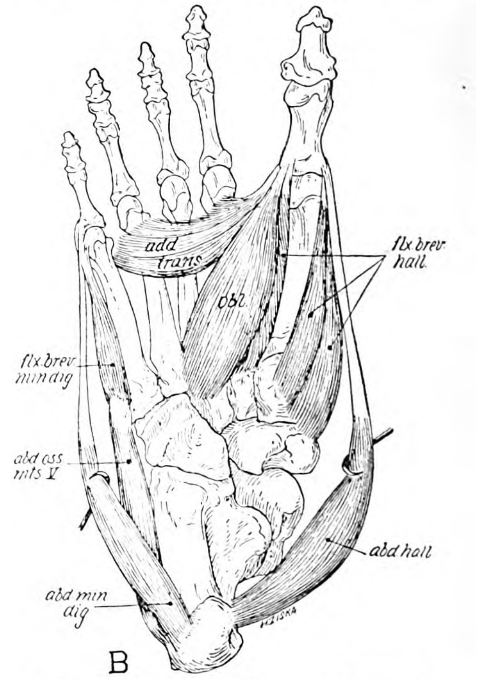
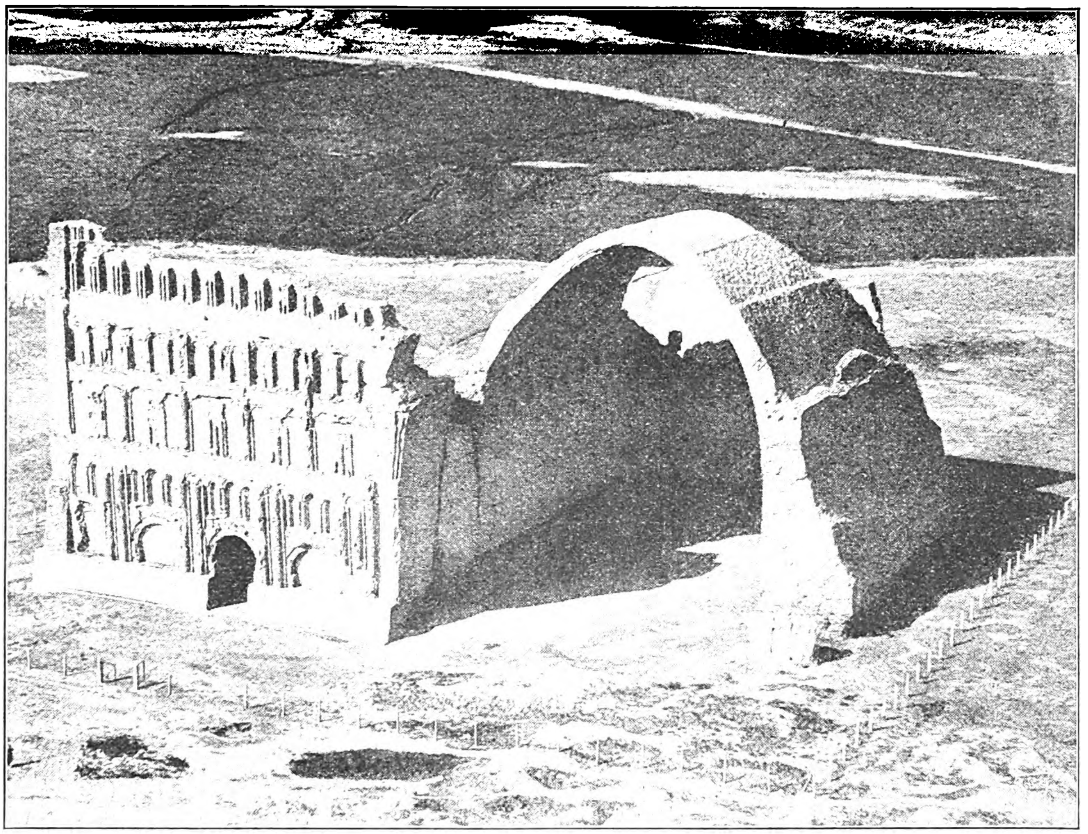


***Figure 18:* The testimony of man's foot as to his arboreal origin. Externally the sole of a human foot superficially resembles that of a bear, but internally its construction is an evident modification of the "biramous" type, with a grasping great toe. In spite of the almost exclusive use of the human foot for walking on the ground, the great toe is operated by muscles that evidently correspond closely with those of the gorilla foot, as is shown. (From Gregory, 1928)**



Crown copyright, permission of the Air Council

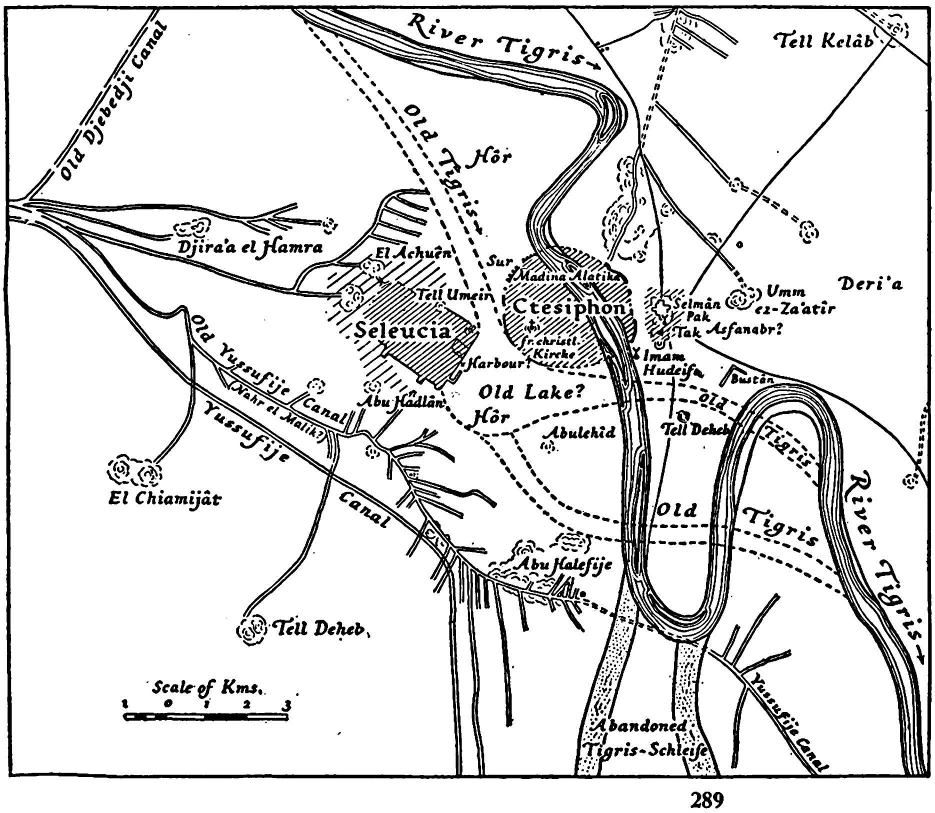
Ctesiphon was an ancient city of Mesopotamia, about 25 miles southeast of Bagdad. The principal remains are a magnificent arch of the Sassanian period. The Neo-Persian Empire was founded in A.D. 226 and was destroyed by Arabs in 637. A tremendous battle was fought here on November 21, 1915

Ctesiphon, A Magnificent Fragment

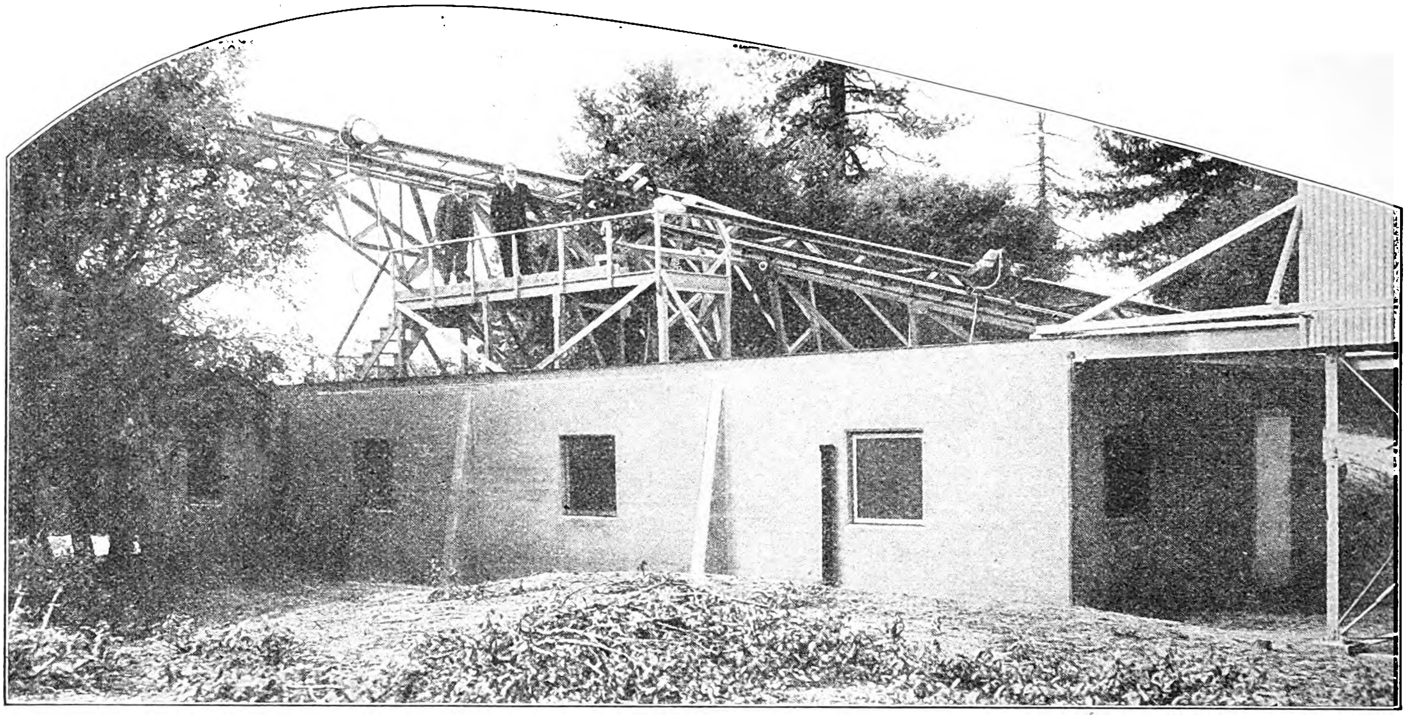
IN the autumn of 1928 a German archeological expedition began to excavate the site of Ctesiphon, the capital of the Sassanid Empire. Here was a great battleground where the conflict raged on the Euphrates and Tigris between East and West, between the Orient and Hellenism. For a thousand years Seleucia was an outpost of conquering Greece in the East while Ctesiphon was the center of Sassanian royal power. Both were symbolic of the two conflicting worlds. Our esteemed contemporary *Antiquity* publishes an interesting account of the painstaking excavations and the results thus far obtained. Our readers probably will be most interested in the gigantic barrel-vaulted hall of the royal palace of Ctesiphon. The date is probably somewhere between 531 and 579 A.D.

The main front of the edifice is 312 feet long, the height is 115 feet and the depth is 175 feet. The great hall has an elliptical barrel vault 86 feet wide and 163 feet long and is open in front. The springing of the vault is 40 feet from the ground. The brick courses are horizontal and project inwards as they rise, so that the actual width of the vault portion is only about 71 feet. The crown of the vault is nine feet thick. It was probably built with centering. Being located on an alluvial plain no stone was available so brick was employed.

The best view of the noble ruin is from the air and now that the authorities of Iraq permit archeological investigations and air flights we may look for further discoveries made by means of aerial photographs.


River Tigris
Tell Kelâb
Old Djebedji Canal
Old Tigris
Hôr
Djira'a el Hamra
El Achuên
Sur
Madina Alatika
Tell Umein
Ctesiphon
Selmân Pak
Umm ez-Za'atir
Deri'a
Tak Asfanabr?
Seleucia
fr. christl. Kirche
Harbour?
Imam Hudeifa
Bustân
Old Yussufije Canal
(Nahr el Malik?)
Abu Hadlân
Old Lake?
Hôr
Abulehid
Tell Deheb
Old Tigris
River Tigris
Yussufije Canal
El Chiamijât
Old Tigris
Abu Halefije
Tell Deheb
Scale of Kms.
1 0 1 2 3
Abandoned Tigris-Schleife
Yussufije Canal

Map of the district around the rival cities Ctesiphon and Seleucia. The former was the center of Sassanian power, the latter an outpost of conquering Greece in the East. In time, both cities fell



The new 50-foot interferometer tipped about one hour east. The outer diagonal flat mirrors stand about 35 feet apart. The lower half of the housing is of concrete, the upper half is a metal shed (see page 293)

The New Fifty-foot Stellar Interferometer

By F. G. PEASE

Mount Wilson Observatory

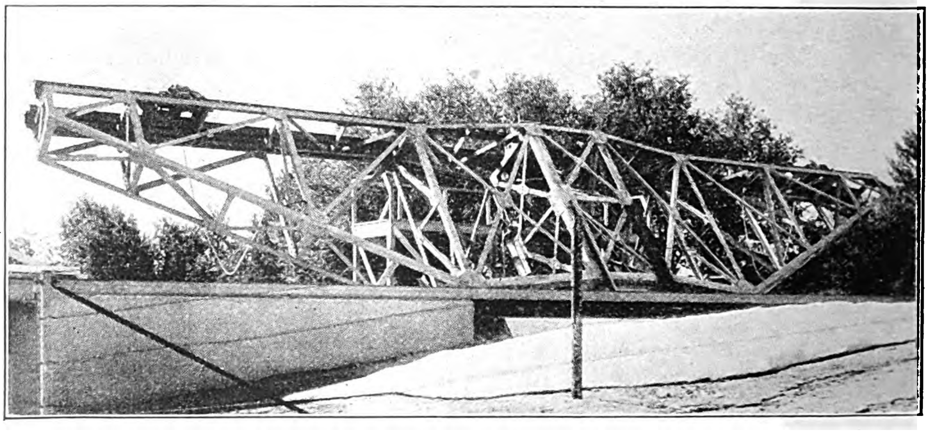
THE star image formed at the focus of a telescope is not a point but consists of a bright central disk surrounded by several dark and bright rings known as the diffraction disk. No known star except the sun has an angular diameter large enough to appear as a real image in existing telescopes, that is, its actual disk can not be seen, consequently one can not measure its diameter with an ordinary micrometer.

Fizeau pointed out that it might be possible to measure the true angular diameter of stars with a stellar interferometer. This instrument utilizes the principle of interference long familiar to physicists wherein two pencils of light radiating from the same small source are brought together again, forming a series of bright and dark bands called "interference fringes."

In the stellar interferometer the star image has the same appearance as it does in an ordinary telescope except that it is crossed by a series of parallel dark bands, that is, the interference fringes. Each point in a star produces one of these interference patterns. If the star is very small in angular size the fringe patterns all lie directly on top of one another and are clear and sharp. If a star of larger angular diameter is chosen each point in it produces a pattern which is displaced a little with respect to the original one, thereby reducing the clearness or visibility of the fringes. A still larger star may be selected in which there may be so many overlapping patterns that all the dark bands disappear and just the ordinary image remains. Two radio sets receiving from the same studio will blend well, but two sets receiving from adjoining studios emitting different modulations, even though the wavelength be the same for both, will not blend but will have only sound as a result.

IN the stellar interferometer we take advantage of the disappearance of the fringes to measure the star's diameter. Mathematicians have computed that when this occurs $a = 1.22\frac{\lambda}{D}$ where a is the angular diameter of the star in radians and λ the wavelength of the light and D the separation of the centers of the two pencils of light.

Since no existing telescope was large enough to give complete disappearance of the fringes Michelson devised a periscopic attachment consisting of four plane mirrors mounted on a stiff frame which is placed on the end of the telescope. Two outer mirrors inclined at 45° face upward, and throw the light to two inner mirrors which are inclined at 45° facing downward, directing the light into the telescope. The outer mirrors move simultaneously on slides to equal distances from the axis of the telescope.



The bridge of the new nine-ton instrument from the north side

The distance to the star from the focus of the telescope over the two paths must be the same to within a very few wavelengths of light, otherwise the fringes will not appear at all. Owing to flexure of the telescope, atmospheric variations, and slight errors in setting the mirrors it is convenient to use an optical compensator just in front of the eyepiece, with which the distance may be equalized.

As an illustration of the practical application of the interferometer method let us turn the 100-inch telescope with its full aperture on Rigel and no interferometer attached to it. We see in the eyepiece a bright image without surrounding rings, since the atmosphere rarely permits their presence in the 100-inch. Placing a canvas over the end of the tube and cutting a hole in it seven inches in diameter whose center lies 47 inches from the axis we see an image very much fainter but larger in size showing diffraction rings.

CUTTING a similar hole in the canvas diametrically opposite, that is, with centers of the openings 94 inches apart, we see an image twice as bright crossed with parallel dark bands. With good atmospheric conditions the image appears single but if the seeing is poor the two images vibrate about a common center. Let us now turn to Betelgeuse. To our surprise we see the bright diffraction image but the fringes are not sharp and distinct. Covering these last two openings and cutting in their stead two others 45 inches apart the fringes become almost as prominent as on Rigel.

READERS who keep up with science doubtless will recall the striking confirmation, made in 1920 by means of the Michelson-Pease interferometer, then new, of the prediction that many of the stars were immense beyond conception. The giant star Antares, for example, was found to be 400,000,000 miles in diameter and Betelgeuse 250,000,000 miles. The brilliant work was what might fairly be called a legitimate scientific sensation.

What the interferometer really did was to measure the diameter of a star, not in miles, but in fractional degrees of arc. The diameter in miles was then derivable from this by trigonometry, since the distance to the chosen stars ("parallax") already were known. How the interferometer actually measures the angular diameter of a star can not be explained here. The interested reader is requested to see Russell, Dugan and Stewart's "Astronomy," pages 740-748, which covers it adequately and understandably in theory and practice.

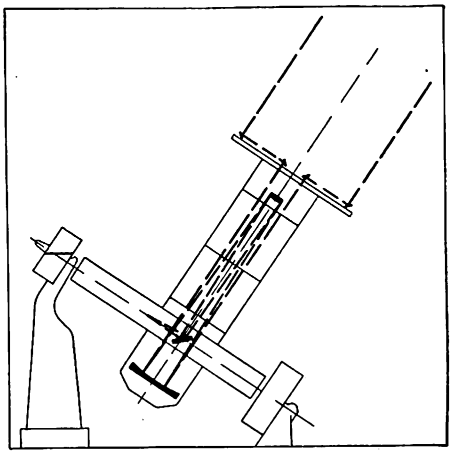
To measure more stars a larger instrument has been needed. Now, ten years later, it has been built and Dr. Pease, who had much to do with its design and construction, was invited to describe it for our readers.

—The Editor.

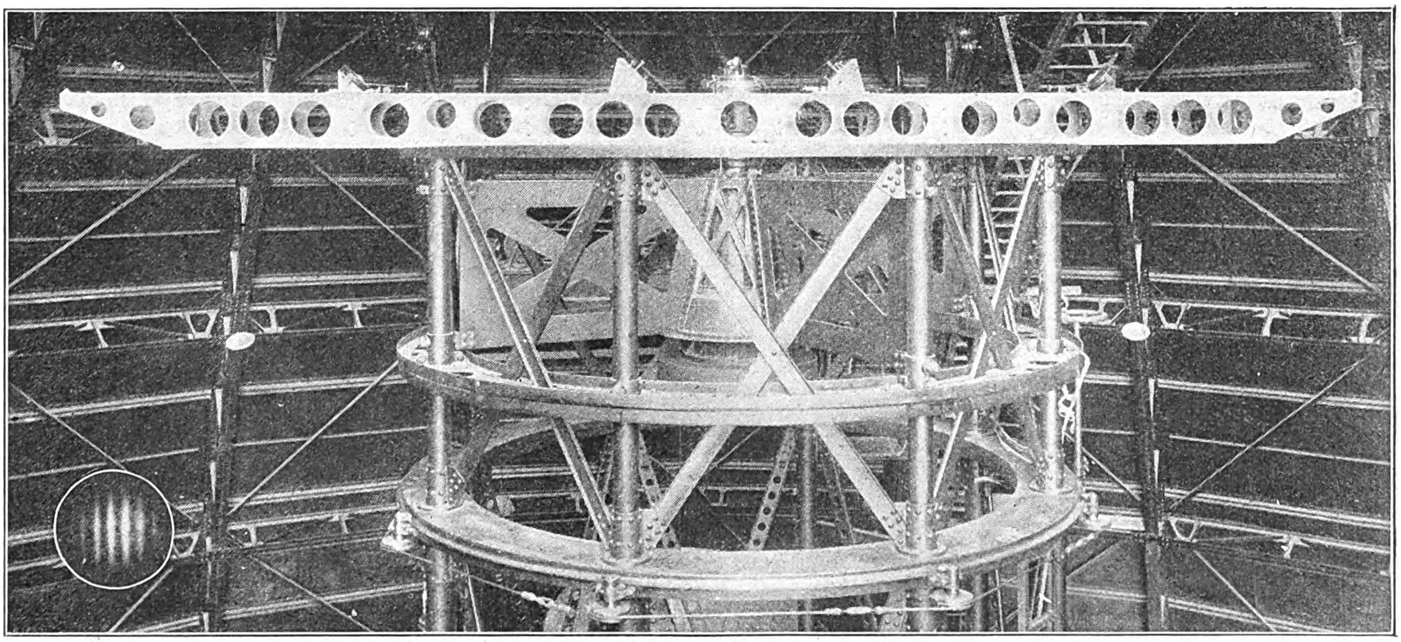
We next place the large steel beam carrying the four diagonal plane mirrors on the end of the 100-inch tube, using the crane, since it weighs about 800 pounds. The canvas will be left over the end of the tube, as the light from the inner mirrors will pass through the openings 45 inches apart. We next set the outer mirrors 110 inches apart and turning to Betelgeuse again, we adjust the compensator until the fringes appear. We have to look very carefully for them because when they do appear they are very weak, the dark spaces having almost disappeared. Shifting the outer mirrors to 120 inches we are unable to see any fringes regardless of how long we search for them. Turning the telescope to Rigel the fringes are found almost immediately and appear as crisp as they did when the apertures were closer together.

Taking the separation of the mirrors D as 120 inches, or 305 cm, and λ as 5.75×10^{-5} cm, we find that α equals 2.3×10^{-7} radian or $0.''047$ arc, the angular diameter of the star. The angular diameter of Betelgeuse appears to vary irregularly; there are days when the mirrors must be moved 14 feet apart in order to cause disappearance of the fringes.

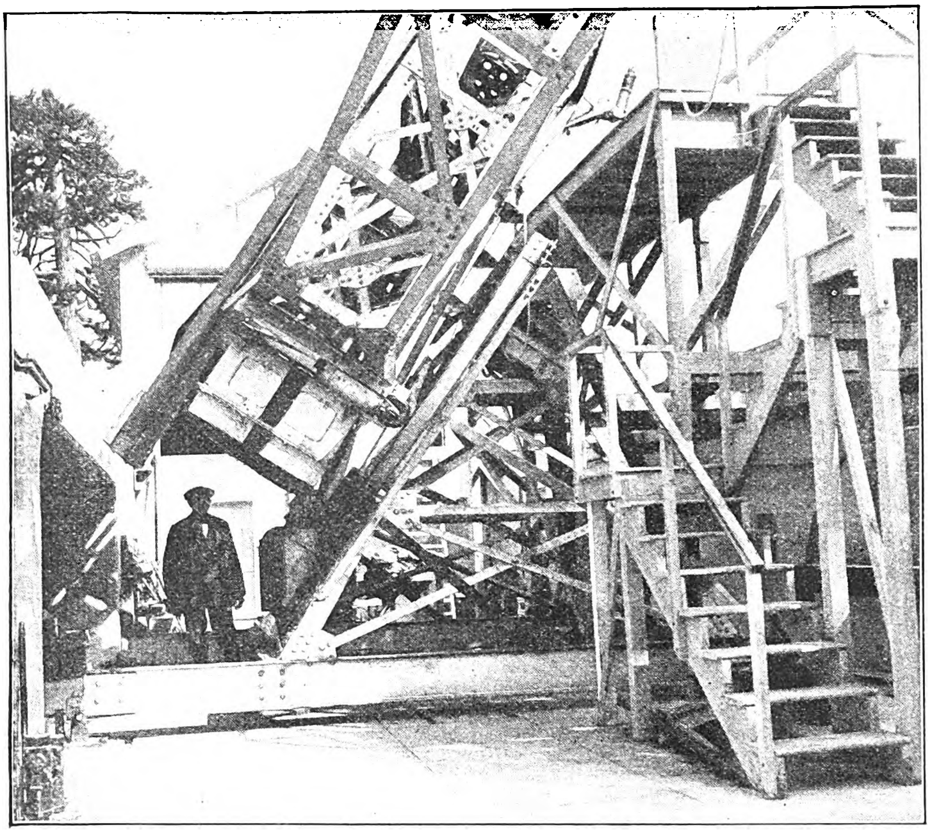
The minimum angular diameter measurable with the 20-foot interferom-



How the earlier, 20-foot interferometer was employed—attached to the 100-inch telescope. Two pairs of diagonal flat mirrors gave it, in effect, a spread or aperture of 20 feet, instead of the 100 inches of the telescope. The diagram shows the light path of two rays



The old 20-foot interferometer beam bolted to the end of the tube of the 100 inch reflector. The two inner mirrors remained fixed but the outer pair could be moved inward or outward. The circular holes in the bar were merely to save weight. *Insert, lower left:* Typical appearance of the interference fringes, a series of bright and dark bands



Pedestal and lower part of the "bridge." The 40-inch main mirror in its cell is above the man's head (Ladd, machinist). Opposite his shoulder is the worm and sector drive. One of the rollers is visible higher up. The slanting polar axis shows beneath the peak of the main supporting A-frame

eter is 0."024. The diameters of Arcturus and *β Pegasi*, which are slightly smaller than this, were found by plotting the visibility curve for various mirror separations and determining D from the extrapolated curves for zero visibility.

The diameters of stars measured with the 20-foot instrument were of the same order as those found by indirect methods. All of the stars measured were "late" type stars.

IN order to measure stars of "earlier" types which have smaller angular diameters it is necessary to have a larger interferometer. Accordingly the new 50-foot interferometer has just been built at the Mount Wilson Observatory, in which the apertures are larger and can be placed 50 feet apart. This instrument will measure a star diameter as small as 1/100 second of arc, about corresponding to that of a cent piece at a distance of 250 miles.

The 20-foot instrument was of such a size that the steel frame carrying the periscopic mirrors was placed on the upper end of the 100-inch Hooker reflecting telescope, the optical system of the telescope itself being utilized in forming the star images. But a 50-foot beam would be too large to place upon the 100-inch. So the new instrument is a unit in itself and is housed in a separate building, whose upper half is a metal shed which moves to the east on a trestle, leaving the interferometer standing in the open air. The building is 60 feet long, 20 feet wide and 26 feet high. The shed is moved by rack and pinion.

The interferometer consists of a large skeleton frame which we call the "bridge," mounted in cantilever fashion on the north end of a short ball-bearing polar axis. A structural steel pedestal supports the whole and carries the mounting for the worm that meshes into a sector on the bottom of the bridge. The bridge lies in an inclined plane parallel to the equator and carries the periscopic mirrors on its upper surface and the image-forming mirror at its lower end.

The bridge is a latticed steel frame 54 feet 5½ inches long. The structural members are all angle iron and vary in size from 6 x 6 x ⅜ inches to 3 x 3 x ¼ inches. The estimated weight of the bridge itself is 8000 pounds and the total load on the axis including the mirror mountings, tracks, and so on, is about 18,000 pounds.

The polar axis is of 0.50 carbon steel with an elastic limit of 80,000 pounds per square inch. It is forged and heat treated and drawn so hard that it was machined with difficulty. Each of its bearings is composed of two S K F annular bearings. To guide the bridge and prevent its vibrating in the wind two rollers nine inches in diameter with spring cylinders behind them are fastened to the bridge and travel on a circular track fastened to the north face of the pedestal.

The driving sector is a large iron casting bolted to the bottom and south sides of the bridge. It is 100.2671 inches pitch radius and has 1440 teeth. The worm is 4½ inches pitch diameter, 0.4375 circular pitch, left hand, single thread. It runs on S K F self-aligning bearings and continually dips into a bath of clock oil which is free from acids and gumming properties.

The driving clock is of the typical weight-driven conical governor type and is self winding. It stands just east of the pedestal and transmits power to the worm through a gear box. Slow motion in right ascension is by means of a motor mounted directly on the planetary gearing in the gear box. The instrument works in right ascension from 2 hours east to 2 hours west.

ONE of the illustrations shows an outline of the optical path of the interferometer. Two outer plane mirrors AA inclined at an angle of 45° receive the parallel beams of star light and reflect them to two similar mirrors BB inclined also at 45° which direct them downward to the large concave mirror C. The converging beams are then returned upward to a 45° plane mirror D, thence southward to a second plane mirror E and upward through the compensator to the eyepiece.

The flats AA, BB, and D are of Pyrex, 15 inches in diameter, D being cut away at the sides to clear BB. E is a glass mirror five inches in diameter mounted with a self-aligning mechanism which directs the beams constantly into the eyepiece tube which may be moved into various convenient positions for observing.

The concave mirror C is of Saint Gobain glass, 40 inches in diameter, 18 feet focus and lies at the bottom

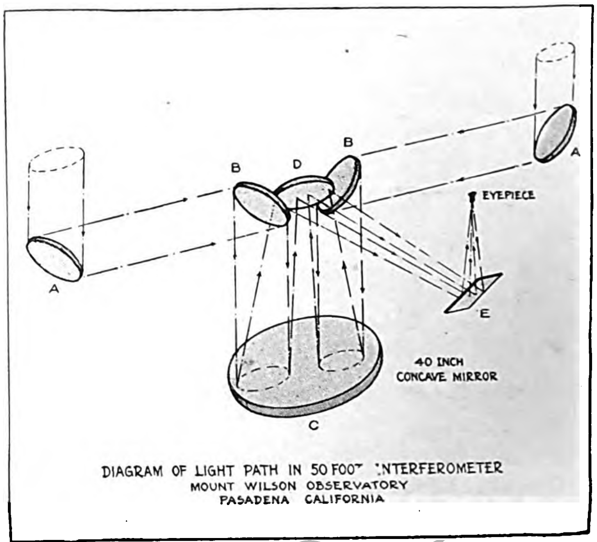
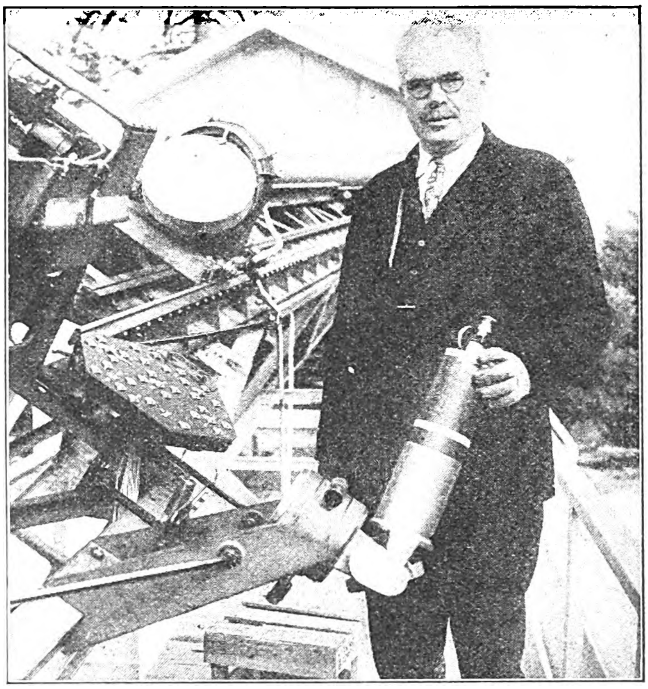


DIAGRAM OF LIGHT PATH IN 50 FOOT INTERFEROMETER
MOUNT WILSON OBSERVATORY
PASADENA CALIFORNIA

of the bridge in an iron cell insulated with corkboard. It is supported on its back by three fixed plates and one central counter-weighted plate and on its edge by four pivoted arcs.

The outer mirrors are mounted on V-wheeled carriages which are moved by motor through a herringbone rack and pinion along tracks placed on the top surface of the bridge. For the tracks heavy machined iron castings of inverted "T" section are bolted to the top of the bridge. To these are fastened steel bars bevelled on both their narrow edges. The upper edges receive the fixed V rollers of the carriages while the lower edges receive similar V wheels mounted on spring counter-weighted arms which always keep the carriages in contact with the tracks.

The carriages may be moved from 6 to 50 feet apart and their positions are read by pointers on scales graduated directly on the tracks. Positions are read through a system of mirrors by a telescope located near the eyepiece tube.



The "business" part of the bridge. The author's hand is on the eyepiece, and at his right are the control buttons. The east diagonal 15-inch flat mirror with its track and rack is visible. When the photograph was made the special mirrors and "telescope" for reading the scales and circles, described in the accompanying text, were not attached

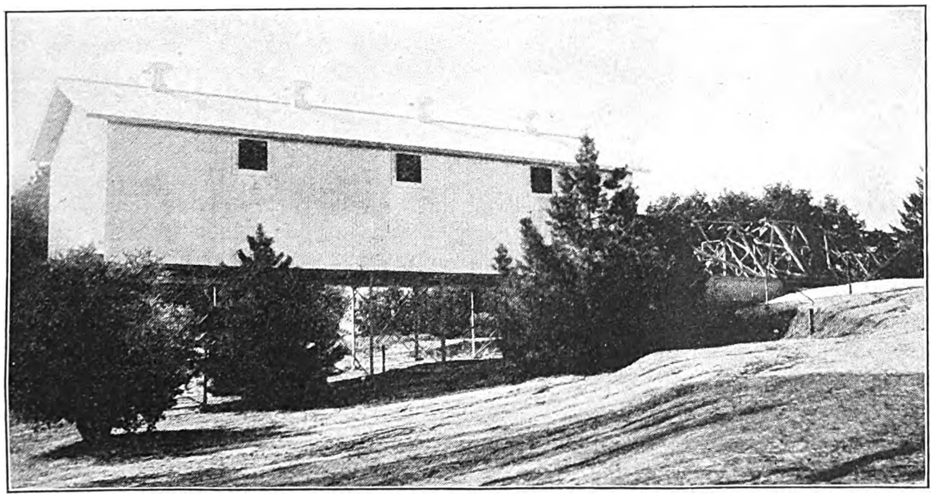
THE outer mirrors rotate for declination about centers passing through a common axis parallel to the top of the bridge. Both fast and slow motions are provided. Readings by circle and vernier are made through a system of mirrors with the same telescope used for reading the mirror separation.

The three central plane mirrors are mounted on a cast iron frame which stands on the top surface of the bridge directly above the large mirror. The central mirror is fixed; the other two can be tilted for slow motion about axes parallel to the polar axis. The east mirror is mounted on a slide capable of micrometric motion along the beam and furnishes an additional means of compensating the optical path length for variations due to flexure, differential expansion, and atmosphere.

Observations are made from a platform located south of the bridge above the polar axis. Here are placed the eyepiece, the control buttons, circle and scale lamp switches, and the telescopes for reading the circles and scales. All motions in the instrument are motor driven and are operated through relays. An eyepiece of one-eighth-inch focus is necessary to view the fringes conveniently.

The alignment of the instrument during construction was made by squaring the pedestal with the house and checking the polar axis for azimuth on the 60-inch reflector axis with level and gage. When the instrument was about finished the alignment was checked on Polaris by means of a rod carrying cross wires clamped to the bridge. Final adjustment was made by taking drift curves of equatorial stars directly reflected from an uncovered portion of the large concave mirror, computing the error and adjusting the screws at the base of the pedestal.

Drift curves were next taken of the images from the flat mirrors which were found to shift in opposite directions along the declination cross wires. Eight and ten foot straightedges were clamped in various positions about the beam and the shifts measured after moving the instrument into various positions. The addition of several ties has practically eliminated this drift.

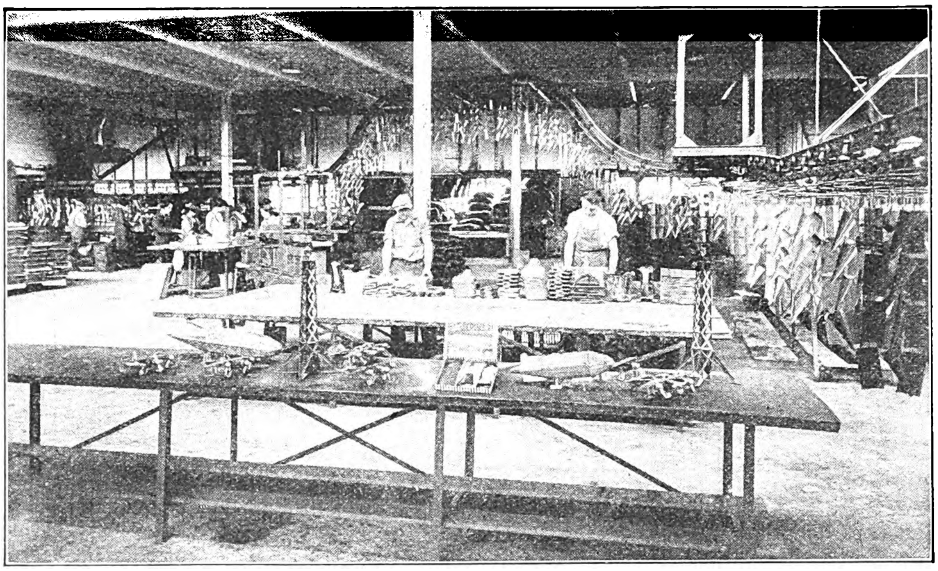


The housing or shed of metal rolled off to the east on its trestle

The first experiment made with the interferometer was to see whether fringes would show at distances greater than 20 feet. Experimental curves obtained with the 20-foot instrument showing decrease in visibility for a drop in the seeing had been plotted for stars of small angular diameter. Extrapolation of these curves indicated that for "seeing" even as low as 1 on a scale of 10, fringes should appear for distances much greater than 20 feet. At the time the 50-foot interferometer was tried out the seeing varied from 1 to 2 and it was noted with feelings of great pleasure that at the distances of 25 feet and 34 feet at which it was tried the readings coincided with points on the curves. Visibility curves of Betelgeuse and Arcturus made during seeing 1 to 2 also coincided with those made with the 20-foot beam, indicating that measures of star diameters made with the two instruments are alike.

IT is estimated that stars as faint as fourth magnitude can be measured and that complete disappearance of the fringes will take place for about 25 stars. Others whose diameters are still smaller can be estimated by plotting the visibility curve. The appearance and amplitude of vibration of the image given by the two mirrors appeared to be the same regardless of their separation, thereby giving evidence of atmospheric conditions favorable to telescopes of large apertures.

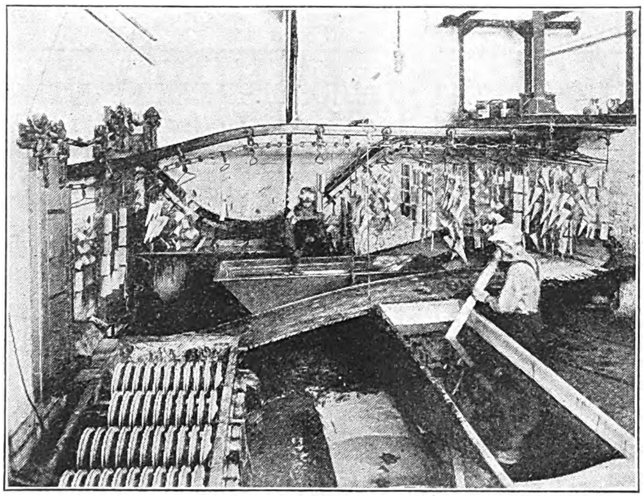
A national organization, the Lyonsport Aero Club, composed of boys owning sets manufactured in this particular plant, is equipped with aviation uniforms and winged pins which admit them free of charge to view certain war films, and also entitle them to a ground course in one of the St. Louis air colleges with a proficiency certificate of the same nature as that for adults.



A section of the electrically-operated carrier system on which metal parts are carried through enameling vats and bake oven, thence to the loading table

THIS Lyonsport Aero Club, commanded by Captain Jack Bursey, has juvenile pilots all over the world. National advertising over one of the big radio chains carries the stories of adventure to this juvenile audience of aviation enthusiasts, and spurs them on to greater work and a broader aircraft education.

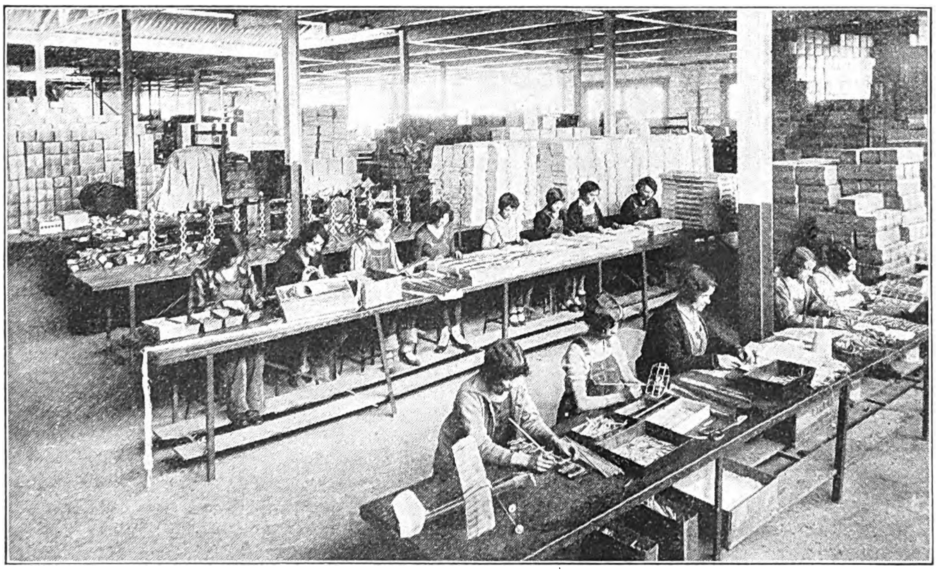
It was about 1911 that the Illinois Model Air Club was organized among Chicago high school boys. Then came the war and interest was directed elsewhere.



The paint room. The carrier dips low so that the toy airplane parts are immersed in the paint

Then Lindbergh's epochal flight in May, 1927, and overnight America became air-minded. Prior to this time, the toy aircraft industry had been very small indeed, but in the next three months it jumped to a quarter of a million dollars retail. By the end of 1928 it had climbed close to the 2,000,000 dollar mark, wholesale, while the Metalcraft Corporation, in October, 1929, wholesaled some 140,000 dollars, as has been noted, in demountable aluminum and sheet-steel aircraft parts for toy models.

Meantime the Playground and Recreation Association of America got behind a movement to arouse juvenile interest in aircraft construction, sponsoring miniature aircraft tournaments all over the country, with a National Tournament held in Memphis, Tennessee, in October, 1927. The vocational departments of many public schools had already adopted a definite program of model airplane construction, with classes, contests, and the like.



Illustrations courtesy The Metalcraft Corporation

Assembling and packing the finished parts in construction sets. The purchaser does the final assembling himself, from the parts supplied in the kit

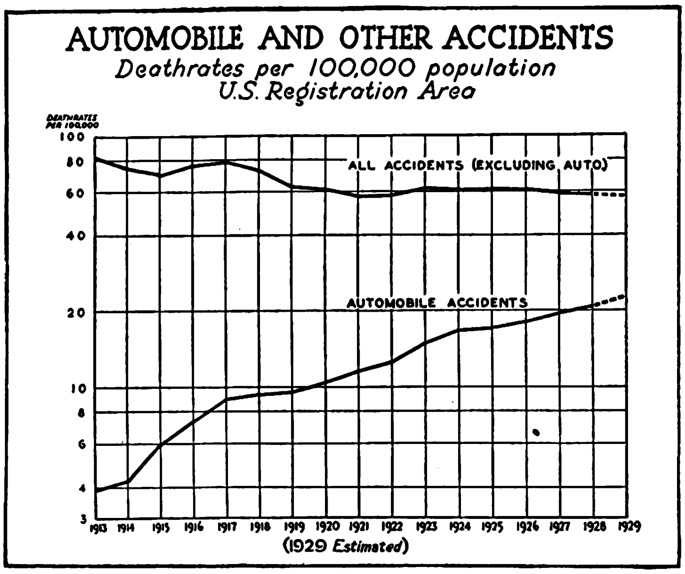
Nor has this work been confined to any one type of plane. Flying stick types, scale models of famous ships, hydroplanes that will rise off the water, and racing planes driven by four propellers and capable of running 50 miles per hour, have been constructed.

The National Aeronautical Association has recognized two of these contests, held annually: the Mulvihill for outdoor models, and the William B. Stout for indoor models—named after the donors of the trophies.

IN June, 1928, the National Indoor Meet was held in Detroit, with boys from all over the country competing for the Stout trophy and some 500 dollars in prizes. It is significant to note that during the World's Air Fair Week, held in the St. Louis Arena during the middle of last February, a National Junior Indoor Model Airplane Contest was held; also, steps were taken for the organization of the first Junior Aircraft Convention, at which time technical subjects as applied to model airplane construction will be up for discussion.

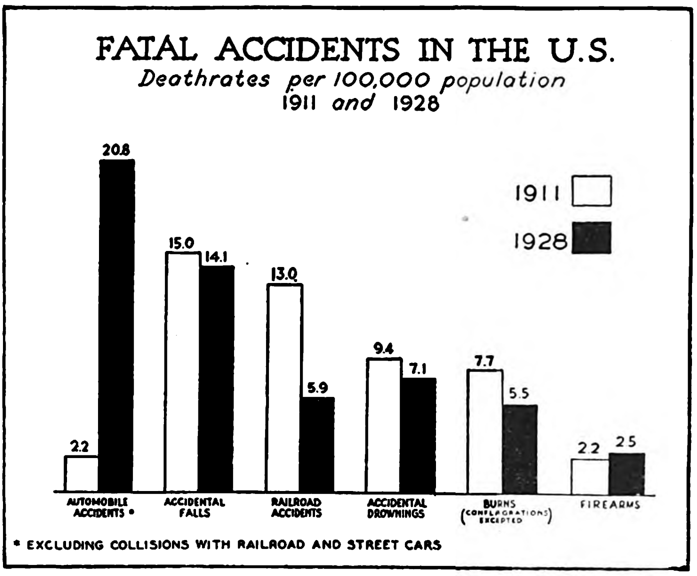
From Florida to Newfoundland, and from New York to Seattle, these model airplane contests are being held. They are being fostered everywhere; special junior technical aircraft magazines—featuring model drawings to scale, for the boy to use in his construction work—have made their appearance.

And the whole of it points directly toward a highly specialized aircraft education for boys—not just haphazard play! The results are bound to be far-reaching in the extreme in their effects upon the aviation of tomorrow.

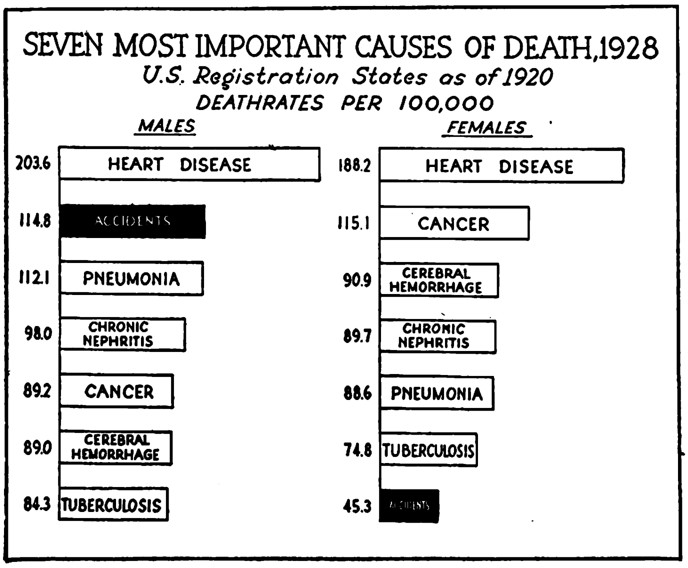


All diagrams courtesy of National Safety Council

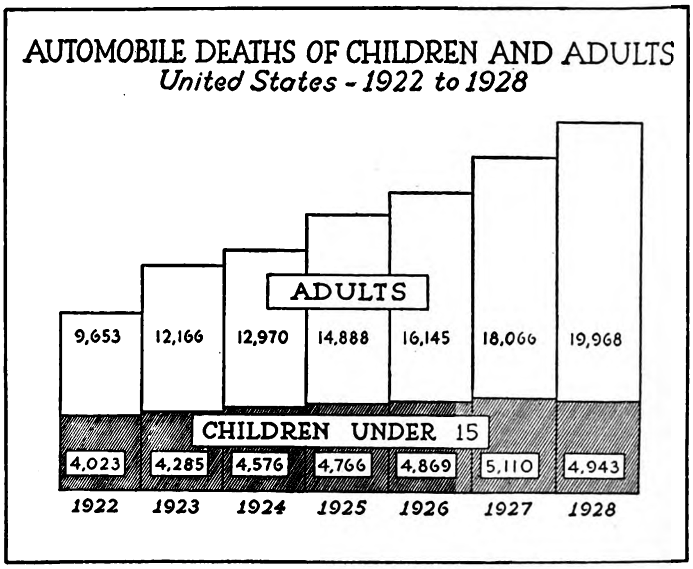
While automobile accidents soar, the death rate for non-automobile accidents is 30 percent below 1913



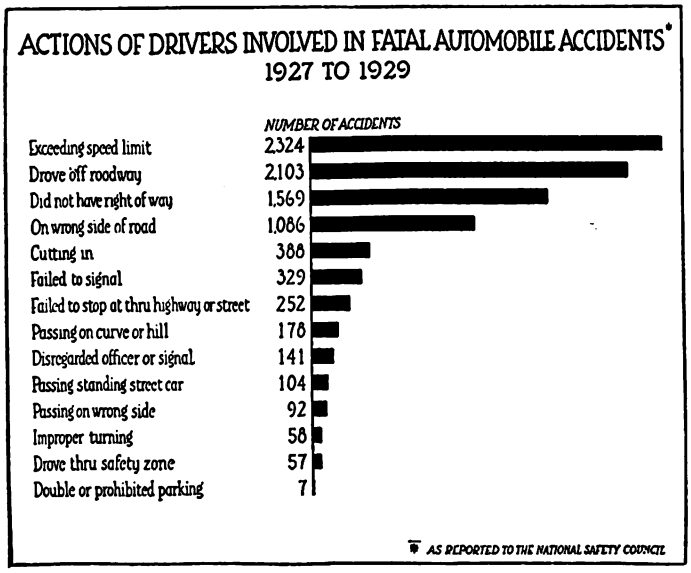
Various types of accidental death, showing a decrease during 17 years except for automobiles and firearms



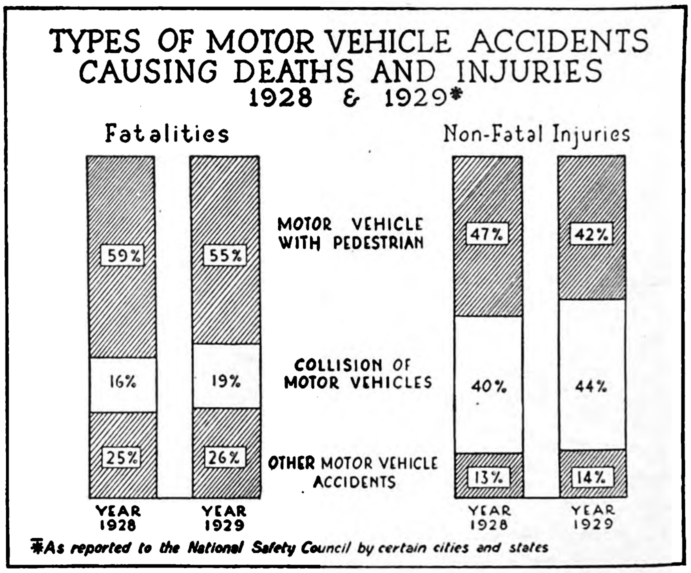
Fewer women than men suffer accidents. Accident death rates compare unfavorably with those of disease



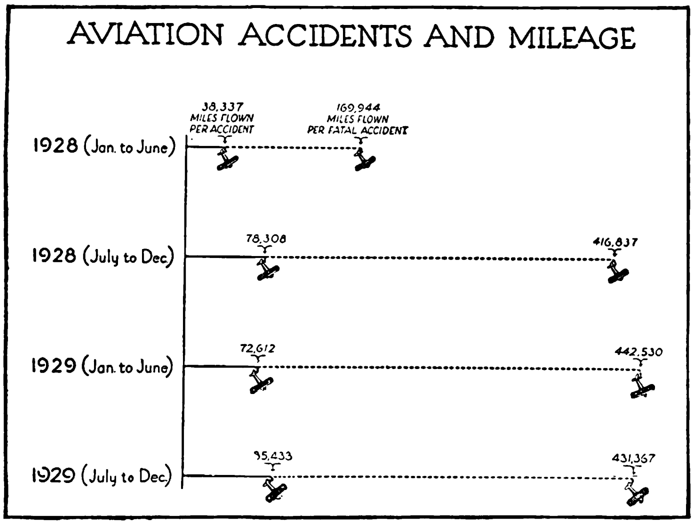
Motor vehicle deaths among persons over fifteen years old are increasing more rapidly than among children



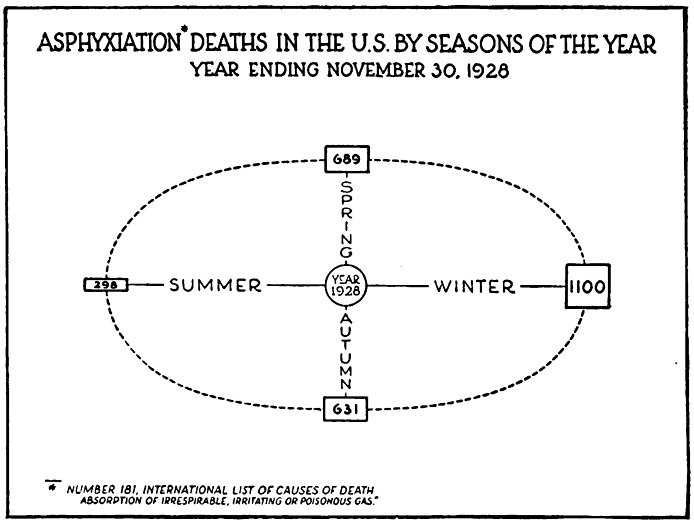
The cause of automobile accidents is worth studying. Speeding tops the list but even parking adds its quota



This interesting diagram shows that the automobile kills 13 percent oftener than it injures the pedestrian



Aviation accidents are on the increase as is described in the text. Four hundred and ninety-six deaths occurred in the year 1928 by airplane and balloon



The third largest cause of home fatalities is asphyxiation; 40 percent of such deaths occur in the winter months. The number is far smaller in the summer

The Penalty of Carelessness

An unprecedented increase in motor vehicle fatalities overbalanced the decreases in all other walks of life last year and America's accidental death toll rose to a new high total of 97,000. The private automobile driver is responsible for most of this increase and he must be curbed before a definite reduction can be realized in the national accident picture. The 1929 total for all accidents has just been made public by the National Safety Council on completion of its accident analysis for the past year. The accident fatalities for 1928 were 95,086. While total fatalities in 1929 were slightly less than 2000 more than in 1928, automobile casualties alone reached 31,000, an increase of 3000 over the previous year. These figures tend to show that motor vehicle fatalities alone are on the increase and that other types of accidental deaths are on the gradual decline.

Accidents to children are increasing far less rapidly than to older persons. In the seven-year period from 1922 to 1928, fatalities to persons of all ages increased almost 25 percent. In the same period accidental deaths of children under 15 increased less than one tenth of 1 percent. If accident prevention work among adults had been as successful as among children, approximately 20,000 lives would have been saved during the past year.

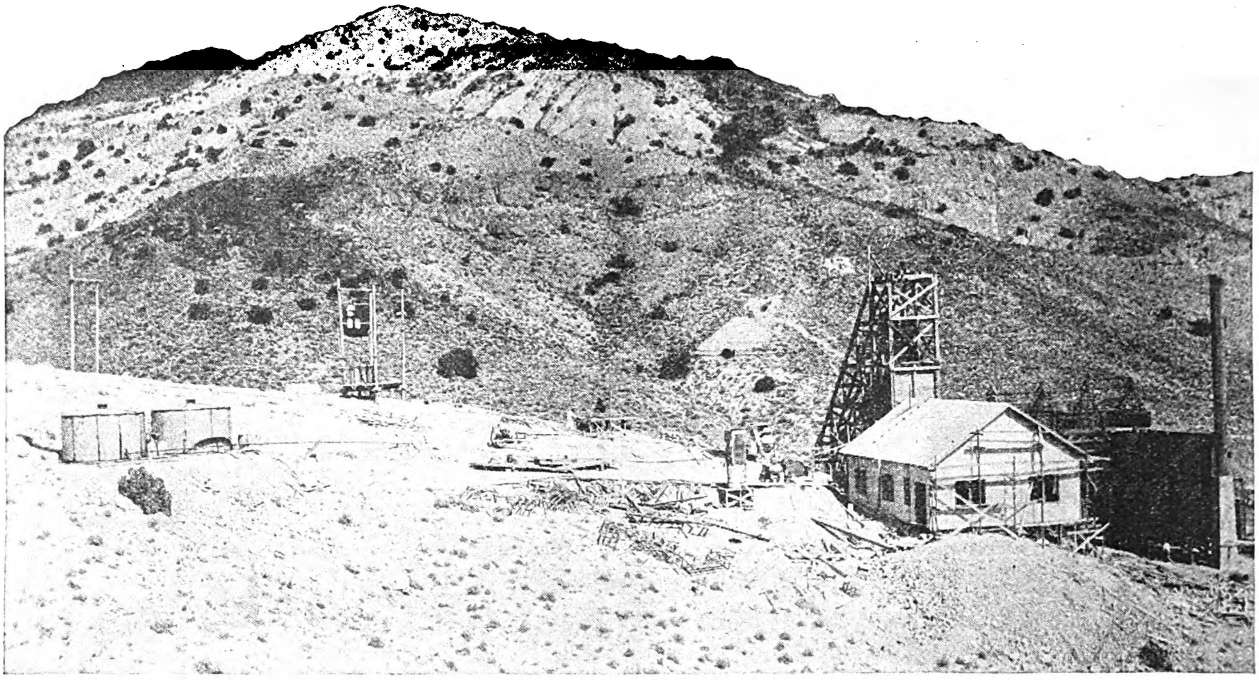
There was very little change in the railroad-automobile fatalities during 1929 and there was an improvement in the accident situation among commercial vehicle drivers. A large part of the increase therefore can be charged indirectly to careless owners of private automobiles.

The 97,000 death toll for 1929 included 23,000 fatalities in or about American homes; 23,000 fatal accidents in industry; and still another 20,000 persons who lost their lives in public accidents not involving the use of a motor vehicle. The principal cause of home accidents was falls, 9200 persons losing their lives in this manner. Burns, scalds, and explosions accounted for the next largest number of home fatalities. Asphyxiation and suffocation were the third most important causes. Carbon monoxide poisoning in closed garages was an important contributing factor. About 200 non-fatal accidents occurred in American homes for every fatal accident, it is estimated.

In addition to the annual study of accident statistics of the United States for the past year the National Safety Council conducted an interesting survey. Inquiries were sent to all governors, to the mayor of every large city, and to numerous other officials and civic leaders, asking their opinions as to the reason for increases or decreases in last year's accidents. Personal studies were made in 12 leading cities. This survey brings out some interesting facts: The states which have rigid drivers' license requirements continue to make better records, in relation to their own past experience, than the states where licenses are not required. Speed is a major consideration in the opinion of quite a number of the state and city officials and other experts. Intoxication is partly responsible for the "obsession to speed," according to the reports. Inadequate enforcement is blamed by many authorities.

There is one hopeful sign brought out in the analysis of the accident experience for 1929. If we could ignore the annual toll from motor vehicle accidents, our national experience would show that the national death rate from all other accidents had been reduced more than 30 percent since 1913.

The number of airplane and balloon fatalities in the United States has increased from 182 in 1920 to 496 in 1928. These are the Census Bureau figures. The Aeronautics Branch of the United States Department of Commerce recorded a total for the year of 485 fatalities in civil aviation. Schedule flying has the best record with a total of only 41 fatalities, or 8.5 percent of the total. According to other reports of the Aeronautics Branch, this type of aviation accounted for over 25,000,000 miles flown out of a total for all types of 79,000,000, or 31.6 percent of the total mileage. Miscellaneous pleasure flying resulted in 277 fatalities, or 57 percent of the total for all types. Of the total fatalities 227 were pilots and 258 passengers. The average mileage flown per accident and separately, per accidental fatality, is shown in our diagram. After extended and careful investigation the Aeronautics Branch announces that in 1929 about 57 percent of all accidents were due to errors of personnel; 18 percent to power-plant failures and 10 percent to some failure in the machine apart from the power-plant. Less than 5 percent were attributed to weather conditions. There was a sharp increase in deaths in airplane accidents in 1927 and a still greater advance in 1928, the latter being over 100 percent.



A quicksilver, or mercury, mine located in the hills of Nevada

The Reviving Liquid-Metal Industry

By J. K. NOVINS

IMAGINE a radio set without a vacuum tube, Milady's vanity dresser without its vermillion cosmetic, the bathroom chest without its reserve of mercury bichloride to guard against fleshy infection, the sick room without a thermometer, and your hunting ammunition unequipped with precussion caps. All of these utilize quicksilver, or mercury, in various quantities. Yet the average man or woman knows little of the origin of this liquid metal or of the methods through which it is extracted from sandstone and poured into flasks, ready for the many uses that man's scientific ingenuity has devised.

Still less do we know of the potential uses of this fluid-metal which touches the life of every man, woman, and child in that it brings freedom from agonizing pain, makes possible home comforts, kills crop-destroying insects, prevents the fouling of ship bottoms, and is used extensively to roughen the hairs of felt products.

Of the two and a quarter million pounds of mercury utilized in this country, only 10 percent enters into the manufacture of electrical apparatus. Yet here is a field that promises unprecedented demand for the metal and is responsible for the present revival in mercury mining. Few know that mercury is essential in the manufacture of neon lights which are now used for display sign purposes. The blue color produced by the neon sign is caused by the presence in the tube of metallic mercury which acts with the neon gas. The green color is produced by mercury without the aid of any other gas or chemical, but the glass tube is tinted.

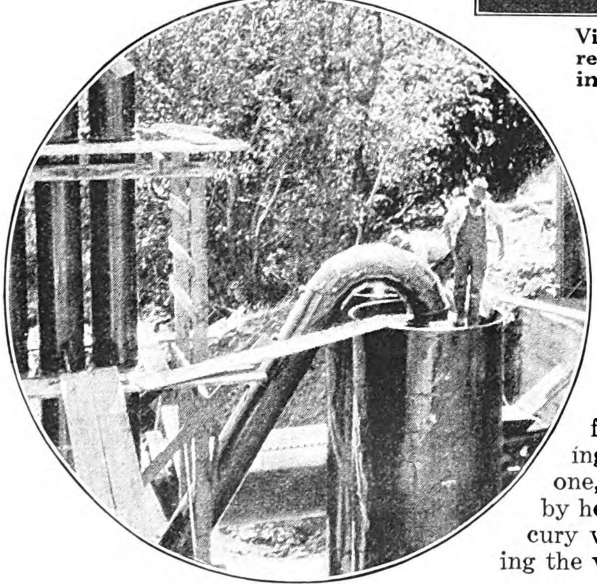
Of greater importance still is the promised use of mercury in power generation. Experiments conducted by the General Electric Company have demonstrated that mercury turbines have a heat efficiency of 85 percent, as compared to the 25 percent or lower heat efficiency of steam electric plants. If applied generally, anywhere from 11,000,000 to 17,000,000 pounds of mercury would be required to take care of the annual increase in generator capacity. This amount of mercury is more than the entire world now produces annually.

THE experimental installation consists of a mercury boiler and mercury-vapor driven turbine, as well as steam boiler and steam-driven turbine. After passing through the vapor-driven turbine, the mercury vapor is condensed. Steam is generated in this condenser by the heat delivered in the condensation of the exhaust mercury-vapor. The condensed mercury is then drained and returned to the mercury boiler. In this manner mercury can be utilized with very little loss.

Only 2.4 percent of the mercury used in this country enters into the manufacture of scientific instruments, such as thermometers and barometers. By far the largest amount—to be exact 32.2 percent—is required by the drug and chemical industries. The largest single use is for fulminate, an explosive, and next in order, for vermillion and oxide. Only a little over 3 percent is used for gold and silver milling, although during the bonanza days in gold mining very large quantities of mercury were needed to amalgamate gold and silver from the metallic ores. In the heyday of gold mining, California, which is our largest mercury producing state, enjoyed a record annual production amounting to 4,000,000 dollars, but now the production has fallen to less than a million. For many years the domestic mercury industry was practically at a standstill, only to be revived recently by increasing demands in industry.

A NUMBER of the old mercury mines in California, which have been idle for years, are now thriving with renewed activity. The Oat Hill Mine, which the writer visited recently, again began to produce the metal from low-grade ore only a few months ago, after it had been abandoned for four or five years. Low prices, substitution of cyanide for gold and silver extraction, and the competition of foreign mines, were responsible for almost a dead stop in domestic production. No other metal has suffered as much from the inroads of substitution. It was formerly used in large quantities to "silver" mirrors, but is now almost entirely replaced by a silver nitrate process. Even as a fulminate, other substitutes have been found, in which lead and silver form the principal products. Now that mercury has been demonstrated as an efficient power generation agent, research has revealed a suitable substitute for it in the form of diphenyl oxide, which is a by-product in the manufacture of carbon tetrachloride and chloroform.

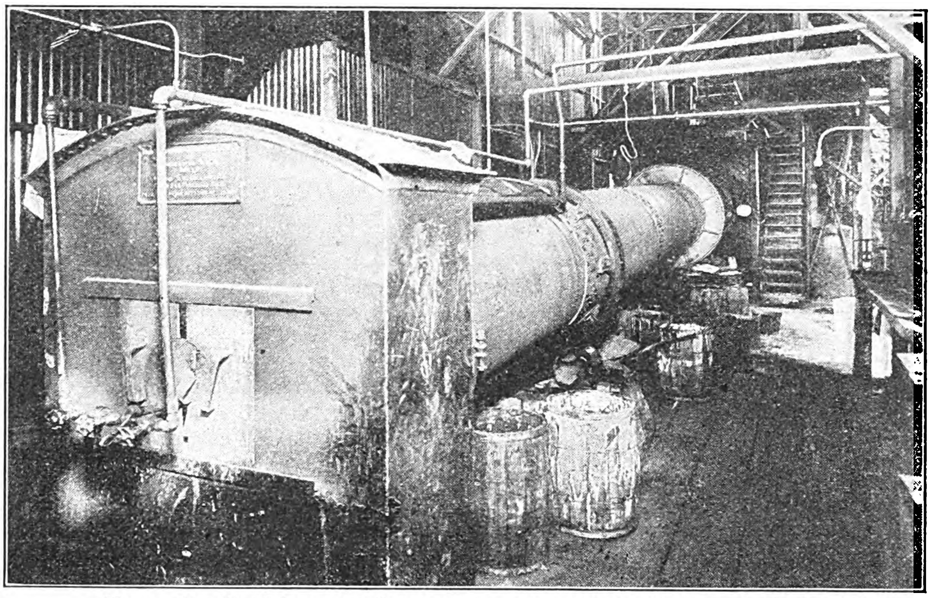
YET, despite its age-long battle with substitutes, mercury has persisted as a separate mining industry since the Phoenicians first began to work the famous Almaden Mine 27 centuries ago. Today this mine, operated by the Spanish government, produces more than one third of the world's supply of mercury, and shows no signs of depletion. Last year this mine produced half of the world's supply. Italy was the next largest producer, and the United States came third in the production of this metal.



From the cyclone tank, on which stands a man, mercury vapors are piped into condensers

The principal mercury mines in California are located without exception in the coast range, where the ore has been lifted toward the surface by volcanic action. The mines are usually located in the vicinity of hot springs. Due to the surface operations, mercury mining in California has not been marked by the hazards of fissure digging in the Almaden deposits, where men have gone to depths of several thousand feet. Due to the greater heat at 2000 and 3000 feet below the surface, mercury has been known to run down the stope walls as so much liquid, thereby subjecting the miners to the danger of mercurial poisoning. Surface mining, confined largely to depths of several hundred feet, have tended to reduce hazards, and the danger of poisoning by contact with vapor has been largely eliminated by the use of modern furnace and condensing equipment to be found in the California mines.

At the Oat Hill Mine, tunnels are bored into the hillside and the ore removed to the surface on a narrow-gage roadway. The ore is a sandstone dotted with red, and is known technically as cinnabar. This heavy, vermillion-colored mineral is composed largely of mercury and a smaller amount of sulfur. The process of extracting the mercury is a simple one, the metal being distilled by heating the ore until the mercury vaporizes and then condensing the vapor into a liquid. This is followed by a purification process to get rid of the sulfur, as well as of carbon monoxide gas and other dangerous fumes. The final process is to "hoe" the mercury from its slimy blanket of soot. The refining process is accomplished entirely at the mine, and takes place within a few minutes after delivery of the crushed ore to the furnace.



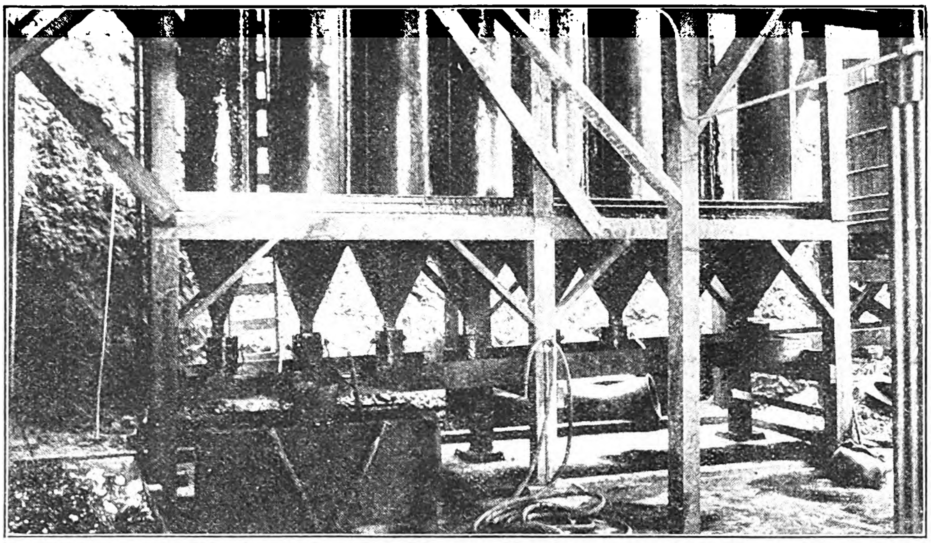
View of a Gould rotary furnace, a type now used extensively for the refining of mercury. Its rotating action helps volatilize the mercury in the ore. Its construction and operation are described below

In mercury mining, a tunnel is driven to as great a depth as 750 feet. There are innumerable tunnels to be found in the vicinity of the Oat Hill Mine, and it is estimated that in the 60 years that this mine has been producing the metal no less than 24 miles of tunnel have been driven. During that time the Oat Hill Mine has produced some 19,000,000 dollars worth of the widely used liquid metal.

From the mouth of the tunnel, the ore rock is conveyed to the gravity sorting bin by a three-ton motor truck. After a perilous mile and a half trip over a one-way mountain road, the truck is backed up onto a loading platform, from which the rock is catapulted several hundred feet to the storage bin below. Yet this truckload of rock will produce only 12 or 18 pounds of mercury, figured at from four to six pounds of the metal to the ton of ore. At present prices—and they are high—a pound will bring less than two dollars, or more than double the production cost. The present price is treble the average price of mercury in the United States during the past 40 years, while production cost has been reduced by utilizing more efficient production methods.

BEFORE the ore is fed to the furnace, it must be crushed and sorted. An automatic feeder introduces the ore particles into the rotary furnace at the rate of 10 pounds every minute. The feeder can be adjusted to feed the ore in various quantities and in different sizes, depending on both the type of ore and the roasting conditions. The "feed" then has to go through the 60-foot rotary furnace, which slowly revolves in order to facilitate volatilization of the mercury from the ore. At the point that the ore enters the furnace a temperature of 1800 degrees, Fahrenheit, is maintained, this being decreased to 450 degrees at the mouth of the furnace.

The rotary furnace turns three fourths of a revolution per minute and inclines at three fourths of an inch to the foot. At the same time that the vapor rises from the ore, the revolving action raises the dust as the rock proceeds downward. A powerful fan in



Mercury condensing system. The vapor travels through these condensing tanks and is deposited as a sort of sludge or slime in the hoppers below

the dust chamber at the head of the furnace sucks the vapor and dust into two cyclone tanks, in which the dust settles and the mercury vapor is made to proceed to the series of 12 condensers. The first cyclone tank is smallest and collects most of the dust. As the dust and vapor enter the cyclone they are driven by centrifugal action from the center to the metallic walls, with the result that the dust, being heavier, will settle, while the vapor, combined with smaller quantities of dust, will undergo further separation in the second, and larger cyclone. The light gaseous vapor naturally rises to the top of the tank directly into pipes which lead to the series of condensers.

The condensers are 16 feet long and 19 inches in diameter. At the bottom of each condenser unit is a cone-shaped outlet. The hot gas enters directly into this lower cone, where it deposits some of its dust, and then travels through a circular pipe to the height of the condenser. The vapor condenses into the familiar liquid against the cool walls, and this liquid metal drops to the cone-shaped hopper, or outlet.

A CERTAIN amount of the condensed mercury will adhere to the wall and can be removed into the hopper below by unscrewing the clean-out hole at the top of the condenser and flushing the walls with water. Even at this stage the mercury can be removed from the hopper in the first condenser in the form of a whitish slime from which the quicksilver must be hoed out.

A certain proportion of the mercury vapor will fail to condense in the first condenser, and will therefore circulate through the other condensers in the series. Experience has shown that most of the mercury will be deposited in the second and third hoppers. The complete series of 12 condensers is needed in order to catch every minute globule of mercury before the sulfur and other gases are afforded an escape to the purifying tanks.

The three purifying tanks are connected by a small pipe. Thus by a process of compression, when the gases enter the pipes, and by expansion during the journey in the tanks, considerable heat is generated, propelling the sulfur and carbon monoxide gases to the stack, from which they are vented into the air.

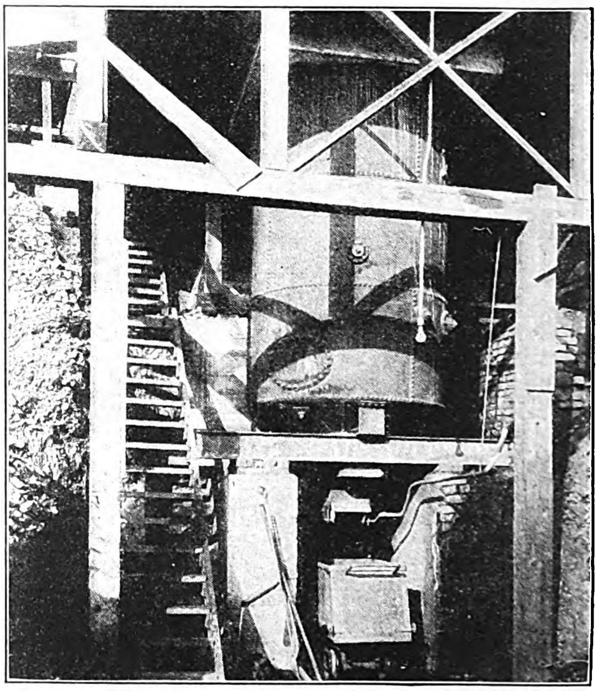
The whitish slime gathered from the hoppers is dumped on a round table. A man with a hoe separates small quantities of the slime, and as he does so, small streams of mercury globules are seen to flow to the opening on the lower end of the table and into a metallic flask which normally holds 76 pounds of mercury. Properly sealed, this flask is ready for the market.

The hoeing process is a survival of ancient times. The minute globules of mercury present in the slime are practically invisible to the naked eye. The action of the hoe loosens the slime in small quantities, making it possible for the small globules to seek each other out, much as drops of water coalesce into a small stream. It is the simplest, yet most interesting process of mercury refining—and the most hazardous.

The hoeing action must be slow; otherwise it will raise little eddies of dust, which if swallowed, even in minute particles, is sure to cause mercurial poisoning. The first symptom of the poisoning is loosening of the teeth, followed by disruption of the digestive system. If the poisoning is not arrested, the operator will suffer an attack of nerves. Leaky pipes in the roasting and condensing system are now the chief cause of poisoning. In the ancient Almaden mines there were so many cases of poisoning that the occupation was considered too dangerous for a free man; therefore convict labor was extensively employed.

H. W. GOULD, a San Francisco mining engineer, recently perfected a mechanical hoeing device which it is expected will eliminate the inefficiency and the hazards of hand hoeing. This device is equipped with mechanical rabble arms to separate the slime and afford free movement for the mercury globules. Mr. Gould is also the inventor of the rotary furnace which is now used extensively in American mercury mines, and is gradually replacing the older methods employed in foreign operations. It is especially adapted for low-grade ores which formerly could not be worked at a profit. At the Oat Hill Mine the rotary converts 80 tons of ore every 24 hours. This ore has less than 0.25 percent of quicksilver. At the Spanish mines the ore has about 8 percent of mercury and can, therefore, be mined economically with the older methods of refining. Although these mines have been worked since 800 B.C., richer ore is now being extracted from great depths.

Paul M. Tyler, of the Federal Bureau of Mines, says that "in many lines, substitutes for mercury are employed; but in other lines there is a constant ebb and flow as consumers experiment with first one and then another, only to return to mercury. . . . To have faith in the future of modern industry is to have confidence in the future of mercury."



Waste ore from the furnace is deposited in a retort and is removed in carts to the rock dump

PROHIBITION and the Physiological Effects of Alcohol

By H. H. MITCHELL
Professor of Animal Nutrition, College of Agriculture, University of Illinois

THE most acute political question of this generation is at the present time being debated largely on the basis of uncertain statistics, and interpretations of them biased by inflexible opinions in regard to moral standards or personal liberty. It should be obvious to those who approach the question of the advisability of national prohibition with an open mind that reliable statistics on the success of prohibition enforcement are not at hand. The interpretation of trends in penal, industrial, and other social statistics that are at hand, in terms of assumed trends in the consumption of alcoholic liquors nevertheless is the stock in trade of the political prohibitionist and the political anti-prohibitionist. After reading the propaganda put out by both sides of the argument, one can agree wholeheartedly with Josh Billings, when he said that it is better not to know so much than to know so many things that aren't so.

THE enactment of legislation aiming at the restriction of the sale of alcoholic liquors can be justified only on the basis of the harmful effects of alcohol on the human body and on human behavior. The extent to which the consumption of liquor should be restricted depends upon how harmful alcohol is and in what dilution its effects become inappreciable. Few would doubt the wisdom of governmental restriction of the sale of the alkaloidal narcotics. The question with respect to alcohol may and should be argued on the same basis, though the answer need not be the same because there are certain compensations in the use of alcoholic beverages that do not pertain to the use of the more powerful narcotic drugs. Without minimizing the importance of the purely practical problems of the probable effectiveness of the machinery for the enforcement of liquor legislation and of the expense involved, it appears to be no exaggeration to say that the purpose and the form of such legislation should be determined largely on the basis of scientific data in regard to the physiological and psychological effects of alcohol.

How does the human body dispose of the alcohol contained in consumed liquor? Requiring no digestion and being readily soluble in water and readily diffusible, it is rapidly absorbed from the digestive tract. In fact, absorption may start in the stomach, from which practically no absorption of the ordinary food nutrients occurs. The absorbed alcohol is taken up by the blood stream and carried to all the tissues of the body. Its ready diffusibility in aqueous media accounts for its penetration into all organs, and after a time it may be present in the brain, liver, kidneys, spleen, heart, and lungs in concentrations approximating that in the blood. Even after moderate doses of alcohol, it may be detected in the expired air, in the urine, and, with nursing women, in the milk secreted.

OF heated articles about prohibition there already have been no end. It may be stated with fair confidence that 90 percent of the general public is thoroughly and heartily sick and tired of them. It is getting so that many people, when they sense the approach, say at dinner, of an oral tilt about this threadbare subject, let out a groan of despair and slide into oblivion under the table. At least they feel like doing so.

Is it not possible that this widespread reaction to the prohibition question is due partly to the fact that one so seldom reads an article or listens to an argument on prohibition that seems really calm and unbiased? But we publish Professor Mitchell's article because we believe it is just that—calm and unbiased. If as a result of its publication we receive a half bushel of letters saying it leans toward the "Demon Rum," and another half bushel saying it leans equally in the opposite direction, our own belief — that it does not lean at all —will be flattered.—*The Editor.*

But the body does not dispose of ingested alcohol to any great extent by excretion from lungs or kidneys. Only five percent or less is gotten rid of in this way. Alcohol is combustible in the body, and is very readily burned to carbonic acid and water, as are sugars and fats. The energy thus liberated may be used by the body in the same way and for much the same purposes as the energy produced from the burning of sugars and fats. But it has not been shown that alcohol can be transformed to sugars or fats and stored in the body.

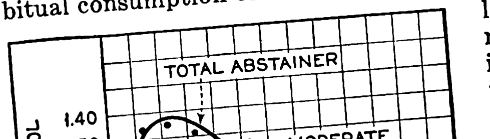
Hence, after a drink of alcoholic liquor the concentration of alcohol in the blood and tissues will rapidly rise to a maximum in the course of one to two hours, depending on the concentration in the liquor consumed, but then it will gradually decrease until after a variable period of time the body will be alcohol-free or practically so. It has been estimated by Mellanby in England, that an average man can burn only from 7 to 10 cubic centimeters of alcohol per hour, so that the time required for the body to rid itself of this substance will be directly dependent upon the amount consumed. A moderate dosage of alcohol, for example, 30 cubic centimeters or approximately one fluid ounce, contained in a pint of fairly heavy beer, would be disposed of in three to four hours or so, but an intoxicating dose may take from 10 to 20 hours for complete combustion.

THE physiological and psychological effects of alcohol have been shown to vary in intensity with the concentration of alcohol in the blood. When the blood contains no more than 0.1 percent of alcohol there are no obvious signs of intoxication. A concentration of .15 percent of alcohol, following the consumption of about 100 cubic centimeters of alcohol (4 pints of beer or 7 to 8 ounces of whisky) on an empty stomach, is associated with a moderate state of intoxication. With increasing consumption of alcohol the maximum concentration in the blood will increase to 0.5 percent, which may be associated with stupor. When a concentration of 0.6 percent is reached, life itself is endangered. Some recent German investigations, in which more recent methods for the analysis of blood for alcohol were used, would indicate that these values may all be low, but the fact remains that alcoholic effects are correlated with alcohol concentrations in the blood, and that the lethal concentration is uncomfortably close to that associated with alcoholic stupor.

It is well known that the effects of a given dose of alcohol depend upon its dilution as consumed. More alcohol may be consumed in dilute solution than in concentrated solution in proeing a given physiological effect, ecause the time of absorption is ex- nded. In agreement with this fact, has been found that the more con- ntrated the solution of alcohol con- med, the greater the blood concen- ation attained and the quicker the aximum concentration is reached. ernon has shown, in illustration of e same relation, that amounts of lcohol may be consumed in small ourly doses without physiological ffect, which in the aggregate would roduce intoxication.

It is also well-known that the consumption of alcoholic liquor during or immediately after a meal produces a much smaller psychic effect than consumption on an empty stomach, for example, three hours or more after a meal. A number of investigations agree in showing that the alcoholic content of the blood is less if a given dose of liquor is drunk immediately after a meal than three or more hours after. The consumed alcohol mixes with the food in the stomach and is diluted by it, so that the rate of absorption in considerably less. Fatty foods are particularly effective in this respect.

Again, it is a matter of common experience that a person not accustomed to alcoholic liquor is more readily affected by it than is a habitual user. And again the blood picture offers an explanation. Thus, Schweisheimer showed that if total abstainers, moderate drinkers, and heavy drinkers imbibe the same quantity of alcohol under the same conditions of dilution and time after the last meal, the resulting concentration of alcohol in the blood is highest for the abstainer and lowest for the habitual heavy drinker. Furthermore, the observed differences were considerable. Possibly the habitual consumption of alcoholic liquors impairs the absorptive powers of the digestive apparatus, or possibly some obscure protective mechanism is developed.



From W. Schweisheimer in Deutsches Archiv fur Klinische Medizin 1912-13

The effect of habituation to alcohol on the concentration of alcohol in the blood after the ingestion of 1.57 cc. per kilogram of body weight (corresponding to about four ounces for a 150-pound man)

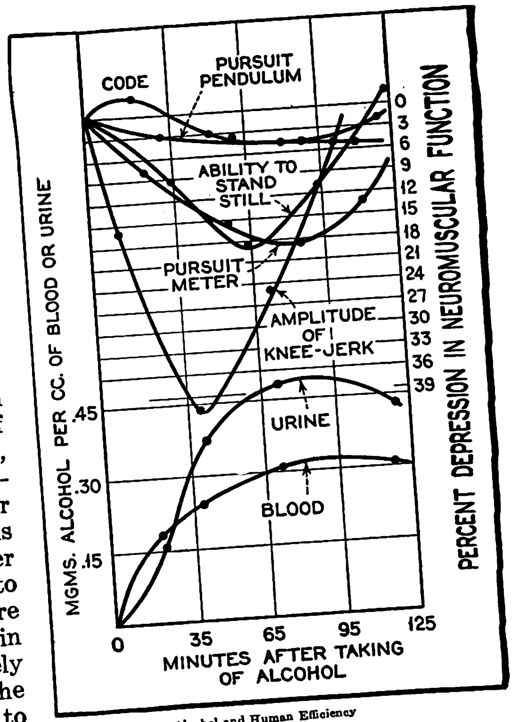
It is true that alcohol is a food in the sense that it is easily oxidized in the body, but unlike the ordinary nutrients it is toxic when it attains even a moderate concentration in the blood and tissues. Also unlike ordinary nutrients, the body has no effective means of regulating its concentration in the blood. When a healthy normal person consumes sugar or starch, even in large amounts, the concentration of sugar in the blood will rise rapidly, but when the rate of absorption exceeds the rate of oxidation and sugar begins to accumulate in the blood, it is withdrawn from the blood by the liver and the muscles, converted into glycogen or fat and stored for future use. The concentration of sugar in the blood will for this reason rarely exceed 0.15 percent. But in the diabetic, who has lost the power to oxidize sugar or to store it in any considerable amount, the consumption of sugars and starches will increase the concentration of sugar in the blood to 0.30 percent or more, and the accumulated sugar clogs the physiological machinery, so that diabetic coma and even death may result.

THERE is thus a similarity between the effects of sugars and starches on persons afflicted with diabetes and the effect of alcohol on normal persons. The diabetic can dispose of absorbed sugar only (or mainly) by way of the kidneys; the normal individual can dispose of alcohol only (or mainly) by way of oxidation, but in both cases the mechanism of disposal is effective only to a certain limit of consumption, beyond which increasingly disastrous effects will ensue, even to the point of death. Thus, regulation of the composition of the blood in neither case is a physiological one, but is largely a matter of voluntary control. However, the diabetic is aware of his condition and of his own peculiar dietetic dangers, and trains himself under medical guidance to limit his consumption of dangerous foods to his own particular tolerance for them. Can the same be said of the habitual drinker?

The outward symptoms of alcoholism are familiar to all, but it is of interest to quote a precise description of them as analyzed by a noted English physiologist, the late Professor E. H. Starling:

"The effects of acute alcoholic poisoning may be described as a continuous and progressive impairment and abolition of the functions of the brain, starting at the highest evolutionary level and progressing downwards. The stage in which there is lessened self-criticism, greater freedom of utterance, and diminished self-control is succeeded by a phase in which there is interference with the social habits of the individual, while the co-ordination of muscular movements becomes more and more imperfect. This gives place to a condition of stupor or drunken sleep in which the individual may persist for many hours until the greater part of the alcohol has been oxidized in the tissues and its concentration sinks once more below the poisonous level. In the drunken sleep the noisy, labored breathing often shows the beginning of interference with the innervation of the respiratory muscles, and if the dose has been sufficiently large this may lead to death from paralysis of respiration. . . . In some cases the result may be a profound shock from the direct irritant effects of the strong alcohol on the stomach, and heart failure may be associated with the gradual failure of respiration."

Popular opinion throughout the



Data from Miles, Alcohol and Human Efficiency

Effect of a small dose (27.5 grams—about an ounce) of alcohol in dilute solution (2.75 percent) on selected neuromuscular responses and the alcohol content of blood and urine. The curves represent averages from eight subjects. The neuromuscular responses may be described briefly as follows: Efficiency of eye-hand co-ordination was tested by the "pursuit pendulum," with which the subject catches in a small cup as much as possible of a stream of water flowing from the lower end of a moving hollow pendulum. Continuous eye-hand co-ordination was measured by the pursuit meter, an electrical instrument of some complexity—the subject, by manipulating a rheostat, endeavors constantly to keep a wattmeter needle on the zero-mark in spite of fluctuations in the electric circuit automatically induced by a disturbing device which remains beyond his control

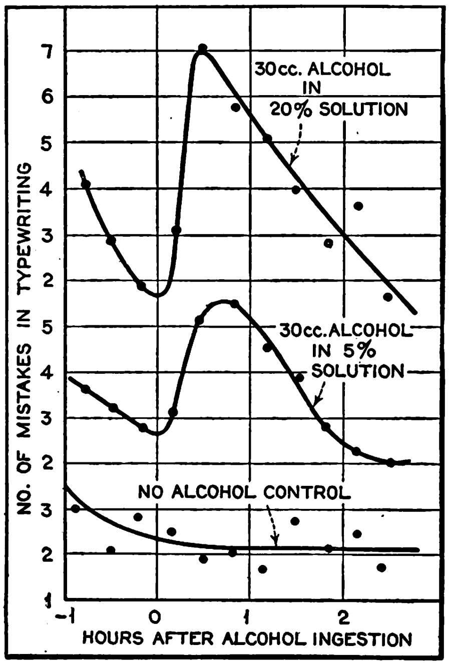
civilized world favors some type of governmental action to decrease the likelihood of alcoholic intoxication, a condition which is disgusting to see and degrading to its victims. The pleasing effects of alcohol are, however, realized long before this condition is reached. The temperate use of alcoholic liquors induces a condition that has been sympathetically described, also by Starling. Picturing a man who is attending a feast of which alcoholic drinks form an integral part, Starling says:

"A man may go to such a dinner full of the cares and work of the day, with little or no interest in those he has to meet, whose occupations may be very diverse from his own, nervous of making any remarks to his neighbors for fear of making himself ridiculous or saying something in which they are not interested. After the first glass of champagne we notice the conversation, instead of being spasmodic and forced, becomes general and free; the self-consciousness and preoccupation of each man with his own affairs become lessened. He is more receptive of the moods and interests of his companions. His emotional responses are more readily aroused; the solemn man unbends, the critical becomes charitable and sympathetic, the silent man more loquacious. Each man thus not only reveals himself more to his fellows, but is more ready to appreciate the merits and conversation of those around him. In a word, the use of alcohol in moderation promotes good fellowship. With this greater freedom of interchange of ideas there is less restraint of gesture; facial expressions become more animated; ideas in every man seem to flow more freely and speech becomes more ready."

EVEN though at such a feast, a second or a third glass of champagne may change the conversation from witty repartee to boresome anecdotes and maudlin expansiveness, there is surely no occasion for the interference of organized society. But when the party breaks up and its members enter their various automobiles for the trip home, possibly through congested traffic, have their psychological reactions and their muscular co-ordinations been so adversely affected that as motorists they are to some degree menaces to public safety? Or if it is a midday meal, and they have an afternoon of work in office, shop, or factory before them, have their physical and mental efficiencies been impaired by this convivial feast?

Unfortunately these questions must be answered in the affirmative. Many physiological laboratories throughout the world, particularly the Nutrition Laboratory of the Carnegie Institution at Boston, have demonstrated beyond reasonable doubt that the consumption of even moderate amounts of alcohol, in dilutions of 10 percent to as low as 2.75 percent, depresses the function of the nervous system generally and in many respects to an appreciable and even a considerable extent. It is true that much of this work relates to drinking between meals rather than at meals, but the results are applicable, if in less degree, to the case in point. Furthermore, it may be supposed that wherever the desirable psychic effects of alcohol are observed, the depressant effects are invariable accompaniments, since both must result from an increased concentration of alcohol in blood and tissues.

If a participant of Starling's feast attempts to stand perfectly still, the swaying of his body may be greater by almost one fourth than it was before the feast; if he attempts to follow with his eye a quickly moving object, or if he attempts to adjust some instrument with his hand according to the guidance of his eye, his performance will be definitely subnormal. His visual acuity has been decreased and the amplitude of his knee jerk (patellar reflex) has been depressed. If he is a skilled typist, his speed in typewriting will be to some extent lowered and the number of errors perpetrated will be greatly increased. In the case of a woman, her speed in threading needles will be much less than normal. In these and many other ways, it has been shown that alcohol in very moderate doses is a depressant, though the imbiber will have the subjective impression that he is performing faster and better than normal. The more skilled the task, the greater is the depression in efficiency.



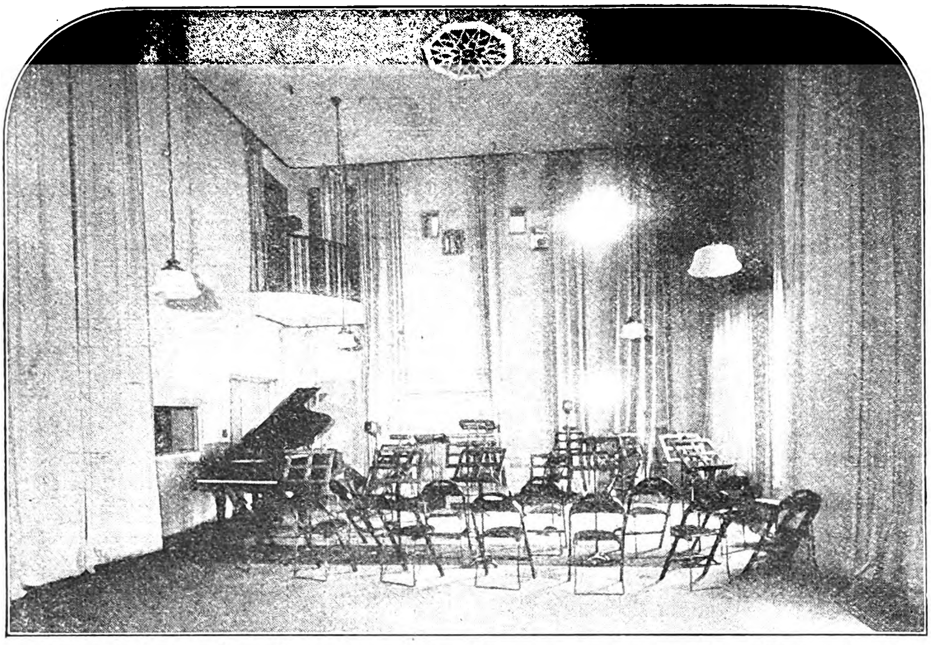
From Report No. 34 Medical Research Committee (Great Britain)

The effect of 30 cc. (about an ounce) of alcohol, taken in dilutions of 5 and 20 percent, on the accuracy of typing a memorized short passage, which required a maximum of two minutes to type

It is very doubtful whether alcohol ever exerts even a small initial stimulating effect on the nervous system, as has been maintained in the past. The change in point of view has resulted from improved methods of study. It is now recognized that many physiological processes are normally kept slowed down by higher controlling centers. When these centers are depressed by alcohol, or ether, or chloroform, the lower mechanisms are released with some of the signs of stimulation, such as an increased pulse, or a flushing of the surface capillaries with an increased flow of blood. The effect resembles that following releasing the brakes of an automobile, as contrasted with increasing the pressure on the accelerator. A British scientific board has summed up the evidence in the statement that "the direct effect of alcohol upon the nervous system is, in all stages and upon all parts of the system, to depress or suspend its functions; that it is, in short, from first to last, a narcotic drug."

THESE scientific findings render superfluous any statistical inquiry of the effects of alcohol consumption on industrial efficiency. A depression of efficiency of some degree is almost an inevitable consequence of even the moderate use of alcohol. The effect upon criminal tendencies can not be so clearly deduced, but the common association of liquor with crime, even before the prohibition regime, must be something more than an accidental one. In so far as the criminal is a psychopath, with an inherited tendency to mental and nervous instability, he is, according to Starling, an especially susceptible victim of alcoholic poisoning.

The facts discussed in this article are not presented as the sole evidence upon which the wisdom of prohibition should be decided. But it may be contended that they should form an important part of that evidence. The basis of discussion of this question should be shifted from the grounds of morality, social reform, and personal liberty, which possess merely a sentimental appeal, to the sounder basis of the control of the sale of alcohol as a narcotic drug. Its potency is much less than that of other drugs long known to be narcotics, but the much more prevalent use of alcohol in much greater amounts will of necessity occasion more misery, ill-health, and inefficiency. However, the use of alcoholic liquors by a large proportion of the population is a striking testimonial to its contribution to the pleasures of life and to conviviality. The solution of the question of liquor control should possibly be a compromise between these opposing arguments.



One of the studios where recorded radio programs are made. Two microphones are visible, one on each side of the window in the background

Recorded Radio Programs

By A. J. KENDRICK

President, Sound Studios of New York, Inc.

IN England the broadcast program is paid for by the public, which is taxed, the money collected being turned over to the radio stations to defray the expenses of broadcasting. The sponsored program does not exist.

In this country, however, business interests, awake to the good-will that may be created for their products and services via the air, pay the stations for the privilege of broadcasting programs. The sponsor also pays for the programs, which entertain the radio public and create good-will for the sponsor. This American system of broadcasting, which makes of radio a business asset, has also introduced a new industry to take the place of that older one which has found the going hard in the face of radio competition. The old industry to which we refer is that of making phonograph records. The new one is the recording of broadcast programs.

It might appear that these two industries are quite alike. They are—in outward respects. The new one has grown from the older. But the new one has progressed to that point where a person familiar only with the old method of phonographic recording would be lost in the new science of recording radio programs. On the other hand, those who would do fine work in the new industry should have at their command experience in the phonograph field, should have grown up hand in hand with recording, from its primitive days to the present time.

It was with the basic idea of creating an organization based on quality that Sound Studios of New York was founded. With Gustave Haenschen and Frank Black, well known in the phonograph and radio worlds, as Vice Presidents and directors of music, we were assured of artistic programs that would please the audience and gain good-will for the sponsors. With C. Lauda, Jr., an authority on acoustics, as Chief Engineer, we were well taken care of on the technical end, especially since he immediately surrounded himself with experts to handle every phase of recording.

THEN we procured studios and equipment of the latest type. Desiring to have full responsibility over every step in the making of recordings, we acquired turntables and recorders, microphones and studios, galvano baths and presses, shaving machines and buffing machines—every item for making disks. With a most complete plant and equipment, with a musical library as fine as any anywhere, with experts along every step of the way from business men and executives, through musical directors, talent, technicians, and workers, we felt ready to proceed.

We formulated ideals and we have stuck to them, without trying to discredit other firms or individuals who are doing a good job. We will rent our studios and equipment and the services of our technicians for recording programs not prepared by us. But we insist that they be of high quality, for we cannot afford to have poor programs recorded in our plant. Nor do we allow the release of programs prepared and recorded by us to stations not properly equipped to broadcast them. The results of these ideals, equipment, and personnel have been the recognition on the part of sponsors and stations that recorded programs have a definite place in the radio field if done properly, and the building of a clientele of the foremost sponsors.

RECENTLY, the Western Electric Company, having developed recording and broadcasting apparatus to a point hitherto unreached, equipped a number of broadcasting stations for operation from disk recordings. Others are being equipped every day. Looking about for a recording company whose work and personnel merited the installation of recording apparatus, Sound Studios of New York was chosen as the recipient of the first Western Electric license for the recording of broadcast programs. An entirely new set of equipment is now being installed in our studios, covering every feature of recording.

Recording broadcast programs involves a combination of artistry and engineering. The artistry lies in the preparation of the program, which should reflect the character, mood, tempo, and atmosphere of the sponsor and his product, appeal to the audience whom he wishes to address, and please that audience, making the listener desire to purchase the sponsored product.

The program having been prepared, the musicians and vocalists rehearsed, and the program given over the network, let us suppose that the sponsor wishes to get the full benefit of this fine program. He desires to use it for "spot" broadcasting from independent stations.

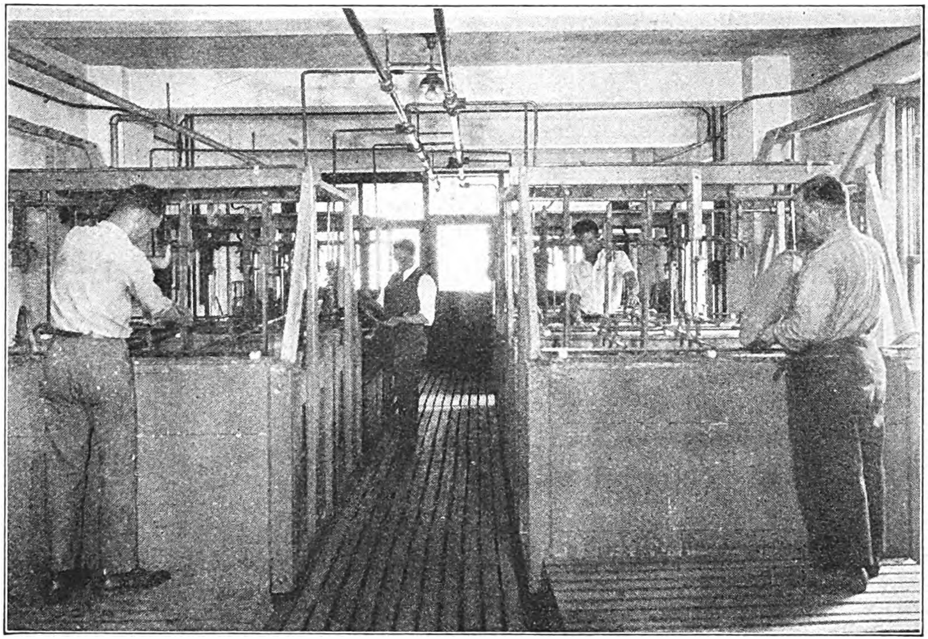
The recording studio is prepared. This room looks very much like any fine broadcasting studio, with soundproof walls and ceiling, ventilator to keep the room at constant temperature, control room looking upon the studio through a glass window in the wall, microphones, and so forth. In addition, there are the turntables, both for the small 10- or 12-inch records which revolve at 78 revolutions per minute and play about $4^{1}/_{2}$ minutes, and for the large 16-inch disks which revolve at $33^{1}/_{3}$ revolutions per minute and play for 10 minutes.

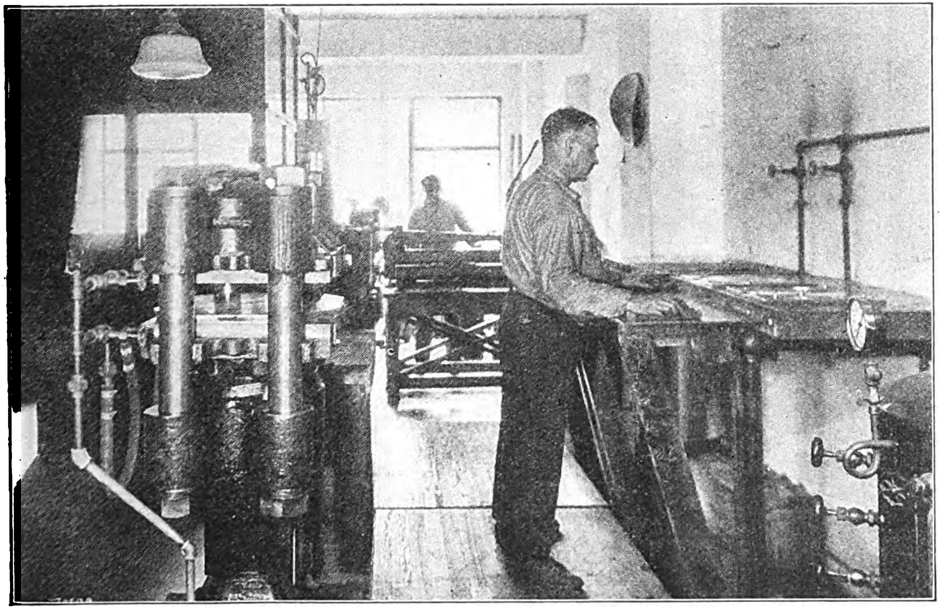
These turntables are powered by synchronous motors, which maintain a constant speed in spite of voltage fluctuations or other factors. The turntables are equipped with faders, by means of which one turntable may be faded off and another faded on, causing no break in the performance when it is desired to play two disks without interruption.

LET us suppose that a program is to be recorded on a 16-inch disk. Disks for broadcast recording, by the way, play from the center toward the rim, the reverse order of the usual commercial records. They are of the lateral cut type, the grooves being of constant depth and the stylus cutting the walls of the grooves; as contrasted to the "hill and dale" type, the name of which describes its principle. The wax—which is really made of soap material—is placed on the turntable, the motor set and the microphones properly placed in the recording studio. Then the program is begun. The man in the control room lowers or raises the volume of each microphone independently. So it is that the soloist is heard above the orchestra even though in the recording studio she cannot be heard above the roar of the drums and the horns as she barely whispers into the microphone which is before her. Sometimes as many as four "mikes" are used at once.

The performance over, the wax, now referred to as having been "cut," is placed in the galvano bath. Swishing back and forth on the end of a long rod in the bath, the cut side of the wax is electroplated, after which the resultant copper "master" is stripped off. This, of course, is a negative of the wax, its marks being raised above the surface whereas in the wax they were indented. The "master" is then taken to the pressing room where two test pressings are made from it. The test pressings are composed of a combination earth-shellac material, identical with the material of the final pressings. This substance is heated, then placed in the press with the "master" and, under enormous pressure and heat, baked. The test pressings are then played for the approval of all the parties concerned. The musical director looks for faults, the sponsor listens closely, the technicians try to find something amiss. If everything is perfect, performance and recording, the technicians, musical director, and sponsor O.K. the pressing. Perchance a certain selection was not as good as it might be. It is performed over again and recorded. Then the first record is played again and recorded on a clean wax, the re-recorded selection being "dubbed" in at the proper time, in much the manner as a movie strip is inserted in the final film. Another "master" is made, and test pressings approved.

Were the final disks pressed from the "master," there would be no impression of the performance should the "master" be injured in the pressing, for the wax has already been shaved for future use. So the "master" is in turn electroplated and the resultant "mother" taken from it. The "master" is then filed away for safe keeping or use for subsequent orders for more pressings of that performance. But the "mother" has its lines indented. It cannot be used to press the final disks. So it too is plated and the "stamper" coming therefrom used to make the final pressings, which are then ready for the broadcasting stations, where they are transmitted by the use of apparatus similar to that on which they were recorded. In this manner is a radio broadcast program recorded.


Left: Adjusting one of the rods which move the waxes in the plating baths. *Center:* Examining a copper "master." *Right:* A wax ready for plating

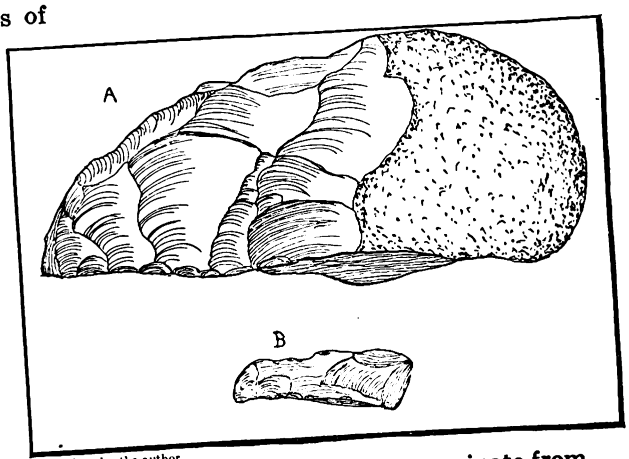

Making test pressings. The earth-shellac compound is being heated at the right to the consistency of dough. *Left:* One of the disk-baking presses

The uses of the recorded program are many and varied. It enables the independent station far from sources of entertainment talent to broadcast programs equal in quality to the finest network offerings, thereby enhancing its reputation and increasing its value to the sponsor. It enables the sponsor to reach his country-wide audience at the same hour despite time differences between the east and the west. It permits the use of radio by sponsors unable to book time on the networks; and for those already using the chain, makes possible the fullest use of their fine network programs. The cost of recording being divided between all the performances given by the disks, the individual programs are low in price, without loss of quality. The recorded program permits of editing, taking the finest portions of several performances, whereas in the direct program any slip passes directly to the audience and cannot be recalled.

FLINT IMPLEMENTS
Great and Small

By J. REID MOIR

As we all know, certain kinds of reptiles of the remote geologic past started their careers when they were of very small size and finished their earthly course when they had developed to gigantic and preposterous dimensions. In fact, so unwieldly and immense did some of them become that it has been supposed their disappearance was due to their great increase in size which made it impossible for them to adapt themselves to their environment. Whether, however, this theory is correct or otherwise, it is of considerable interest and, strange to say, has some kind of bearing upon certain problems which students of early man find themselves called upon to solve.



Drawings by the author

Figure 1: **A is a massive rostro-carinate from beneath the very ancient Red Crag of Suffolk. B is a diminutive rostro-carinate from the much later, second interglacial age in Suffolk**

THANKS to the researches which in recent years have been carried out in deposits containing the earliest flint implements, it is possible, and of much importance, to trace what may perhaps be termed the career of any particular type of artifact from its first appearance until it passed out of use. When this is done it is realized that in most cases flint implements, unlike ancient reptiles, first appear of a very large size, and dwindle finally to minute, and as it would seem, to almost useless proportions. It must of course be clearly understood that the earliest examples of any particular type of flint implement are not all of great size. But although this is the case, it remains true that the majority of these examples are of massive porportions.

The reasons for this largeness are by no means easy of explanation. It is probable that the size of the raw material played an important part in the dimensions of the resulting implements, but this reason must not be over-stressed. For, although it would not be possible to make large implements from small nodules of flint, it would be quite easy to manufacture small artifacts from masses of flint, however big. Again it may be imagined that the earliest men were of great muscular strength, possessing hands much larger than those of their descendants, and this may be regarded as a probable explanation of our problem, as certain very ancient flint implements which have been found are provided with what appear to be carefully prepared hand grips which were evidently not meant for hands of the span of those of today.

Whatever may have been the cause, a survey of the flint implements made by prehistoric man will show that, generally speaking, the more ancient these specimens are, the bigger will be their size. There is a difference of the same order to be observed in the flaking as, in the older implements, the flake-scars are large and caused evidently by powerful blows, and this peculiarity becomes progressively less marked as the specimens of later cultures are examined. It must not, however, be imagined that the fact of an implement being coarsely flaked points to a lack of knowledge of flint flaking on the part of its maker. In fact, in my experiments I have actually found it more difficult to produce say, a hand axe, solely by the removal of large flakes than by the detachment of smaller ones. It is, of course, true that the later implements exhibit a more delicate outline, or form, than the earlier, but this does not in every case mean that the former are more skilfully made than the latter. For instance, it would not be correct to claim that a Mousterian *racloir* exhibits more skill in flint flaking than does an early Chellean hand axe, and of the two types I would regard the Mousterian specimen as being much more easily produced.

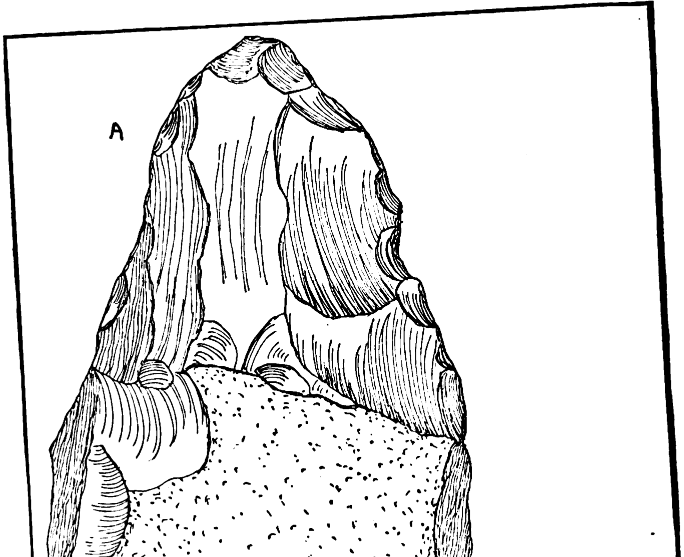


Figure 2: **Another contrast. A is a huge seven-pound hand axe and B is a diminutive hand axe**

ALTHOUGH up to a point it is legitimate to compare the invention, age, long use, and gradual discarding of any particular type of flint implement with the appearance, existence, and final disappearance of some form of life, yet I know of no particular form of artifact which, like certain animals, became actually extinct, and left no descendants. Even in Neolithic times the most primordial types of implements, the eoliths and rostro-carinates, appear occasionally; and other forms, clearly related to earlier artifacts, occur at that epoch. Neither is it possible to hold that such and such an implement appears first at a certain period and, as it were, to claim a "special creation" for it at that time; for a careful collecting and examination of the flaked flints of earlier epochs, will usually reveal forms clearly ancestral to that under discussion. As an example of this, mention may be made of the *tranchet* axe found particularly in the shell mounds of Denmark which are of early Neolithic Age. It is not long since this type of implement was regarded as making its first appearance at this epoch but recent researches have shown it to occur in the lower Paleolithic cultures of South Africa, at the lower level at Le Moustier in France, while I have found an example in a "floor" of early Mousterian Age in Suffolk.

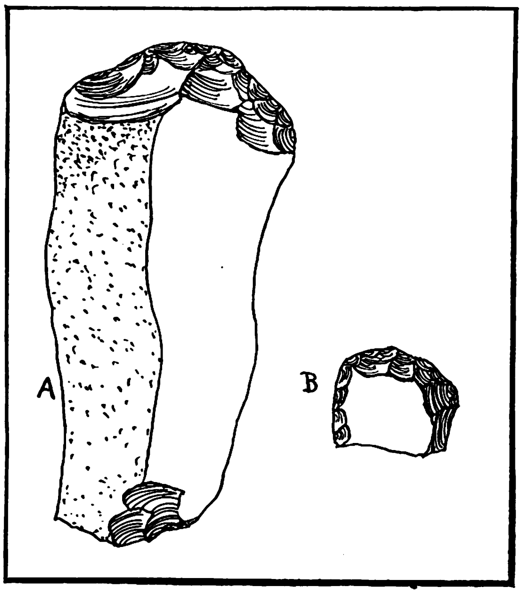


Figure 3: **Contrast *A*, a seven-inch Mousterian (Neandertal) scraper, with *B* of Bronze Age from burial in Suffolk**

It becomes clear, therefore, that modern work in archeology is demonstrating that no prehistoric culture can be regarded as in a "water-tight" compartment, but each is indissolubly related to that which goes before and to that which comes after. But at certain epochs particular types of implements made occasionally in earlier times, suddenly, for some unknown reason, sprang into favor and these types became the dominating artifacts of those epochs.

THE problem of the implement of minute size is by no means easily solved. In Figure 1 are shown two rostro-carinate specimens, the larger found beneath the very ancient Red Crag of Suffolk, and of several pounds in weight, while the smaller, found in beds of second inter-glacial age near Ipswich, is a true rostro-carinate but of very small size. There is no difficulty in realizing the uses, such as chopping and picking, to which the larger of these two specimens could be put, but to what useful purpose can the smaller be referred? Again, in Figure 2, a huge hand-axe from the Cromer Forest Bed of Norfolk is illustrated beside a very small example of the same type of implement found in a floor of Upper Paleolithic age at Ipswich, Suffolk. Here the same difficulty of assigning a use for the smaller artifact arises, as it does also in the case of the scrapers (Figure 3) and *tranchet* axes (Figure 4).

I have sometimes wondered whether these very small implements of certain types were ever made for any utilitarian purpose but represent, rather, "models" of artifacts, the forms of which had been handed down by tradition. We know that in the Bronze Age flint scrapers, for example, were occasionally scattered over the burial sites of that period, thus showing that these specimens had acquired some magical value. It seems possible, therefore, that in the Stone Age some ancient types of implements were made also for the same occult reason and this may explain the minute artifacts to which attention is drawn in this article.

But while this may be the case, such an explanation can not apply to the widespread "pigmy" culture which marks the closing phases of the Stone Age. At this epoch, from the Vindhya Hills in India right across to western Europe and Britain, a remarkable flint industry is found in which many of the implements are literally of microscopic size. Some of them are as small as a grain of rice and exhibit edge flaking which is so minute that a strong lens has to be used in order to see it satisfactorily.

THERE is, of course, no doubt that these specimens are the work of man but it is also evident that their makers must have been possessed of eyesight much keener than the average person of today, who, with unaided vision could not flake flints in such a manner. Some of the specimens assume geometrical forms and are believed to have been inserted in pieces of wood as harpoon barbs. But this explanation does not cover all the types of pigmy flints, and the uses to which many of them were put remain obscure.

Associated with these very small artifacts and obviously of the same age are numerous implements of much larger size, thus showing that the smaller were made for some specific purpose. The notion was at one time put forward that these microscopic implements were made by a race of very small people, of about three feet in height. But this view was soon demolished by some one who pointed out that if a flaked flint one eighth of an inch in length pointed to its maker standing only three feet, then by the same reasoning a specimen 10 inches long must have been produced by a super giant. When, as in very ancient specimens, definite hand grips are found to have been produced upon implements, it is possible to come to a conclusion as to the size of the hands of those days, but to judge of the height of past races of mankind by the length of the implements they made is patently absurd, for this would connote the previous existence of numerous races of true story-book giants, and we are sure there were none.

The fact of the matter is that our knowledge of the uses to which many stone implements were put is almost negligible. We have at present reached the stage when it is possible to claim on scientific grounds that certain examples exhibiting flaking have been shaped by man. Further, we can with equal certitude state that these specimens were weapons, implements of one kind or another.

BUT it is not possible for us, and it may never be, to assert that these artifacts were put to this or that particular use. It is clear, however, that the great majority of the humanly-flaked flints which are discovered are merely tools with which other things of wood, ivory, and bone were made. But, except in a very few cases where conditions have been favorable to the preservation of such specimens, they have failed to survive the vicissitudes of the past. This fact should always be kept in mind when attempting to reach a conclusion as to the state of culture existing among any prehistoric people, as the flint implements they made are only the indestructible residue of their industry, and to judge of their condition of advancement merely by taking into account this residue, must clearly be entirely misleading.

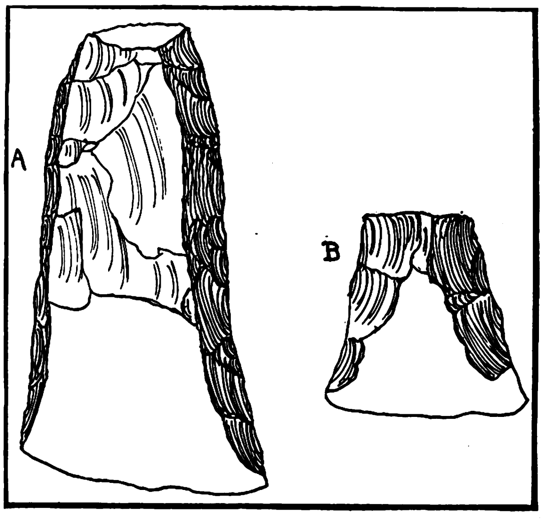


Figure 4: ***Tranchet* axes great and small. *A* is from Paleolithic deposits in South Africa and *B* is from much more recent beds near Ipswich, Suffolk**

The Scientific American Digest

Conducted by F. D. McHUGH

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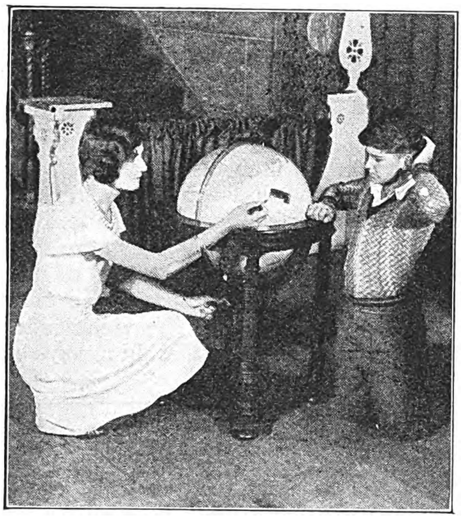
Index Globe for Study of Geography

THE self-pronouncing dictionary now has a rival in geography in the form of a unique globe which was shown at the American Library Association conference in Los Angeles recently. The globe was invented by Charles M. Williams, a resident of Los Angeles for 40 years.

By means of paper rolls inside the globe, the location of more than 43,000 towns, mountains, rivers, and bays is indicated automatically through a small window when a handle at the bottom of the globe is turned. When the location is noted from the inner index, the globe may be turned, and the place found immediately by means of a special finder scale. If the globe is turned farther, a description of the country, a list of its products, its climate, and photographs of scenes in the country may be seen through a second small window on the side opposite the first. This globe also shows the point in the world where any constellation of stars will be visible at a specific time, and the point on the earth where, on any particular date, the sun will be directly overhead.



Courtesy *Los Angeles Herald*

As the handle is turned, the index gives the information desired

Hudson River Bridge Cables Completed

THE spinning of the last wire for the last cable of the Hudson River Bridge at New York, took place shortly before noon on August 7, thus marking the completion of a major and probably the most spectacular phase of the building of the structure. The occasion was informally observed at the Jersey end of the span. Commissioners of the Port of New York Authority, which is constructing the bridge, and a number of other interested persons assembled on the Palisades as the last wire, to which was attached a small American flag, came across the river from the Manhattan side.

The spinning of the four enormous cables was completed in less than 10 months, the first permanent cable wire having been strung on Friday, October 18, 1929. The number of men engaged in the spinning operation was approximately 400. One man was killed at the New York anchorage while setting up spinning equipment, but none was seriously injured or killed during the spinning operation. Only about 27 days were lost due to inclement weather conditions.

Complete details of the cables and the methods of spinning were given in an article in the January, 1930, issue of SCIENTIFIC AMERICAN.

Illegal Guns Slaughter Waterfowl

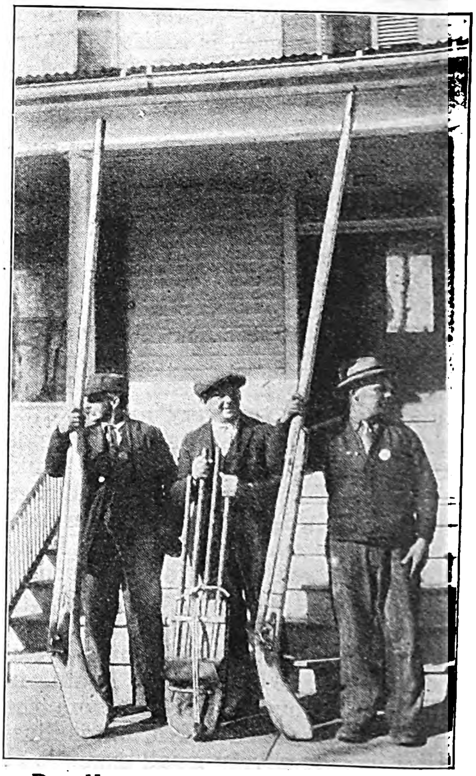
DESPITE the fact that both federal and state laws prohibit the use of guns larger than 10-gage in taking waterfowl, game wardens from time to time discover elaborately built "artillery" used for this purpose. Every person, whether he be a sportsman or not, should assist the authorities in wiping out this illegal method of hunting and use every effort to assist in securing conviction of the violators.

In the accompanying photograph are shown three illegal guns captured by game wardens in Maryland. The one in the center was captured last January by Aleck Tyler on Fox Island, which lies along the Maryland-Virginia boundary line. It consists of four barrels, each of a different length and having muzzles one inch in diameter, all bound to a large oak block by means of an iron band. The total weight is 125 pounds. Carved in the wood at the base of the barrels is a groove for powder which is ignited by means of a percussion cap fired by a hammer on the right hand barrel. This arrangement causes firing of the four barrels in rapid succession.

The two long guns, one eight feet and one nine feet long, and weighing 90 and 100 pounds respectively, were confiscated by Warden Tyler, together with two Deputy Wardens and Orin D. Steele, United States Deputy Game Protector. These guns are made of two-inch galvanized piping with one end brazed to form a chamber, mounted on home-made stocks. The charge for one of these guns consists of about one fourth of a pound of powder and one pound of shot.

Such guns are used by violators of wild fowl laws for hunting wild fowl at night. The large single barrel guns are usually locked to a skiff, the barrel projecting over the bow and the breech supported by some object at the butt and fastened in such a manner as to take up the recoil. The battery type is usually mounted on a swivel. These guns are very destructive and will kill at one firing from 100 to 150 birds and cripple many more.

The hunter who follows this method of



Deadly guns for slaughtering waterfowl, confiscated in Maryland

shooting wild fowl is very hard to apprehend since he uses a small skiff with a short paddle, sneaking at night into large rafts of waterfowl on their feeding grounds. Since the water is shoal on these grounds, it is very easy for the pot-hunter to get within range of the birds before they become suspicious.

Entoptical Effects—Can You See Them?

MR. L. F. CULVER of Gautier, Mississippi, one of our readers, sends us the following note concerning a peculiar effect in the realm of physiological optics. He describes phenomena which other readers may be able to duplicate.

"Many times," Mr. Culver writes, "while lying on the ground with a straw hat over my face I noted that for each tiny opening through which light came I saw a round light spot about one fourth inch in diameter and with a dark center. At length I saw that these light spots were all of the same size, and I also observed that the dark centers were of irregular form, but all exactly alike in detail, except that the spot seen by one eye was totally different in form and detail from that seen by the other eye.

"Then I noticed on successive days that these dark spots always looked exactly as at first. As their form was not at all dependent on the form of the openings in the hat through which the light came, I concluded that what I was seeing was within the eye itself and must be the blind spots on the retina, that I had learned of in my school days.

"I tried other ways of seeing them and discovered much that was unexpected and very interesting and beautiful. This, I found, required considerable patience and perseverance, but the reward was ample. I think it best, however, first to try the method described above.

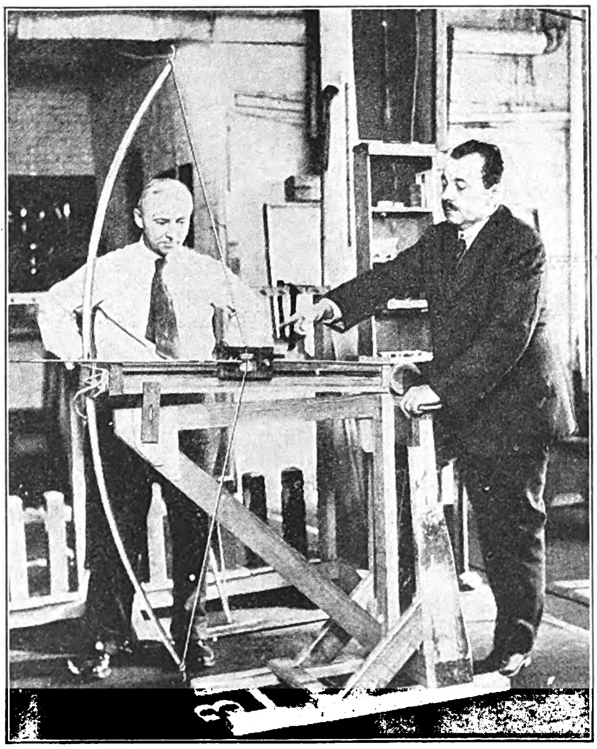
"At night sit with the side of the head toward the source of light and facing a darkened part of the room or a door opening into a dark room. Hold about one inch from the eye farthest from the light some small, polished, spherical surface of one-eighth inch or less in diameter to reflect the light into the eye. This illuminates a part of the retina. Near the center of the illuminated part will be seen the blind spot. The dark nucleus of the spot evidently is bordered by a row of highly sensitive nerve filaments which appear like a row of brilliant bright dots close together. In my left eye there are three small blind spots outside of the main spot. The borders of these also are studded with bright points. The group reminds one of a group of sun spots seen through a telescope. Under stronger illumination, as with direct sunlight, bright points appear, sparsely scattered over the entire blind area, and much new detail is seen. Whatever the reflecting surface used, these spots change their form. The amount of detail seen varies greatly with the degree of illumination."

These phenomena are known as "entoptical" effects and are described in works on physiological optics, most comprehensive of which is the famous "Treatise on Physiological Optics" by the great German authority Helmholtz. This three-volume work of 1700 pages is an old standby to all physicists and opticians. Recently it has been translated, and thus made easily available to English speaking readers, by Professor James P. C. Southall of the Department of Physics at Columbia University, author of "Mirrors, Prisms and Lenses," himself an authority on optics.

"Under suitable conditions," says Helmholtz, "light falling on the eye may render visible certain objects within the eye itself. These perceptions are called entoptical. . . . There are some objects in the eye, particularly the blood vessels of the retina, which fulfill the latter condition by being very close to the sensitive membrane and therefore in position to cast shadows on the retina." Fully to describe these and a wider variety of entoptical effects would, however, demand as much space as is devoted to them in Helmholtz' treatise.

While Mr. Culver's discovery is not new to science, he made it independently. When his note, as reproduced above, was submitted to Professor Southall for opinion, the latter commented, "I think Mr. Culver deserves much credit for having made these experiments for himself."

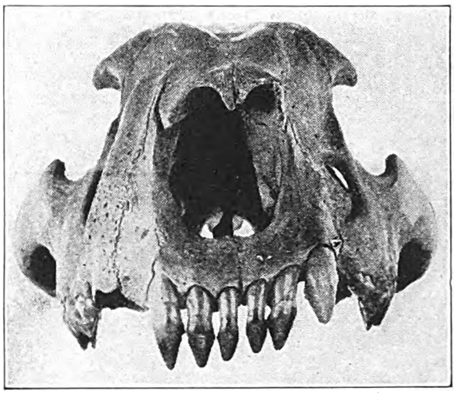
Perhaps others of our readers can duplicate these effects.



As the age-old sport of archery takes a new hold on the interest of thousands, problems of constructing bows and arrows have had to be solved anew. Much success has attended the efforts of the manufacturers, but there is still much to learn. The illustration shows a new machine displayed some time ago by the archery club of Seattle, Washington, for testing the accuracy of arrows. With this home-made contraption, arrows can be tested so that their feathers may be trimmed, thus making possible the shooting of an entire quiver of arrows under any given set of conditions

When the Tiger Lost a Saber

IT is said that Mrs. Paleolith would quiet her young Paleoliths by saying she would call Old Saber-Tooth; and these giant long-toothed cats were indeed fearful-looking creatures. Once in a while saber-tooth skulls from which a saber 10 inches long had been lost, are seen, but the animal had survived the loss bravely. It is thought that these toothed cats used the long sabers for stabbing the prey in order to drink the blood, but it was possible, when a saber was lost, to survive by eating flesh. This particular tiger lost the saber when young, the saber-tooth being broken off far up in the socket. Its loss produced a curious asymmetry due to the necessity of filling in the large socket. In loosing a saber the great cat had had its face lifted. The front teeth in the tiger's left jaw are elevated and the bones reduced.



When this tiger lost one of its saber teeth at an early age, its jaw grew asymmetrical, one-sided

Chemistry and the Old Rag Man

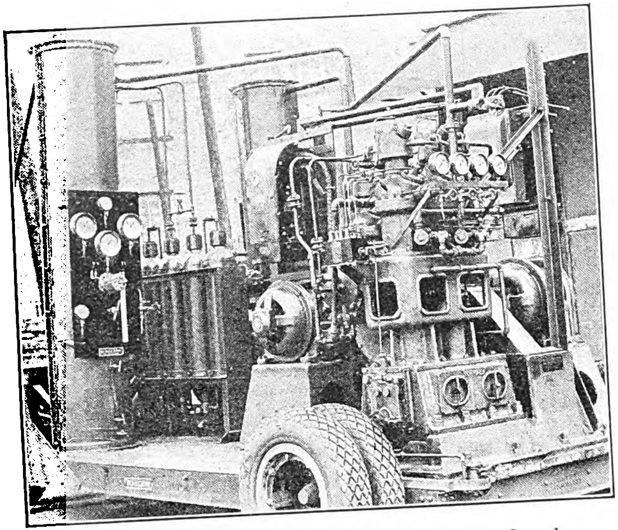
RAYON has given us wonderful and beautiful varieties of cloth but, when the glossy fabric has served its purpose and found its way into the rag bag, it is not popular with the rag man. Before the advent of rayon, "old rags" were the raw material for the finest grades of writing paper. Recent tests by the United States Bureau of Standards disclose the fact that rayon rags are valueless for this purpose, and may actually be detrimental. Laboratory tests were conducted at the bureau to determine the paper-making quality of rayon when subjected to the same treatment as rags in the production of fine papers.

Cotton and linen fibers are commonly used for papers, such as bonds and ledgers, on account of their strength and durability. In addition to their value in these respects they are used in the manufacture of papeteries and other fine writing papers, as well as to impart softness and other desirable characteristics of surface and finish. The presence in rag stock of any fiber which would affect these qualities of paper is undesirable.

Samples representative of the four general processes of rayon manufacture—viscose, nitrocellulose, cuprammonium, and cellulose acetate—were included in the tests. The equipment employed in the preparation of the pulp and its subsequent conversion into paper was on a laboratory scale and is that used at the bureau for the preliminary tests of all paper-making materials under investigation. The caustic soda and lime processes were used in the cooking operation. Paper-making stock was prepared from the pulp, alone and in admixture with sulfite pulp, and converted into paper on a sheet mold.

Owing to loss of strength when wetted, the rayon filaments tended to break into short lengths during the preparation of the paper-making stock without the fibrillation and fraying necessary for good felting properties. As a consequence, the all-rayon sheets lacked the strength to withstand the handling necessary in the pressing and drying operations, and the pliability characteristic of rag papers. Likewise, sheets made of rayon in admixture with sulfite pulp were considerably weaker than those made from sulfite alone.

Since increasing amounts of rayon are being found in the rags and textile waste used in rag-paper manufacture the test data are believed to be of value to that industry.



When helium becomes diffused with ordinary air—a condition that might take place in a dirigible due to leakage of the gas envelope—its "lift" is decreased in proportion to the adulteration. Because of this fact, the mobile helium re-purifier shown here was built for the Goodyear-Zeppelin Corporation. It removes air and any other diffused gas from helium by the process of freezing out, as explained in the text

A Chemical Service Station for Dirigibles

In a few years, when air travel is as commonplace as railroad travel today, machines like that pictured here may become as familiar to travelers as the workman who taps the axles while the train is standing in the station. This trailer full of motors and compressors will draw up alongside your dirigible and will start to work, drawing the helium gas out of the balloonet, removing the air that has mixed with it, and returning it to the ship with its full lifting power restored.

The mobile helium re-purification plant was built for the Goodyear-Zeppelin Corporation, of Akron, Ohio, by the Helium Company of Louisville, Kentucky. The entire plant, with a capacity of 1500 cubic feet of gas per hour, is mounted on a pneumatic-tired trailer body and can traverse any terrain which a truck can negotiate.

The mobile plant consists essentially of two compressors, one handling air, the other helium. The air compressor supplies air at high pressure to an expansion column, which serves to liquefy a portion of the air, forming a cooling bath at a temperature of —170 degrees, Centigrade. The second compressor forces helium at 2000 pounds pressure through copper coils immersed in this liquid air, with consequent removal of impurities by liquefaction. The helium passes through nearly a half-mile of copper tubing, and is finally discharged at a purity of 98 to 99 percent to any desired point and at any pressure up to 2000 pounds per square inch. The loss in repurification is approximately 1 percent.

The mobile helium repurification plant was designed by R. R. Bottoms, director of research, and E. G. Luening, executive vice-president of the Girdler Corporation, which operates the Helium Company. These men were also responsible for the development of the special fuel gas used by the Graf Zeppelin on its first return trip to Friedrichshafen from the United States. *—A. E. B.*

"Jake" Paralysis

During the past few months thousands of cases of paralysis from drinking bootleg Jamaica ginger have occurred, principally in the southwestern portion of the United States. Studies made by chemists indicate that the poisonous substance is a derivative of coal tar or phenol. Few of the patients have died, but practically all of them have developed forms of paralysis which seem to be fairly permanent. The nerves affected include those of both the arms and legs. The nerves conveying sense of pain, touch, and heat have not usually been disturbed, but in some cases the patients seems to lack also these sensations. In one instance in Oklahoma City a traveling man 66 years of age died following paralysis from drinking Jamaica ginger. Postmortem examination indicated that in some manner the poison had selected the nerve of motion in the arms and legs. The tissues of the brain were not apparently greatly influenced by the poison. Post mortem examination also revealed that death was apparently due to a previous kidney disease, complicated by his secondary illness, rather than to the Jamaica ginger.*—M. F.*

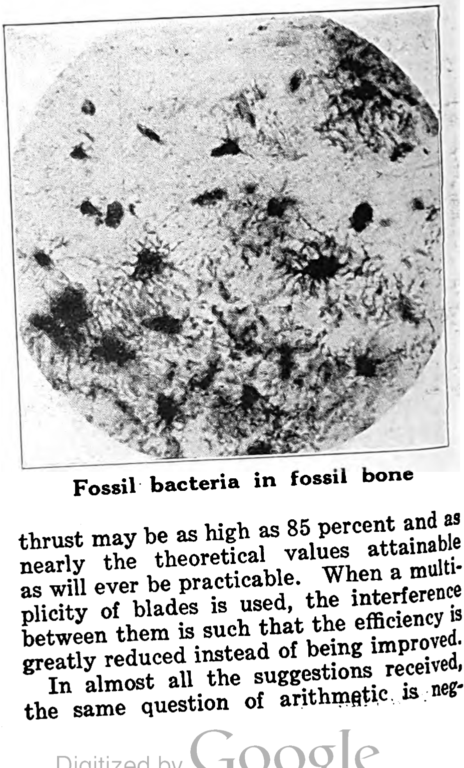
Ancient Bacteria Preserved in Fossil Bone

It has been a matter of surprise that such minute, delicate bits of protoplasm as bacteria should be found in thin sections of bone many thousands of years old. Yet in the bone of an ancient tiger, under the microscope, are found undoubted germs resembling some of the bacteria of today. The picture shows, at a magnification of 400 diameters, colonies of bacteria in the minute, thread-like canals leading out from the bone cells which appear in the picture as dark diamond-shaped bodies. It is not known whether or not these ancient germs brought on disease but it seems likely that they were the germs of decay.

Peculiar Aviation Inventions

We are constantly receiving suggestions for peculiar types of aircraft and aviation accessories, some provocative of thought, some merely of amusement. The inventors, however, are in dead earnest, and full of the desire to advance aviation. Here are extracts from an anonymous letter, with the envelope bearing a Canadian postmark. "Dear Sir. I am quite unknown to you and you are to me. However I do not hesitate to address you this letter; for if the idea that it contains is good it matters little to know whence it comes but it matters only to use it. So I desire to remain unknown but I desire also an experiment to be done, that, in my opinion will give the best results . . . The motor of the plane works in the air by means of the propeller. But the propeller with two blades is an instrument with which the motor can work but little in the air in one turn . . . . however let us consider that to the two blades of the propeller, one can add 16 other blades on the same circumference. That makes a propeller with 18 blades; it is the American Wheel. . . . To be used for speed it is necessary for a motor to make much work during a turn."

The suggestion is a typical one. Such inventions always come down to a question of arithmetic. It seems at first sight plausible that with only two propeller blades on a shaft, the intervening air is not worked upon properly. But when the suggestion is examined technically, it is found that two propeller blades already take up the entire power of the engine, and that the efficiency of the two-bladed propeller in producing thrust may be as high as 85 percent and as nearly the theoretical values attainable as will ever be practicable. When a multiplicity of blades is used, the interference between them is such that the efficiency is greatly reduced instead of being improved.



Fossil bacteria in fossil bone

In almost all the suggestions received, the same question of arithmetic is neglected. Dozens of plausible helicopters are suggested, with some screws for lifting, some for propulsion, and so on. There is nothing theoretically wrong in such helicopters, but when the invention is examined it is found that the inefficiency of the various elements, the complication of the mechanism, and failure to consider certain factors of stability and control make the idea quite impracticable. There appears to be in the United States an inexhaustible fund of inventiveness and courage. The prime necessity is to add to mechanical instinct at least a modicum of analysis with reference to air forces and efficiency. At the same time, one dare not predict that some instinctive mechanic will not yet contribute to our knowledge without such basic analysis!—*A. K.*

A Chemical Paradox

NOTABLE among the triumphs of industrial chemistry during the past decade has been the development of commercial processes for the synthetic manufacture of ammonia and nitric acid. Because of the efficiency of these new methods, ammonia is being sold at prices which make it attractive in many new industrial roles, some of which were described in an outstanding paper presented by Jasper E. Crane, of the duPont company, at a recent meeting of the Manufacturing Chemists' Association.

Among the most attractive of the newer uses for ammonia is its application as a source of hydrogen, particularly for welding. It seems, offhand, to be paradoxical to state that it is economical to combine hydrogen with nitrogen to form ammonia, then to separate the two gases again in order to obtain the hydrogen. The answer to the paradox lies in the fact that one cylinder of ammonia, when "cracked" is equivalent to about 17 cylinders of hydrogen. As the principal part of the cost to the user of hydrogen is the cost of the cylinder, he finds that he saves about one-half by buying 17 times the volume of hydrogen in a single cylinder. Simple, inexpensive apparatus has been developed for cracking the gas by use of an electrically heated catalyst.

An even more striking reduction in cost is that of nitrogen made by the cracking process. The cracked gases are burned in air, producing water and nitrogen. One cylinder of ammonia, in this case, is equivalent to about 36 cylinders of nitrogen at one ninth the cost.

Other better-known uses, of course, are much more important as tonnage markets for ammonia. These include the production of synthetic organic chemicals in great variety; nitric acid and synthetic sodium nitrate; fertilizers; nitrided metal products; and its uses as a cheap alkali.—*A. E. B.*

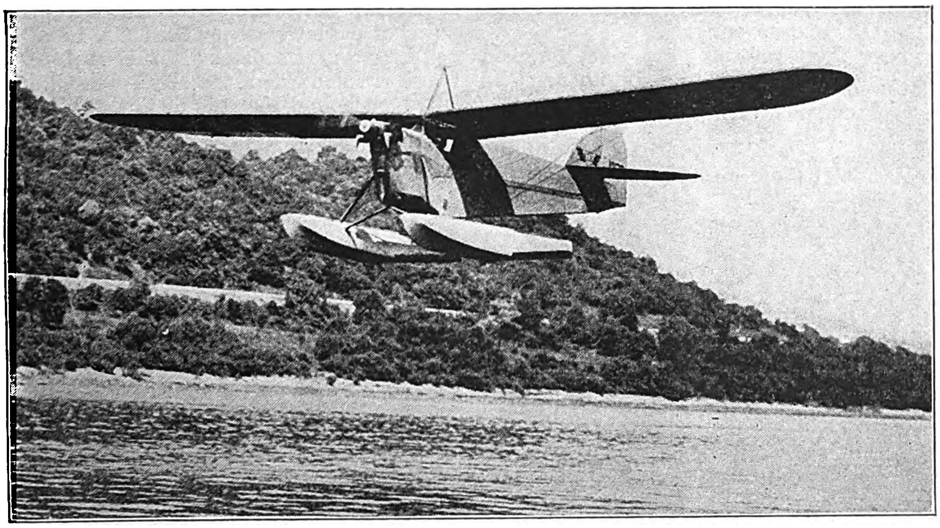
An Interesting Light Plane

THE popular interest in gliders has been followed by enthusiasm for the light plane. One of the most successful of these small planes, with success measured not only by flying ability, but by large sales also, is the *Aeronca* built by the Aeronautical Corporation of America. This plane is equipped with a relatively small engine of the two-cylinder opposed type, 4 1/8-inch bore and 4-inch stroke, rated at 30 horsepower at 2500 revolutions per minute. The weight empty is 385 pounds, the disposable load (with one occupant) 315 pounds; thus the total or gross weight is only 700 pounds. The span is 36 feet and the wing area 144 square feet. The top speed is given as 85 miles per hour, the landing speed as 31 miles per hour, and the initial climb as 550 feet per minute. Such performance is quite adequate for private flying, except for cross-country work under adverse wind conditions.

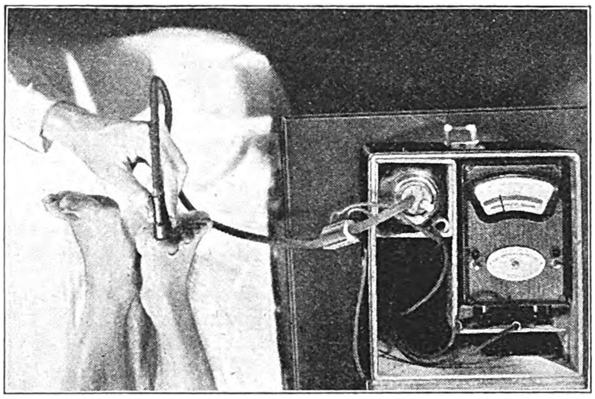
The main interest of the *Aeronca* from a flying point of view is in the low wing loading, the use of relatively large control surfaces, and of large dihedral and vertical fin areas.

The low wing loading, 4.8 pounds per square foot of wing area, means low landing speed, quick getaway, and short pull up. This makes for safety and for the possibility of using small fields.

The large dihedral (raising of the wing tips relative to the center) makes for stability in a side slip. The large vertical tail surfaces give weather-cock stability, the plane swinging into a side wind instead of swinging dangerously away from it. The large control surfaces, on the other hand, make for ease of control in spite of the inherent stability. The aerodynamic conception, although not exactly novel, makes for ease in flying. Machines of equal stability and the reasons for such stability have been known since 1910 or thereabouts. But it is gratifying to see designers take perfect stability as their objective again. If there is to be private flying, machines must nearly fly themselves. There is but one serious disadvantage to such a lightly loaded plane: gusty weather is apt to result in difficulties near the ground and considerable bumpiness aloft.—*A. K.*



Quite adequate for private flying, this plane, empty, weighs 385 pounds



Most of us are familiar with the clinical thermometer but few, among laymen, realize the necessity for taking temperatures on the surface of the body. The illustration shows an improved electro-thermal instrument for measuring body surface temperature and the text herewith explains the need for it

Body Temperature Measurement

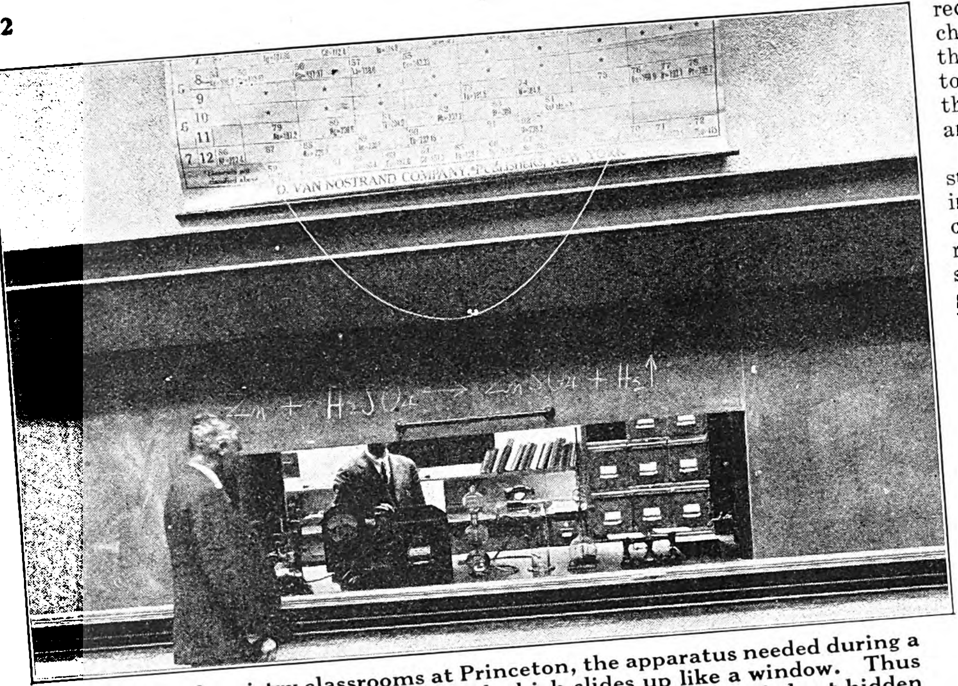
THE measurement of the temperature of the human body on the surface and at various points represents one of the most important observations made by the physician in the diagnosis of disease. It has been recognized for years that infection produces congestion and fever. There is increased flow of blood to the part involved which is responsible for the changes that occur.

Investigators in the Mayo Clinic have recently developed an electrothermal instrument for measuring surface temperature and also for measuring temperatures of various organs at any given time. In case the temperature of an organ or of the spinal fluid or of the brain is to be determined, a needle is introduced and by means of the thermocouple method the temperature at the point of the needle can be ascertained. The sensitivity of the electrothermal junctions is increased by putting four couples in series; the galvanometer is calibrated in degrees Centigrade. Thus it is possible to measure the temperature at any point in the body in 10 seconds, absolutely accurately, and within a fraction of a degree.—*M. F.*

Lightning and the Airplane

WALTER E. BURTON, writing in *Aviation*, describes some interesting experiments now being conducted by the Ohio Insulator Company on the effects of lightning on the airplane.

In a thunderstorm, lightning is more feared, but wind is much more dangerous.


D. VAN NOSTRAND COMPANY, PUBLISHERS, NEW YORK
Zn + H2SO4 → ZnSO4 + H2↑

In the new chemistry classrooms at Princeton, the apparatus needed during a lecture is kept behind this blackboard which slides up like a window. Thus while the professor lectures, attention-distracting equipment is kept hidden from the students although it is set up ready for instant use when needed

Nevertheless the effects and dangers of lightning are well worth investigating.

The lightning laboratory of the Ohio Insulating Company is unique. With new equipment being installed, the laboratory will be capable of producing a spark at more than 3,000,000 volts pressure, nearly 30 feet long. In an open-air laboratory three transformers, the largest ever built, are used to produce the huge spark. The units are arranged in steps on a special porcelain tile base; the highest stands 50 feet above the ground. A number of oscillators are available to produce a continuous spark discharge. A camera with a shutter operating at 1/50th of a second is used for photographic studies of the flash.

At one end of the open air laboratory, a system of poles, guys, and insulators will allow the suspension of airplanes as large as a Ford tri-motor for experimental purposes. Because wind may blow discharges to one side, the airplane is in a field which is sheltered by groves of trees. So far experiments have been made only on airplane models. Later a full-size plane will be suspended with every part complete, the gasoline tanks full, and the engine running. It is not yet certain, however, whether the experiments with gas aboard and engine running will be possible without undue danger.

One problem has already been solved: a plane can be struck, can deflect a lightning discharge and become part of its path as it travels from cloud to cloud, or from cloud to ground. Among the many other problems to be investigated systematically are:

If a plane is struck, what is the probable effect on pilot and passengers?

If a lightning discharge takes place near a plane without actually striking it, will the pilot receive so large a shock as to lose control temporarily?

How vulnerable is the ignition system?

Do the exhaust gases, because of their ionizing effects, create a path for, and attract the lightning?

What is the fire hazard for tanks, fabric covering, and so forth?

What happens when metal parts are not completely bonded? Will sudden currents of several hundred thousand amperes passing through imperfectly bonded joints fuse the metal parts instantaneously?

We shall await with great interest the results of the experiments.—A. K.

Germans Isolate Ethyl Radical

POLITICIANS have definite, though varying, ideas of what a "radical" is, but when the chemist refers to a "radical" he means something quite different. In chemical parlance, a radical is a certain definite combination of atoms which stick together persistently and act, chemically, as a single atom. Thus, the two elements sulfur and oxygen are prone to link together as the radical SO_4 and to retain the identity of their union in compounds such as sulfuric acid, (H_2SO_4), calcium sulfate, ($CaSO_4$), and so on.

Now these radicals have been assumed to exist for years, although no one has ever seen any SO_4—it doesn't exist alone. Neither had anyone ever seen the important radical C_2H_5 which is part of the molecule of ethyl alcohol, (C_2H_5OH), until recently. Now, however, two German chemists report that they have isolated the radical C_2H_5—an announcement which to a chemist is about as startling as saying that a soul has been separated from a man and put in a glass case for observation.

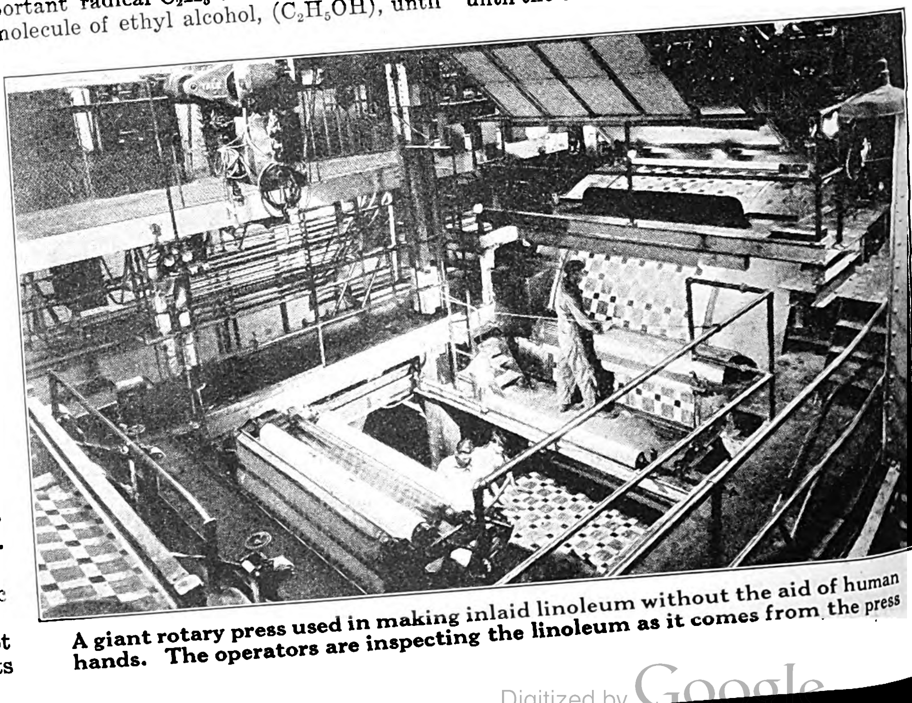
Professor Paneth and W. Lautsch have succeeded in producing the radical ethyl in a free form by the thermal decomposition of the vapors of lead tetraethyl in a current of hydrogen under diminished pressure. The ethyl radical is just as aggressive as the methyl recently isolated by Paneth and Hofeditz. Free ethyl converts such metals as lead, zinc, antimony, and cadmium into volatile compounds, which are clear as water at room temperature and 760 millimeters pressure. —*A. E. B.*

An Industry That Grew from a Paint-Pot

A PAINT pot, accidentally left uncovered, furnished the clue to several great industries that have grown up since Frederick Walton found his paint covered with the tough skin of dried oil. In his efforts to make something useful out of that film, Walton eventually laid the foundations for the linoleum business, for he discovered that the dried oil could be ground up, mixed with granulated cork, and made to adhere to a canvas or burlap foundation. The inventor died recently at the age of 94, having lived to see a giant industry arise from his early experiments.

Although modern linoleum is characterized by a beauty and durability undreamed of in the early days of its manufacture, the process of manufacture is fundamentally the same as described in Walton's original patents. Linseed oil, pressed from flaxseed, is boiled to the consistency of molasses so that it will oxidize or dry out quickly. This same boiling process is the beginning of patent leather manufacture and that brings us to the place where our chemist friend, Professor J. S. Long, of Lehigh University, comes into the story.

Several years ago, a certain manufacturer of patent leather asked Dr. Long to tell him why the patent leather surface of shoes cracked when the shoes were worn. Dr. Long found that the boiling of the linseed oil was done in an empirical manner, the operator simply continuing the cooking until the oil felt about the right consistency,



A giant rotary press used in making inlaid linoleum without the aid of human hands. The operators are inspecting the linoleum as it comes from the press

when rubbed between the fingers. The chemist, knowing the fallibility of human judgement, began to investigate the reason why linseed oil "thickens" on cooking. He soon confirmed his suspicion that the change was due to an increase in the molecular weight of the oil. From there it was easy to develop a simple method of determining the molecular weight of the oil as the "cook" progressed, and to stop at exactly the right point. Thus, perfect uniformity of product is obtained, and the patent leather manufacturer is no longer subject to the troubles that were his lot when he depended on the guess of his workmen. This piece of research work was the starting point for a series of investigations at Lehigh University that have almost as much significance for the users of linseed oil as Walton's curiosity about the film in the paint pot.

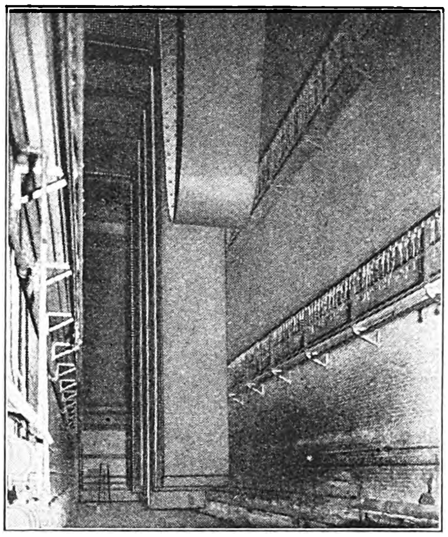
In the modern linoleum plant, the boiled linseed oil is run into a trough, from which it trickles down over sheets of scrim which hang from ceiling to floor of the oxidizing shed. The boiled oil oxidizes rapidly, forming the tough, elastic skin, which is ground up to a pulp and then mixed with rosin and other gums in large kettles. When the mixture cools, it is chopped up into convenient sized chunks and aged for several weeks before it is mixed with the finely ground cork. Color pigments are also added to the mix which is fed between huge steam heated rollers. The usual backing material is burlap. To obtain the many colorful designs which make printed linoleum such a popular floor covering, the plain material is run through massive printing presses, after which it is run into the "stoves" for drying and toughening. The more expensive grade, known as inlaid linoleum, is made by fitting vari-colored tiles of linoleum into a pleasing pattern, which is fused in position in hydraulic presses.—*A. E. B.*

"Sunshine" Lamps

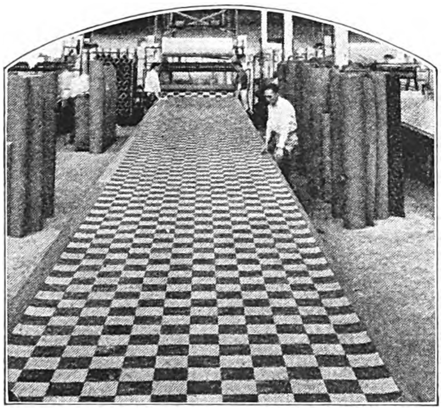
THE tremendous vogue of the use of lamps producing ultra-violet rays has caused considerable consternation among physicians who realize the limitation of these lamps for health and also the fact that there are all sorts of peculiar devices offered to the public, in many instances without any certainty that the device will actually produce good results or that it will provide the ultra-violet that the person wants. In order to bring some control into the field, the Council on Physical Therapy of the American Medical Association has issued a manifesto to manufacturers, defining the limitation of such apparatus and the claims with which it may be sold.

Because of the possible danger of lamps of high intensity, the Council has taken the stand that any "sunshine" lamp sold directly to the public should be so constructed that the radiant energy emitted shall not differ essentially from sunlight. In general, the Council believes that more conservative claims for the necessity of strong sunlight should be made by the manufacturers of lamps for home use, such statements being restricted to those which can be justified by conclusive scientific evidence. The Council is not convinced that human beings in good health require the great amount of ultra-violet energy which one is led to believe is the case from the advertising and descriptive matter pertaining to some of the so-called "sunlamps" sold to the public.

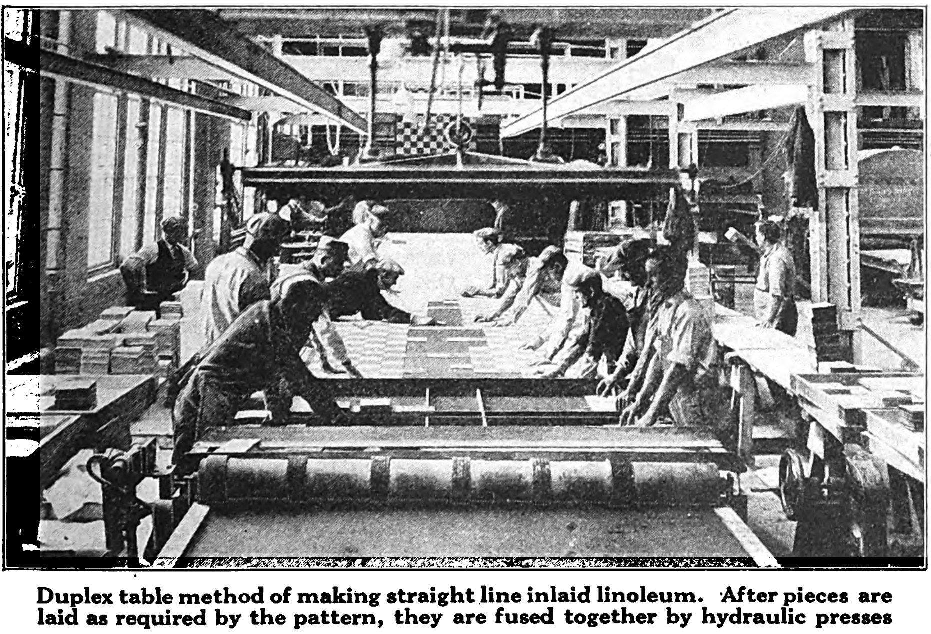
A number of the more responsible manufacturers have fully agreed with the opinion of the Council. The emission characteristics of their lamps are in essential agreement with the requirements established by the Council, and in their advertisements they carefully avoid making curative claims. Furthermore, in these advertisements attention is called to the advisability of consulting one's physician before exposing oneself to ultra-violet radiation.—*M. F.*



One of the "stoves" in which printed linoleum is "festooned" for final toughening and aging



Each roll of linoleum is inspected by experts but also is subjected to as many as 110 laboratory tests before it is ready for shipment



Duplex table method of making straight line inlaid linoleum. After pieces are laid as required by the pattern, they are fused together by hydraulic presses

Reforestation in 1929

REFORESTATION in the United States last year restored to tree growth a total of 111,175 acres, the Forest Service of the United States Department of Agriculture reports. This included the planting of 31,430 acres by 21 states and two territories, 5920 acres by municipalities, 25,088 acres by industrial organizations, 539 acres by schools and colleges, and 1516 acres by other organizations. Farmers planted 24,825 acres to wind-breaks and woodlots, and other individuals planted 3650 acres. The Forest Service planted 18,207 acres of land on national forests last year.

The First International Air Safety Congress

THE First International Congress for Safety in Aeronautics will be held in Paris during December, 1930. It is being organized by the *Comite Francais de Propagande Aeronautique*, under the presidency of the French Air Minister. Aircraft safety is not a matter of a single invention, but a question of improvement along innumerable lines. Nothing illustrates this fact as much as the program of the Congress, to which eminent authorities from every civilized country will be asked to contribute memoirs and investigations for consideration by the delegates.

The Congress is divided into seven groups and six sections. Group A will deal with safety organization in various countries and with the statistics of accidents. Group B will cover the general problems of air safety, under the following six sections: Safety of Materials; Aerodynamic Safety; Engine Reliability; Aids to Navigation; Meteorology and Aerology; Navigational Instruments and Radio Communications. Group C will consider the application of the best safety methods to all branches of commercial aviation. Group D is concerned with the physiology of the pilot and other questions of a medical aspect. Group E is concerned with the training of flying and ground personnel. Group F will take up methods of protection such as parachutes, means of preventing or extinguishing fire, et cetera. Group G will be devoted to lighter-than-air craft.

Valuable results may be expected from this well organized international gathering.

Explosion of Anesthetics

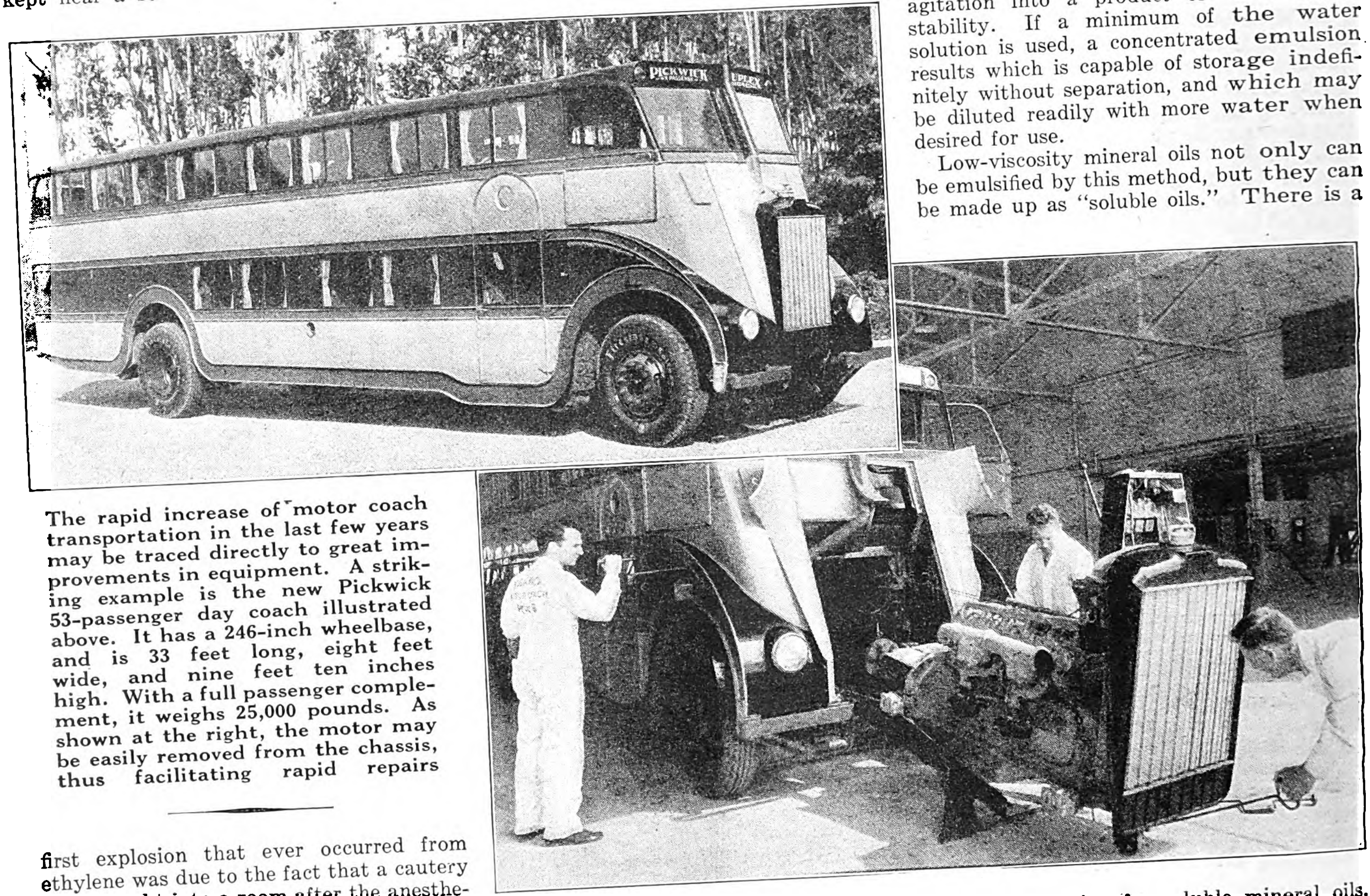
MIXTURES of air and ether, and of ethylene and air and of various other gases, occasionally explode. Obviously this constitutes a hazard in an operating room where a person is inhaling such a mixture of gases. It has long since been recognized that an open flame must not be kept near a source of ether vapor. The first explosion that ever occurred from ethylene was due to the fact that a cautery was brought into a room after the anesthesia apparatus had been removed but some of the gas was still in the atmosphere.

Recent studies indicate that electric sparks may be sufficient impulse to set off an explosion. The entire subject has been reviewed by Dr. H. B. Williams, who recommends the elimination of rubber from apparatus for giving anesthetics, making the equipment as far as possible conductive throughout. He also recommends metallic tubing and a general connection of the face piece to the tubing so that when removed from the face piece the upper part of the mask will remain in electrical connection with it. In this manner, the entire apparatus can be kept at a uniform electrical potential and no high voltage is likely to develop even if the apparatus is not grounded.

Among other precautions for preventing explosions are the following directions:

There should be provision for grounding the operating room personnel, to prevent sparks passing from their persons to the apparatus, which is more likely to occur in winter weather and in severe climates. If rubber soled shoes are worn, rivets of copper may be put through from inside to outside. Great care must be exercised in placing blankets removed from a warming closet on the patient. These, if very dry, may cause copious and intense sparks when unfolded or shaken. They might well be kept from becoming so dry. Blankets of wool may contain surprisingly large quantities of water without feeling damp; they may, in other words, be damp enough greatly to diminish the hazard of electric sparks without being in the condition popularly described as a "wet blanket."

Ethylene should under no circumstances be used in any operation in which an actual cautery or surgical diathermy apparatus is to be used, and ether should never be used in any throat operation in which a cautery or surgical diathermy or similar apparatus is required. Care should be taken, especially in very dry weather, not to comb or stroke the patient's hair until the ethylene has had time to become thoroughly dissipated. It would be well to wrap the hair in a linen binder during and immediately after the operation.—*M. F.*



The rapid increase of motor coach transportation in the last few years may be traced directly to great improvements in equipment. A striking example is the new Pickwick 53-passenger day coach illustrated above. It has a 246-inch wheelbase, and is 33 feet long, eight feet wide, and nine feet ten inches high. With a full passenger complement, it weighs 25,000 pounds. As shown at the right, the motor may be easily removed from the chassis, thus facilitating rapid repairs

"A Good Mixer" Welcomed in Industries

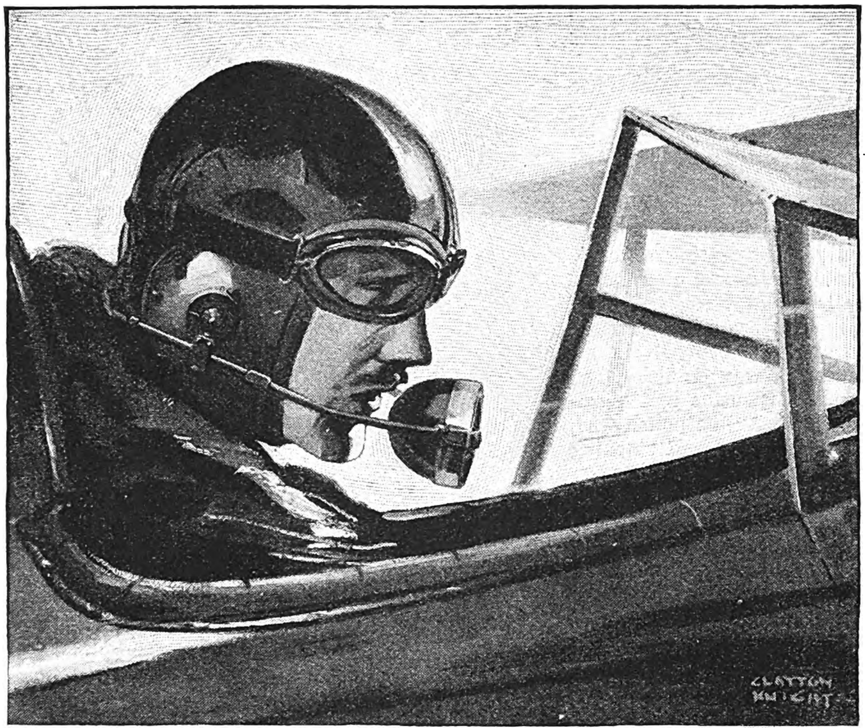
THE word "emulsion" always brings first to our mind a certain patent tonic which we were bribed and cajoled into taking before meals in the fast receding days of childhood. Emulsions, however, play a very important and ubiquitous part in a great many commercial products which are not related to medicine. The suspension and dispersion of fats, oils, and waxes in a liquid medium with which they are not naturally miscible is a basic step in the manufacture of a wide variety of useful substances. For this reason, the recent discovery that the compound, triethanolamine induces emulsification to an astonishing degree, is of prime importance.

Ordinarily, emulsification has been accomplished by slow mixing and vigorous stirring. In contrast, when an oil solution of a fatty acid is added to a water solution of triethanolamine, an emulsion tends to be formed spontaneously. This method, therefore, consists in simply dissolving in the oil approximately 6 to 20 percent of the fatty acid, which includes any free fatty acid naturally occurring in the oil, and mixing the solution with a 2 to 8 percent solution of triethanolamine in water. This method usually yields a spontaneous emulsion which is converted by moderate agitation into a product of satisfactory stability. If a minimum of the water solution is used, a concentrated emulsion results which is capable of storage indefinitely without separation, and which may be diluted readily with more water when desired for use.

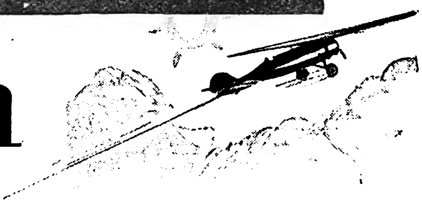
Low-viscosity mineral oils not only can be emulsified by this method, but they can be made up as "soluble oils." There is a wide application for soluble mineral oils. They form the basis for machine cutting oils, for orchard sprays, for polishes, and for a number of textile oils.

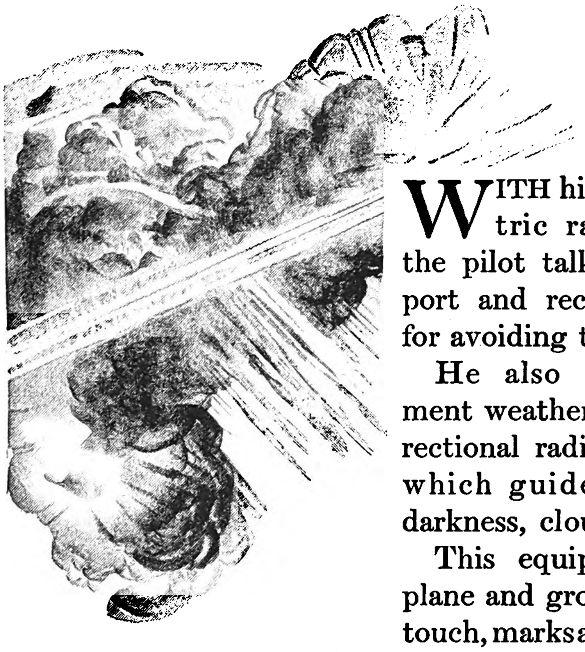
The most interesting field for these oils, perhaps, is in the textile industry. Although mineral oils are theoretically best fitted for textile lubricants, they have hitherto been at a disadvantage due to the great difficulty experienced in removing them completely out of the finished cloth. Oils prepared with triethanolamine overcome this difficulty, and tests have shown that the above soluble oils, even after several weeks of aging in the cloth, are readily emulsified and removed with pure water.

The linseed-oil emulsions offer very interesting applications. Inasmuch as most boiled oils have an appreciable content of free fatty acid, emulsions may be made with the addition of only triethanolamine in the amount of 0.5 percent. Such emulsions, in the water phase, are used as the base for paints that are required to be of exceptionally low fire hazard, and for



Out of the storm





–*by telephone*

With his Western Electric radio telephone the pilot talks with the airport and receives directions for avoiding the storm.

He also hears Government weather reports and directional radio beacon signals which guide him through darkness, clouds or fog.

This equipment, keeping plane and ground in constant touch, marks a great step ahead in flying. It helps to put the new mode of travel on a dependable, efficient basis—doing for air transportation what telegraph, telephone and wireless have done for railroads and steamship lines.

The airplane telephone is backed by more than 50 years' experience with problems of voice transmission.

It was designed by Bell Telephone Laboratories and tested under actual flying conditions in their own planes. It is made with the same care and skill as all the Western Electric apparatus used by the Bell System.

When you travel or ship goods by air, ask whether the plane is equipped with Western Electric Airplane Telephone.

MADE BY
THE MAKERS OF
BELL TELEPHONES

Western Electric

Aviation Communication Systems

paints, such as are used for lettering asphalt, which must have no solvent effect on the under-surface.

Wax emulsions are finding a growing use due to their increased cheapness and low fire hazard compared with hydrocarbon solutions, especially since coating and polishing operations can be performed practically as readily with either type of dilution. A paraffin emulsion has been applied successfully to the coating of paper, board, and window shades and a carnauba emulsion to leather and linoleum. Together with other constituents they have a wide variety of applications. As an example, the carnauba wax emulsion has been made up with turpentine and nigrosines to give an excellent shoe polish with cleaning, scouring, polishing, and blacking properties.

The kerosene emulsion is especially interesting as a tree-spraying material. It may be made in a very stable form with a concentration of kerosene up to 85 percent of the oil by volume and readily dilutable with water; in this respect, at least, it is far superior to the usual orchard sprays.

Further emulsions which have been made with triethanolamine confirm its general utility in this field. A number of edible oils, such as olive, castor, and refined oils, the palatability of which is greatly increased by emulsification, are readily emulsified with this base, although they may not be recommended for internal use until the physiological inertness of triethanolamine has been confirmed.—*A. E. B.*

Art as Sales Stimulant

THE growing importance of art in commerce as exemplified in the increasing attention on the part of manufacturers to improve the appearance of products was emphasized by the Secretary of Commerce, Robert P. Lamont, in an address before the annual convention of the American Federation of Arts in Washington.

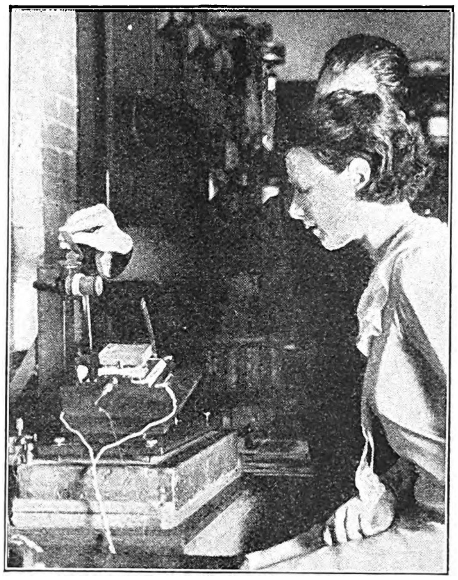
Mr. Lamont said that more and more people are realizing the association of art to everyday life and that this association is manifesting itself in the minds of designers and producers of merchandise. The incorporation of beauty through color and form into the products of our industry should increase the market for our goods.

Measuring the Oilyness of Oil

THE accompanying illustration shows W. C. Wilharm, Research Laboratories, Westinghouse Electric and Manufacturing Company, demonstrating to a visitor the device he has developed for measuring the oilyness of oil.

The device consists of a weighted platform supported by three highly polished steel balls and resting on an equally highly polished steel plate which is covered with a film of oil. The steel balls cut through the fluid film and rest on the tightly absorbed film built up by certain molecules present in the lubricant. The plate is fastened to a hinged platform which is raised slowly by means of the crank which Mr. Wilharm is shown turning in the photograph.

Thus, the angle between the plate and the horizontal is increased gradually until the weighted platform supported by the steel balls moves, slipping over the absorbed film of molecules. The slightest movement of the platform is rendered perceptible by the action of a voltmeter connected in a circuit which is closed when the platform comes in contact with a needle after moving only .001 inch. The tangent of the angle between the plate and the horizontal attained when the platform begins to slide is the coefficient of friction.



Demonstrating a device designed to measure the oilyness of oil

In this way, the device, determining the angle at which the balls will slide over their absorbed film of lubricant molecules, measures the oilyness of the oil. Of course, the smaller this angle, the greater the oilyness and the better the oil for lubrication purposes.

Rural Radios

A RADIO in every country home is the wish of the Virginia commissioner of agriculture, George W. Koiner, as expressed in a statement just issued.

"It is stated that 35 percent of the farmers have radios," Mr. Koiner said. "In some sections there are more than in others. The radio is a great boon to the isolated country home. The best music in the great cities may be brought to the home which could never be heard otherwise. Also the important market news and the interesting sporting news for both the old and the young. We wish there could be a radio in every country home."

Is Private Flying Dangerous?

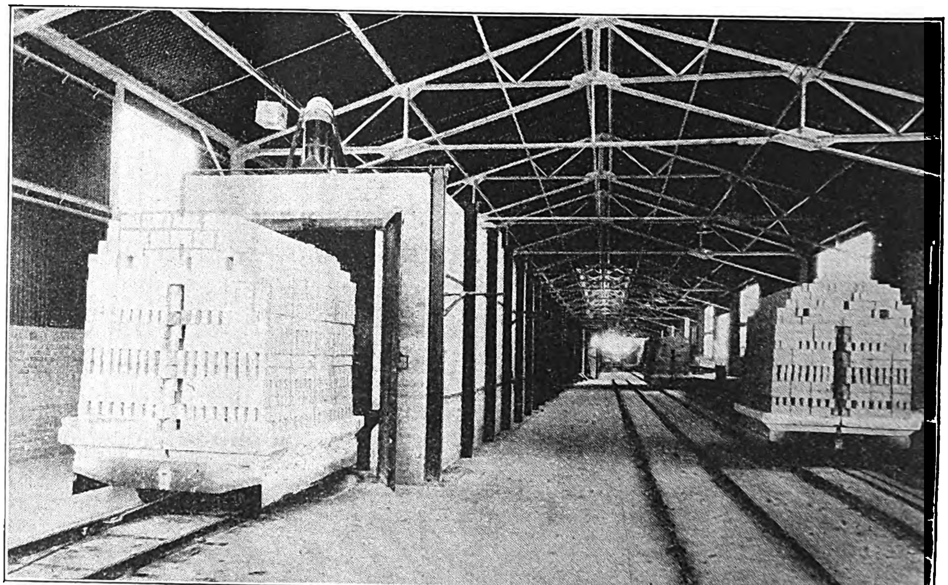
EARLE OVINGTON was the first airmail pilot (1911). He is President of the Early Birdmen, a semi-serious, semi-humorous secret society and he has kept up-to-date by recently securing a transport pilot's license. His views on private flying, as expressed before the Seattle Aeronautical Meeting of the American Society of Mechanical Engineers are therefore, though somewhat pessimistic, worthy of serious consideration.

Mr. Ovington asks "Why are there so few private owners of airplanes?" and continues: "I will answer this question by saying: because the airplane really suitable for the private owner, has yet to make its appearance." Perhaps the readers of these columns will disagree with Mr. Ovington—practical light planes are with us already, in the opinion of many observers.

His views on certain desirable characteristics of the light plane are far less open to controversy.

He would like to have:
Perfect visibility.
The pilot's seat as far as possible from the engine, to minimize crash hazard.
A smooth six-in-line, inverted, air-cooled engine.
A landing speed far lower than that of the conventional airplane of today. A private plane should not land at the speed of an express train.
Perfect stability.
No dangerous stalling.
No noise.

He does not consider less cost im-



Only a few years ago, temperatures of 2800 degrees, Fahrenheit, were believed impossible for tunnel kiln operation in the manufacture of bricks. Progress in the ceramic art, however, has been so great that the gas-fired kiln, shown above, has been developed to a point where it operates continuously at the temperature mentioned, and turns out fire brick for furnace linings at the rate of 12,000 per day. The kiln is 325 feet long and a 100-ton hydraulic pusher moves the flat cars loaded with brick through it

POWERFUL LITTLE DROPS

A GALLON of Ethyl Gasoline contains only about a teaspoonful of Ethyl fluid. Yet these few drops change the action of the fuel entirely when it gets inside the cylinder.

Ethyl fluid is a governor of combustion. With increased compression, the gasoline tends to burn abnormally and the engine "knocks." Ethyl fluid regulates the combustion so that instead of a sharp irregular explosion that *slaps* the piston downward, Ethyl Gasoline burns with slowly gathering force that develops a powerful *thrust.*

That's why Ethyl Gasoline gives so much more power. That's why it develops the maximum efficiency of the new high-compression motors. That's why it stops "knocking" and gets additional power out of every automobile.

Just a few drops of Ethyl fluid, but they are *powerful drops.*

Try Ethyl. Try it on hills, in traffic, under the most trying driving conditions. Ethyl will improve the performance of your car, whatever its size, type or age. Fill up with Ethyl at any pump bearing the emblem shown below. Ethyl Gasoline Corporation, Chrysler Building, New York City.

The active ingredient used in Ethyl fluid is lead.

WITH ETHYL BRAND OF ANTI-KNOCK COMPOUND ETHYL GASOLINE CORPORATION NEW YORK, U.S.A.

Knocks out that knock

Wherever you drive—whatever the oil company's name or brand associated with it—*any* pump bearing the Ethyl emblem represents quality gasoline of high anti-knock rating.

© E. G. C. 1930

GOOD GASOLINE + ETHYL FLUID = ETHYL GASOLINE

portant. It is more safety that we want.

Mr. Ovington believes that the Curtiss *Tanager*, winner of the Guggenheim Safe-Aircraft competition is a step in the right direction, though far from being an ideal plane.

Comparing the safety of private flying with that of regular air-transport flying, Mr. Ovington gives the transport service the best of the argument:

Two complete sets of instruments and controls are mounted in the cockpits of this new sport trainer

"When you fly on a schedule airline, the circumstances usually are 'right.' The pilot is well trained; his experience has been extensive; the plane is the best obtainable; its mechanical condition is everything that could be desired; the airway is well known to the pilot; emergency landing fields and airports are usually frequent along the route; and undue risk is not usually taken on account of weather conditions.

"In private flying, the pilot often is not well trained; his experience is often inadequate in spite of the fact that he must pass the Department of Commerce tests in order to get his license; his ship, so far as design and construction is concerned, does not always compare favorably with the large air transports, and its mechanical condition is not always perfect; because the private owner does not, as a rule, follow an airway, landing fields and service stations are not always convenient. Only when it comes to weather conditions is the private owner better off than the air-transport pilot; the private owner is usually a fair-weather pilot and largely avoids weather risks."

On the other hand Mr. Ovington has quite a splendid time with his own plane. This veteran pilot paints a glowing and interesting picture, particularly for the man who is mechanically inclined. He does his own servicing, adjusting, and grooming. His airplane is a hobby with him. "I'm never happier than when I'm in my hangar, unless it be when flying my always well-groomed ship."—*A. K.*

Rheumatic Fever

RHEUMATIC fever is responsible for at least one half of all cases of heart disease and the death rate for heart disease in the United States is more than twice that of the second greatest cause of death. For this reason, research on heart disease is attracting more and more investigators throughout the world. Coombs, who has studied the disease extensively in England, is convinced that children acquire rheumatism because defects of inheritance and environment combine to permit invasion of the germs that takes place through the tonsils in at least one third of the cases. Miller of England places special emphasis on the living conditions, finding this disease particularly in poor and damp neighborhoods.

All authorities are agreed that the chief hope of control of these conditions is early recognition and considerable attention to such early signs as pains in the limbs known as "growing pains," slight rise in temperature, and fatigue. Whenever the tonsils are infected, the heart must be examined repeatedly to find out whether or not it is involved in the infection. Miller warns particularly about watching the pale, tired child with poor appetite, who looks feverish and sick and who has a little fever at night.

In view of the lack of knowledge as to the actual cause of this disease and of the way in which children are infected, it becomes obvious that the attack upon it must be made from every possible point of view. In modern research, biology, chemistry, bacteriology, pathology, and all of the other related fundamental medical sciences, are brought to bear in searching for the solution of any disease problem.—*M. F.*

A Neat Sport Trainer

THE aircraft industry is peculiar in that the training of students is one of its most important activities. But some day flying will become so easy to learn that airplane trainers will disappear. For the present, however, the number of training planes built per year equals, if it does not exceed, the number of all other airplane types. However, as flying becomes gradually a private owner's affair, the attempt is made by dsigners to combine the functions of a trainer with that of a sport machine. Hence the name "Sport Trainer" for the new two-seater biplane built by the Verville Aircraft Company. It is an excellent example of what our manufacturers can do at their best.

In the matter of equipment, for example, much more is available now than in the early days of cockpits empty of everything but seat, control wheel, and rudder bar.

The Sport Trainer calls for the following accessories: standard steel propeller; Heywood air starter; balloon wheels; dual A. P. C. brakes; oildraulic shock absorbers; fully castorable tail wheel; dual stick control; parachute seats; head-rest; two 3-piece safety glass windshields; gasoline gage; tool compartment and kit; air speed indicator; two tachometers; compass; two altimeters; two oil pressure-gages; navigation lights; dry battery; fire extinguisher; first aid kit; dual throttles; dual switches; dual stabilizer adjustment; and baggage compartment. The brakes can be controlled from either cockpit, separately or simultaneously.

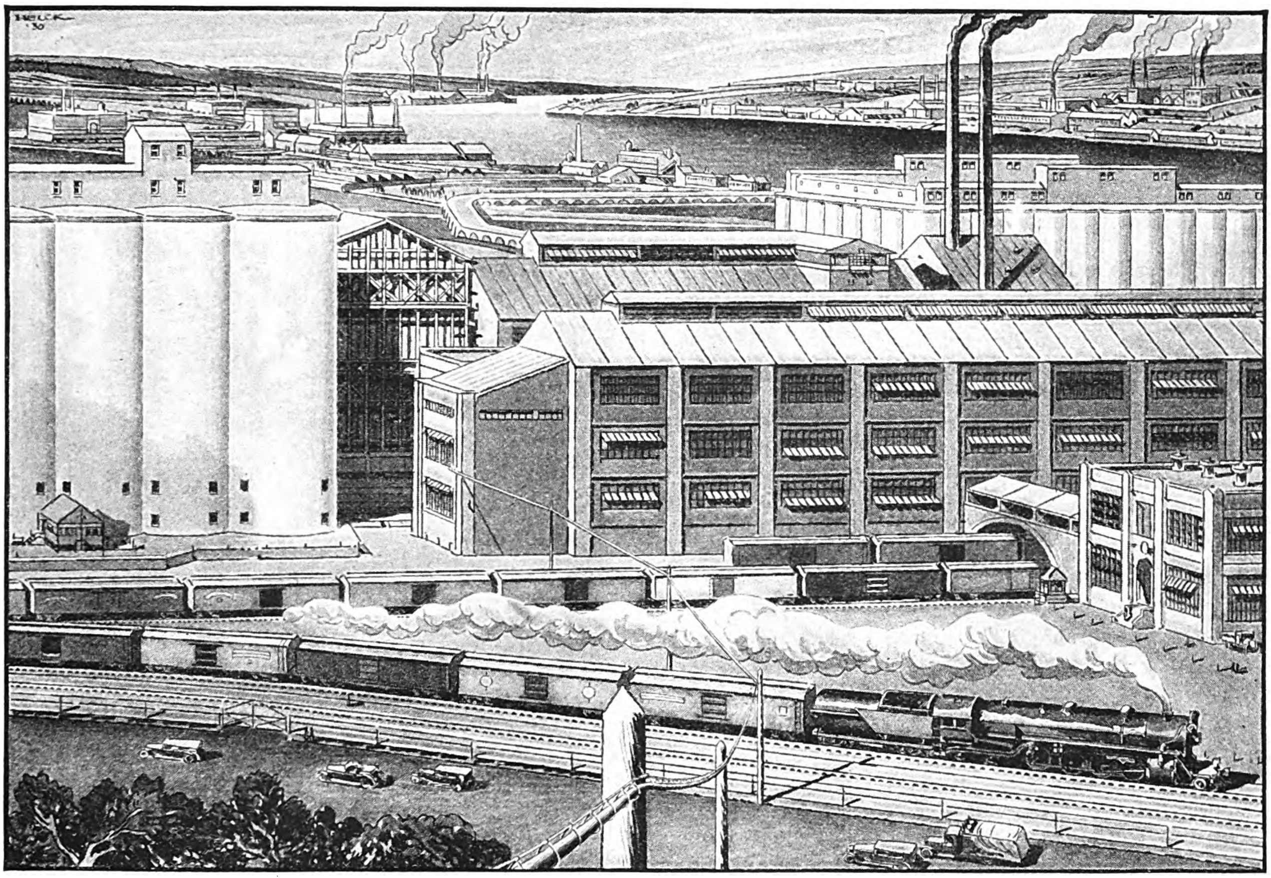
The reader will note the repetition of the word dual. For many years there was a controversy as to the installation of instruments in a training plane. Designers argued that the same instruments should be seen by both instructor and student, and that the student did not need to have all controls under his command at the start. This resulted in peculiar arrangements of the instrument board. So that both occupants could see them, they were sometimes mounted on the trailing edge of the upper wing, sometimes at the side of the fuselage, and in other unlikely locations. With improvement in instrument construction, so that two sets of instruments can be relied upon to read exactly alike, duality has apparently won out.

The specifications of the Trainer are as follows: Span, 31 feet; length over-all, 24 feet 3½ inches; height over-all, 8 feet 9 inches; power plant, Continental A-70, 165 horsepower at 2000 revolutions per minute; fuel capacity, 36 gallons; fuel consumption at crusing speed 9 gallons; normal range, 328 miles; wing loading, 9.27 pounds per square foot; power loading, 13.6 pounds per horsepower; pay load, 420 pounds; weight empty, 1562 pounds; gross weight, 2243 pounds; high speed, 115 miles per hour; climb, 900 feet per minute; cruising speed, 95 miles per hour.

The arrangement of the cockpits in a training plane is most important. There should be good vision forward and down. It should be easily possible to make a parachute jump from either cockpit. If our reader will imagine himself seated in either cockpit, he will see that both objectives are attained. There should be,

(*Please turn to page* 323)

A three-quarter front view of the Verville sport trainer



Giants out of the earth

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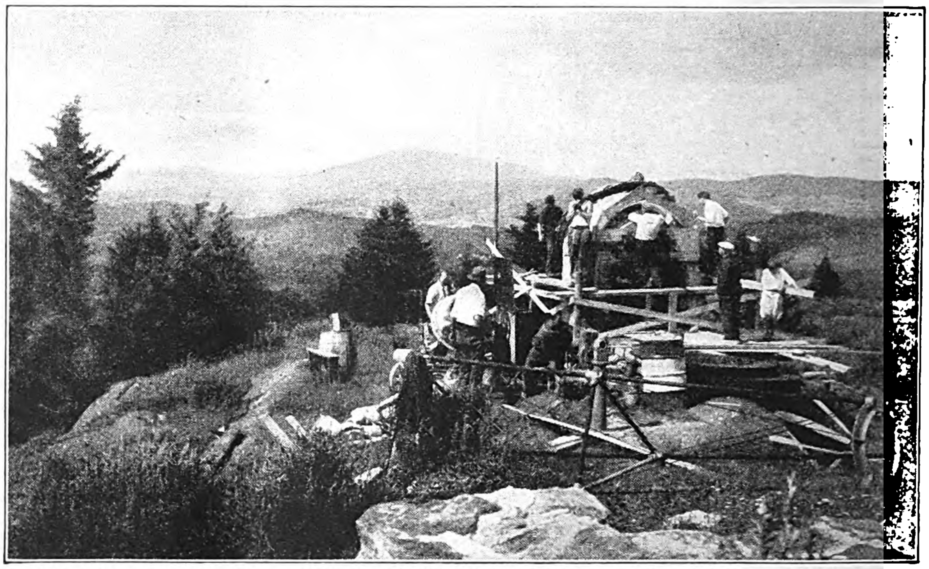
The Amateur Astronomer

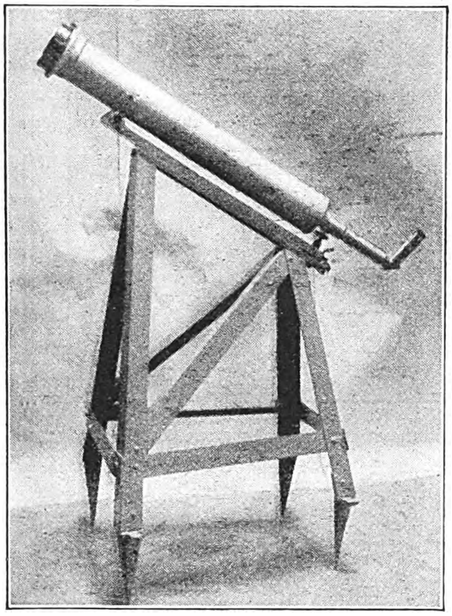
Conducted by ALBERT G. INGALLS



The Telescope Makers of Springfield erecting the new Porter turret telescope

JOHN M. PIERCE, President of the "Telescope Makers of Springfield" (Vermont) estimates that 2000 telescopes actually have been made since 1926 when this journal opened its amateur telescope making campaign. That figures about 30 percent of those who have obtained the SCIENTIFIC AMERICAN instruction book "Amateur Telescope Making" and is a good showing when the unusually exacting nature of this work is considered.

Telescope making is not a hobby which is likely to appeal to the masses; it is a little too stiff for them. It recently was tried on the readers of several newspapers, who were given a syndicated series of simple "how-to-make" instructions for a reflector. The results, to put it mildly, were nothing to shout about. (Recently, by the way, we stated in these columns that amateur telescope making was too stiff for boys as well as average newspaper readers and several of our readers took the word boys to connote all minors. Perhaps "kids" was the intended word. One might say the dividing line between the "too-stiff-fors" and the "not-too-stiff-fors" is plane geometry. If a lad has studied geometry, nothing in the amateur telescope making hobby should stump him, other things being equal—namely that he be fairly handy and a bit more "stick-to-it-ive" than the average lad.)

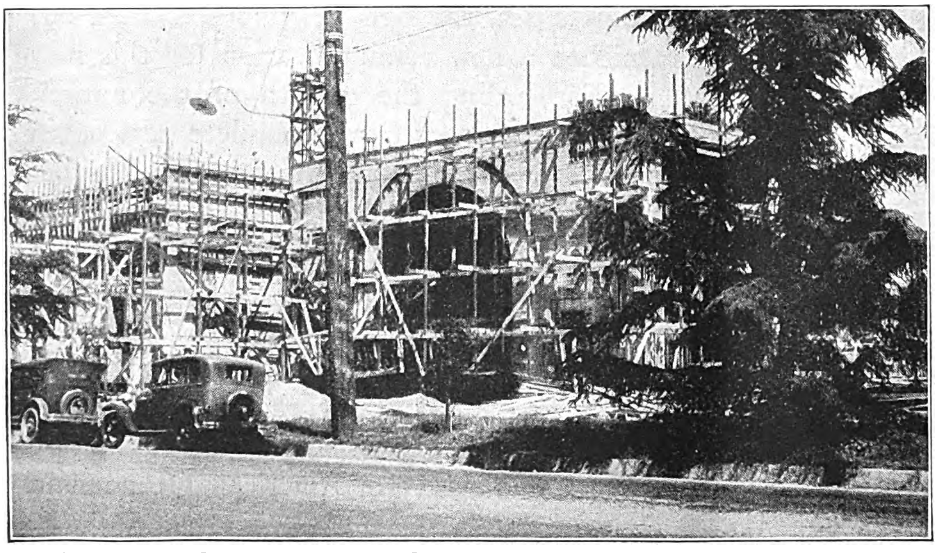


One of the six 4-inch refractors designed by Porter for use on *Polaris* to study "seeing" by Anderson's method at several sites in California and Arizona with a view to selecting a suitable location for the 200-inch telescope. Two larger telescopes will be used in the final tests at a later date

Another gratifying evidence of the consistent, even if not meteoric, spread of the amateur astronomical and telescope making hobby was the attendance at the yearly "get-together" of the worst addicts—the flea-bitten regulars who take telescope making instead of their meals—held last month at "Stellafane," near Springfield, in the hills of southeastern Vermont. As these words are written (in a jiggling Pullman berth) the fifth of these annual conclaves is just over and, despite the frowns of bad weather, more visiting fans from neighboring states attended than on any of the previous occasions. Running down the list of registrants one sees a well scattered following, as connoted by their home towns, Newport, New London, Boston, Pittsfield, Brookline—all places in nearby New England; also New York, Princeton, Philadelphia, Rochester, Pittsburgh, and Detroit. A special contingent came from Pittsburgh, representing the thriving association of amateur telescope makers recently organized there.

As usual there was a Saturday evening "feed," although the time-hallowed "piece of resistance," real beanhole beans, did not materialize. The evening meal stowed away, the assembled enthusiasts listened to a talk by Russell W. Porter, Associate in Optics and Instrument Design on the staff of the California Institute of Technology. Mr. Porter spoke on, or rather "around," the subject of the great 200-inch telescope. Nearly all the extant plans are tentative and therefore little of a definite nature may be told about them as yet. We reproduce two photographs showing the first tangible beginnings, but the mammoth telescope doubtless will be many years in the making.

The small testing telescope shown is equipped with gooseneck prism and an eyepiece which is essentially a compound microscope giving a magnification of 7500 diameters. The quality of seeing afforded at a number of sites which are under careful investigation is determined by ascertaining the number of diffraction rings visible around the central disk of a star and how much the image of a star shifts, in terms of its diameter, when local atmospheric disturbances affect it. The



Through this large, arched portal adjoining the new instrument shop of the California Institute of Technology will go the 200-inch mirror blank to be ground and polished in the large optical shop to be built later to the right

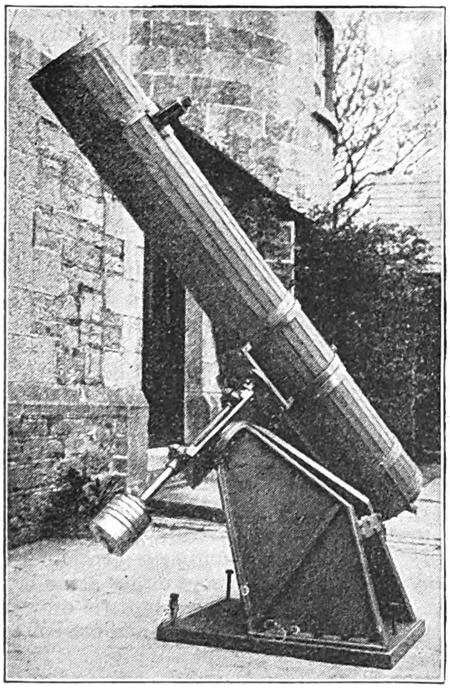
star *Polaris* is the test star. Any other star would suffice, but careful study of the picture will show that the telescopes were designed especially for use on *Polaris* because that star remains for all practical purposes at the same place all night—in other words the use of *Polaris* is a matter of convenience.

As other new facts concerning progress on the 200-inch telescope become available for publication this journal will endeavor to report them.

The telescope enthusiasts, convened at "Stellafane," obtained a glimpse of the new Porter turret telescope—"new" only because recently set up (see one of the illustrations, which shows the work in progress just before the meeting; also see "Amateur Telescope Making," second edition, page 51, illustration at VI). We hope to publish a picture in a later issue, showing the complete mounting.

The turret, made of concrete, will house two telescopes, the larger one a Porter combination having a 16-inch paraboloid and a 16-inch flat, focal ratio *f* 13; the smaller one a 12-inch Cassegrainian with *e. f. l.* of 4 on 4, or *f* 16. The rings of the turret are of iron and have an external diameter of seven feet; they show toward the lower right. In the foreground is the long arm, made of tubing, to carry the 16-inch paraboloidal mirror. It, with the iron ring, dome, and counterwieight, will weigh about 4000 pounds.

The picture shows "the boys" at work erecting the telescope. Porter, the gang boss, is the figure with the long stogie; the rest are working—especially Pierce, whose hat alone is visible (on the skyline) while he compacts the concrete in the forms with his feet. The photograph was taken by Oscar S. Marshall. In the background is Ascutney Mountain. Next year when you come to the Sixth Annual Astronomical Riot at "Stellafane" the new Porter turret telescope will be ready for you to use.



An 8½-inch reflector recently built for Senor Jose Fernandez of Argentina, by the Reverend Mr. W. A. Ellison of Armagh Observatory, who did not send further description. The roof of Ellison's stone workshop shows at right

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Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Bibliography of Aeronautics, 1928, gives the information in dictionary form with author and subject entry and one alphabetical arrangement. Citations of the publications of all nations are included in the language in which these publications originally appeared. *Superintendent of Documents, Washington, D. C.—50 cents (money order).*

Instructions for Installation and Care of Brown Electric Flow Meters (Instruction Book 214). The flow meter is an instrument of precision and must be treated as such; this book tells how. *The Brown Instrument Co. of Philadelphia, Pa.—Gratis.*

Bearing Value of Soils—Foundation Engineering deals with soil pressure, soil character, soils under load, soil tests, examples of failures, and so forth. The paper was prepared by C. C. Whittier. *Robert W. Hunt Company, 2200 Insurance Exchange, Chicago, Ill.—Gratis.*

European Motion Picture Industry (Trade Information Bulletin No. 694, United States Department of Commerce) gives up-to-date information such as the fact that at the end of 1929 there were 1670 European motion-picture houses wired for sound films. Continental film leaders now regard the soundfilm as the entertainment of the future and the multilingual feature as a necessity for foreign trade. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

The Bowie Method of Triangulation Adjustment in the First Order Net in the Western Part of the United States (Special Publication No. 159, Coast and Geodetic Survey, U. S. Department of Commerce) by Oscar S. Adams, Senior Mathematician. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Fertilization of Shade Trees (Bulletin No. 1, June 1930, Research Department, The Davy Tree Expert Co.) deals with the advisability of chemical fertilizers for conifers. *The Davy Tree Expert Company, Kent, Ohio.—Gratis.*

A New Method of Evaluating the Potency of Antineuritic Concentrates. (Reprint No. 1348 from the Public Health Reports), by Maurice I. Smith. A study in the chemistry of the antineuritic vitamin. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Preventing Cracks in New Wood Floors (Leaflet No. 56, U. S. Department of Agriculture) by L. V. Teesdale, Senior Engineer, Forest Products Laboratory, Madison, Wis., gives valuable information as to cause and prevention of floor cracks. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Sectional Map Indicating Main Automobile Roads Between Canada and the United States is divided into four sheets—Atlantic, Great Lakes, Middle West, and Pacific sheets. When ordering, indicate in which section you are interested. *Address F. C. C. Lynch, Director, Natural Resources Intelligence Service, Ottawa, Canada.—Gratis*

The Killifer Tillage System is a valuable, fully illustrated treatise on a system of soil tillage. *Killifer Manufacturing Co., 5525 Downey Road, Los Angeles, Cal.—Gratis.*

Museums, a Magazine Popularizing Museums. Edited by Ralph Clifton Smith, *Editorial Office, 3732 Van Ness St., Washington, D. C. $3.00 a year, single numbers 25 cents.*

Geology of the Eagle-Circle District, Alaska (Geological Survey Bulletin 816, Department of the Interior) by J. B. Mertie, Jr. *Superintendent of Documents, Washington, D. C.—50 cents (money order).*

Borate Mineral from the Kramer District Mohave Desert, California (Professional Paper 158-I., Geological Survey, Department of the Interior) by Waldemar T. Schaller. *Superintendent of Documents, Washington, D. C.—20 cents (coin or money order).*

Review of Legal Education in the United States and Canada for the Year 1929 by Alfred Z. Reed deals with the missing element in legal education, practical training, and ethical standards. *The Carnegie Foundation for the Advancement of Teaching, 522 Fifth Ave., New York City.—Gratis.*

Beginning the Second Century is a piece of institutional literature produced in celebration of the centennial anniversary of the invention of the platform scale by Thaddeus Fairbanks, and the founding of the company which bears his name. It is beautifully illustrated. *Fairbanks, Morse & Co., Publicity Department, 900 South Wabash Ave., Chicago, Ill.—Gratis.*

Hickory Golf Shafts (Commercial Standard CS18-29, Bureau of Standards, U. S. Department of Commerce) gives full diagrams. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Tractor Lubrication is the title of a little monograph which shows that power economy is the ultimate objective in tractor lubrication.—*The Texas Company, 135 East 42nd St., New York City.—Gratis.*

Personnel Research Agencies (Bulletin of the United States Bureau of Labor Statistics No. 518) has been prepared by Estelle M. Stewart of the United States Department of Labor. It is a most valuable pamphlet of over 200 pages dealing briefly with such subjects as employment management, industrial relations, employment, safety, hygiene, cost of living, et cetera. *Superintendent of Documents, Washington, D. C.—35 cents (money order).*

Foreign Students and the Immigration Laws of the United States. (Bulletin No. 1, Institute of International Education) by Ruth Crawford Mitchell is a monograph on a subject on which it is rather difficult to obtain dependable information. Two editions have been called for in 1930. *Institute of International Education, Inc., 2 West 45th St., New York City.—25 cents.*

Ethnology of the Mayas of Southern and Central British Honduras (Publication 274, Anthropological Series, Vol. XVII. No. 2) by J. Eric Thompson, Assistant Curator of Central and South American Archelogy, Field Museum of Natural History. Here we have detailed anthropological studies of some of the living descendents of the ancient Mayas written in most interesting style. *Field Museum of Natural History, Chicago, Illinois.—$3.00 plus postage.*

Design for Kansas Farm Homes (Kansas State Agricultural College Bulletin, Vol. XIII. No. 10) by H. E. Wichers, is a publication (Bulletin 23) of the Engineering Experiment Station. The 102 page pamphlet gives 38 designs for houses accompanied by floor plans. It is a valuable contribution to the small home literature.—*Engineering Experiment Station, Kansas State Agricultural College, Manhattan, Kansas.—Gratis.*

Principles and Operation of Pioneer Instruments is a pamphlet containing many diagrams and is sold either alone or with a set of enlarged diagrammatic drawings which are 17 x 22 inches and are suitable for classroom or lecture use. The "manual" contains reduced copies of the diagrammatic drawings with accompanying text. *Pioneer Instrument Company, 754 Lexington Ave., Brooklyn, N. Y.—Diagrammatic Drawings and the Manual $2.50; Diagrammatic drawings only, $2.00; Manual only 75 cents.*

The Scientific American Digest

(*Continued from page* 318)

and is, a neat, heavy cowling for the front end of the fuselage. The exhaust ring and the engine as a whole should blend gracefully into the fuselage, and they do. The landing gear should have a wide tread and be rugged, and it is. The landing gear should absorb shocks readily, and it does, since it is provided with both oildraulic shock absorbers and air wheels. It should be easy to take the upper wing down, and since it is in one piece, this is easily accomplished. There should be a handy catwalk on the lower wing on either side of the fuselage, and there is.—*A. K.*

New Fertilizer Reported

A NEW phospho-nitrogen fertilizer, obtained from a base of natural phosphates, is reported by the United States Assistant Trade Commissioner in Paris, to have been perfected by a French engineer, a technical director of one of the Algerian mining companies. Natural phosphates are treated with hydrochloric acid in the proportion of one to one. Ammonium sulfate is then added to the clear solution, the mixture filtered in order to eliminate the precipitated calcium sulfate, and calcium carbonate is then added to the filtrate. The fertilizer manufactured in this manner contains 18 percent phosphoric acid, soluble in citrate, and 14½ percent of ammoniacal nitrogen.—*A. E. B.*

Salt of the Earth Made to Fit Varied Needs

THERE is a silver thread of salt closely woven into the fabric of all human history, says Dorothy Robinson in a recent issue of *Food Industries*. It is doubtful if any commodity has had a greater effect upon the history and civilization of the peoples of the earth. Its value from ancient times is most clearly indicated, perhaps, by the prominence salt has occupied, not only in commerce but in religious and moral development. Invariably it was used in religious rites as a worthy offering, and every language has its common sayings concerning the welding of bonds of friendship through the eating of salt. Such a one is the Arab phrase "There is salt between us."

The modern salt plant, such as the one at Manistee, Michigan, described by Miss Robinson, is located over the vast underground deposits of rock salt. A pipe is sunk 2000 feet below ground and through it water is sent down to dissolve the salt. The salt solution is then pumped up into huge wooden settling tanks where some of the impurities settle out. The salt solution is then evaporated, either slowly in open vats called "grainers," or rapidly in steam heated vaccum pans. The product of the grainer is a flake salt whereas the vacuum pan produces a granular salt. The salt thus crystallized is dried and screened to obtain the many varied grades demanded by different users.

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flour. The meat packers in Chicago alone, last year, used 500,000 tons of coarse flake salt in curing and preserving meat. In other words, each manufacturer must have a salt which is adapted for his purpose, and by varying treatment of brine, methods of manufacture, drying, and screening, all of these demands can be supplied.

Even the farmer has salt put up especially for his use. Fifty-pound lots of granulated salt are dried and pressed in a large hydraulic press at 1000 tons per square inch pressure into a salt block to be used as a salt lick for cattle. For table salt, 1 percent of filler is mixed with the salt to prevent absorption of moisture and consequent hardening. For the much-advertised iodized salt, 0.02 percent of potassium iodide is added, as iodine compounds are an aid to health in the prevention of goiter.—*A. E. B.*

Alcohol As Motor Fuel

EFFORTS of the Brazilian government to popularize use of alcohol motor fuel are meeting with success, according to reports to the Department of Commerce by Assistant Trade Commissioner J. Winsor Ives, Rio de Janeiro.

Official cars are required to use this fuel and 60 percent of all cars in Pernambuco are regular consumers.

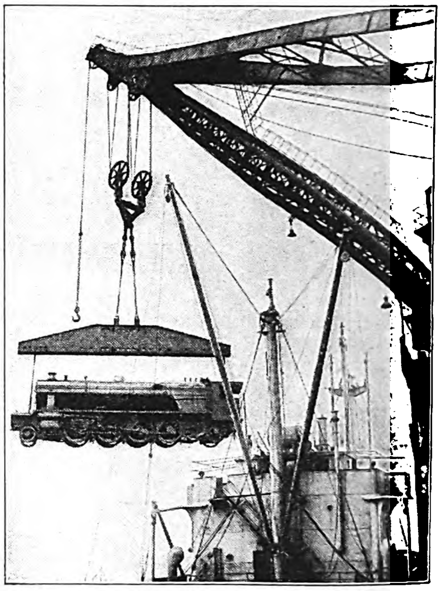
Petroleum companies maintaining branches in Pernambuco report reduced sales of gasoline due to the lower price of alcohol fuel. Alcohol motor fuel, which consists of a mixture of cane alcohol and ether, is selling from 500 to 700 reis (approximately six to eight cents) per liter, with gasoline approximately 18 cents.

Proprietary and Medicinal Foods

THE old time tonic and patent medicine has given way to the stimulating food. Years ago everyone who became depressed or fatigued or disabled in general, thought he ought to have something from a bottle to give him back the vim, vigor, and vitality that he had lost. The Food and Drugs Act and the publicity which followed its passage have made people realize the preposterousness of this belief. The newer knowledge of the vitamin has, however, brought into the situation the attempt to replace the old time products by new combinations of vitamin foods. The food faker, as has been pointed out by Dr. W. McKim Marriott, follows closely behind the investigator of nutrition, picks out an occasional truth, and distorts and broadcasts it to the unsuspecting public. Diabetic foods, pre-digested foods, and brain foods are sold with claims that are preposterous—are sold indeed with the impression that it is possible for the food to depart from the stomach and go immediately to the one portion of the body to which it may be aimed. All of the foods are reduced in the digestive tract to elemental substances, resynthesized into products that can be taken up by the blood and then distributed generally to the various parts of the body.

In addition to special foods for special portions of the body, there are products sold with a vaunting of the claims of calcium, iron, phosphorus, iodine, and all of the alphabetical vitamins. Claims are made again and again for special virtues associated with the use of certain food substances, before scientific research definitely has established the fact that the claims are warranted. Because a fresh product contains vitamins, it can not be assumed that the preserved product has retained the vitamins.

Perhaps one of the most significant phases of modern research in the canning field has been the attempt to substitute exact knowledge for guessing in the promotion of the canned food. Already it is known through research conducted in your own "laboratories" that the sun ripened tomato is much more likely to be an adequate source of vitamin C than the green product hastily ripened by artificial means. It is known that American canned tomatoes are likely to contain much more vitamins than English canned tomatoes. Because exposure to the sun's rays produce vitamin D in the body, it can not be assumed that exposure to the sun's rays or to artificial ultra-violet will produce vitamin D in every other living tissue. Unless a sufficient quantity of ergosterol, the precursor of vitamin D, is present in the tissue, exposure to ultra-violet rays will not produce the vitamin.



Although it weighs 119 tons, this locomotive is lifted like a toy to the deck of the S. S. *Belhor* by a huge 150-ton crane. The engine is destined for a railroad in India

It is also important to remember that foods must be taken into the body primarily for growth and health and not primarily for the control of disease. True, the degenerative diseases which afflict mankind are the effects of wear and tear and may be minimized by suitable control of the diet; true, the diseases due to defects of nutrition and the lack of the necessary food substances may be controlled by the provision of the missing vitamins, but in the vast majority of cases mankind eats in order to provide his body with fuel for his energy consumption and to maintain his tissues in a state of health.

Hence the folly of claiming for various natural foods special contents of infinitesimal quantities of various mineral salts and vitamins must not be permitted to dominate the manufacture of millions of cans of staple foods, of millions of packages of cereals, and of millions of pounds of meat. The statement is particularly apropos in connection with recent campaigns asserting the special value of canned foods prepared from fruits and vegetables grown in soils especially rich in iodine or iron or other mineral salts. The quantity of iron or iodine or calcium or phosphorus required by the human body is now definitely known, and it is understood among scientific nutritionists that these quantities are to be had through a vast variety of foods and that a person who eats a well balanced diet is likely to get these quantities without paying special attention to any one of these particular salts. There is no necessity for limiting the output of canned fruits and vegetables to any particular portion of the United States. Wherever these products grow in quantities and in a quality suitable for preservation, they may well be packed for preserving as part of the American diet in a season and at a time when the fresh fruits are not generally available.—*M. F.*

New Finish for Aluminum

A NEW, simple, and cheap method of giving aluminum a dead white finish was described by Leon McCulloch, research chemist of the Westinghouse Electric and Manufacturing Company, in a report to the American Electro-chemical Society. The metal is boiled in milk of lime to which a little calcium sulfate is added. The new coating will be tested as a base upon which to apply paints and enamels to aluminum.—*Science Service.*

Sand as Source of Helium for Airships

MONAZITE sand, source of thoria from which gas mantles are made, may provide the lifting power for future British airships. Work at the Chemical Research Laboratory at Teddington by R. Taylor has shown that this sand is a possible source of helium, the non-inflammable gas that replaces hydrogen in American airships. The United States now has a practical monopoly of helium which is found in extractable quantities only in the natural gas of certain American gas wells. Large quantities of monazite sand are available in the British Empire, especially Ceylon and Travancore, India.

The natural gas from Texas contains about 1 percent of helium, while the monazite sand yields about one cubic centimeter of helium to every gram of sand. This means that to fill a ship of 5,000,000 cubic feet capacity, the size of the *R-100*, newest of British dirigibles, 150,000 tons of sand would have to be refined. The gas escapes from the sand on heating, so in treating it for the manufacture of thoria, large quantities of helium are wasted. In the process for its refinement worked out by Mr. Taylor, the gas is treated with heated magnesium metal which removes most of the nitrogen, and then final treatment with heated calcium removes the rest of the nitrogen and other gaseous impurities—*Science Service.*

Chemist Peers into Atoms With Aid of X Rays

IT is just 35 years since Roentgen discovered X rays. The application of his discovery during that time to medical diagnosis has been of inestimable value to mankind. But there is another, more recently discovered, field of usefulness for the X ray, namely the exploration of the atomic structure of matter. By the use of X rays, the scientist is permitted to "look" down into the fine structure of matter far beyond the power of any microscope. On the 35th anniversary of Roentgen's discovery, the foremost explorer of these hitherto hidden realms, Dr. George L. Clark of the University of Illinois, itemized, in *Chemical Markets*, some of the wonderful recent applications of the X ray diffraction method to industrial problems:

1: Numerous determinations of proper heat treatment of metals. In one case, the X-ray results showed that at the correct temperature for annealing of cast steel parts a better structure was obtained in 30 minutes than in the six hours previously taken.

2: An improvement in the transparency of waxed paper from 40 percent that of air to over 80 percent by a simple application of the diffraction results to influences affecting the crystallization of paraffin wax.

3: A genuine improvement in the quality of rayon by fundamentally showing the structural effect of every step in the process and of adapting these to produce the necessary ultimate structure, or diffraction pattern, essential for proper tensile strength, extensibility, gloss, and so forth.

4: A method of specification for asbestos (single pattern) by comparison with standard patterns associated with practical behavior.

5: Control of addition of dyes and other agents to rubber, and of the primary effects of various treatments on colloidal size—the only method of ascertaining true reproduction of natural rubber in synthetic rubbers.

6: Measurement of particle size in paint pigments, and control of production of carbon blacks.

7: The only exact method of analysis of any material to prove whether or not it is true cellulose.

8: Measurement of film thickness of every kind.

9: Determination of proper conditions for manufacture of best quality of ice-cream, as to size and distribution of ice crystals.

10: Classification and identification of precious and semi-precious stones and routine method of differentiation between fine and cultivated—containing mother-of-pearl center—pearls.

These are but a very few of the remarkable achievements of the X ray when used for the study of atomic structure. So delicate is the diffraction method that the mine from which a sample of asbestos was taken is established by its X-ray photograph, as is the exact age of a growing cotton fiber or the exact process by which a rayon thread had been manufactured.—*A. E. B.*

A Rigging Handbook

SAFETY in flying depends in a large measure on plane maintenance, and this in turn depends on the skill and knowledge of the airplane mechanic. Few American books have dealt especially with the subject of airplane rigging, and we therefore welcome the "Airplane Mechanics Rigging Handbook" by Lieutenant Colonel Rutherford S. Hartz and Lieutenant Elzor E. Hall. It covers the rigging of the modern airplane in clear and simple language, is splendidly illustrated, and is written by men thoroughly conversant with their subject. In addition to covering

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rigging and inspection, the handbook provides a compendium of practical information on aircraft materials, wood and glue, metal airplane parts, wires, dopes, fabrics, and so forth. The care of parachutes forms a useful concluding chapter.—*A. K.*

Visualizing the Kidney

ONE of the most valuable procedures used in scientific medicine for the study of disease is the method known as "cystoscopy," whereby a tube is introduced into the bladder and the interior of the bladder studied thoroughly. In addition, it is possible to inject substances into the bladder which are opaque to the X ray and thereafter, by means of the X ray, to study the outlines of the organ.

A general examination of the kidneys is an exceedingly difficult matter. The kidneys are connected to the bladder by two tubes called the ureters and the introduction of catheters into the ureters and then to the kidney is an exceedingly painful and difficult task. It has also been necessary, if one wished to take suitable X-ray pictures of the kidneys, to inject a substance into the kidney by means of the tube introduced first into the bladder and then by the catheter into the ureter.

Several years ago Dr. Evarts Graham and his colleagues in Washington University, St. Louis, developed a dye substance which could be injected into a vein and which would then localize in the gall bladder. By this means it became possible by use of the X ray to visualize the appearance of the gall bladder. Attempts have been made over a number of years to develop a similar method for visualizing the kidney, but until recently without success. Such a method is now being discussed in medical periodicals and apparently the goal has been reached. The dye substance used is a derivative of iodine and pyrridone. The substance finally used has been developed after a dozen or more similar substances were used and discarded because of unfavorable side effects.

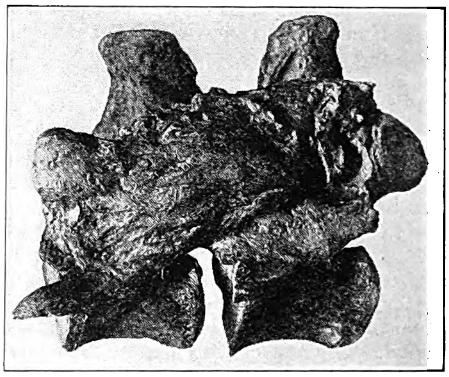
The final product, when injected into a vein, apparently is excreted in the kidney and an X-ray picture will reveal the outline of the organ. By its use in several hundreds of cases, it has been possible to diagnose the presence of cancers or tumors of the kidney, unusual formations of the kidney such as contractions or dilatations, or horseshoe shapes, and the presence of stones and other abnormalities. The method will, no doubt, make it possible, when it is fully developed, for the average practitioner to increase the certainty of his diagnosis. It will also be possible in many instances to avoid the necessity for the more complicated and difficult procedure known as cystoscopy and ureteral catheterization.—*M. F.*

Commercial and Financial Aspects of Aviation

AVIATION has gone through a tremendous boom and is now suffering an equally severe depression, at least from a financial point of view. The thousands of investors in aviation securities are seriously worried. Since knowledge is the best guide to investment or liquidation of investment, we recommend R. R. Bennett's book "Aviation, Its Commercial and Financial Aspects," to all those interested in these phases of this new industry. Published by the Ronald Press, New York City, and written by a man who has made his mark in newspaper writing on aviation, the book discusses the following subjects: The Present Status of Aviation; Safety and Dependability; Financial Aspects; Manufacture of Aircraft; Air Transportation; Airports; Aids to Navigation.—*A. K.*

Stiff Back in the Saber-tooth

THE saber-tooth, dreaded by our cave-dwelling forbears, had a stiff back as shown in the accompanying illustration of two backbone joints which are joined by a heavy bridge of bone brought on by disease or injury. Among the thousands of skeletons of the saber-tooth found in asphalt pits at Los Angeles, California, there are many which show the effects of disease, a study of which sheds light on the nature of ancient maladies. The one pictured here recalls a human disease in which the muscle of a part turns to bone, a disease which the doctors call *Myositis*. In some cases the backbone is completely solid for a distance of several inches.



The bridge of bone found on the backbone joints of a saber-tooth

Chemical Vapor Degreases Metals

AN apparatus for degreasing metal and other products prior to plating, enameling, or other finishing operations, has just been perfected as a result of the application of an ingenious chemical principle. In this process the material to be degreased is suspended in a bath of the vapor from one of a class of chlorinated solvents known under the trade name of Cecolene. The vapor, being much heavier than air, has no tendency to overflow but fills the container in which the parts to be cleaned are placed and condenses in contact with water-cooled condensers around the sides of the container and in contact with the cold objects being cleaned. It is claimed that the condensate carries all dirt and grease to the bottom of the tank where it remains in the liquid without danger of vaporization. The device is adaptable to gas, steam, or electric heating.—*A. E. B.*

British Fog Flying Experiments

SINCE England "enjoys" more fogs than any other country, the subject of fog flying is of real interest to the British Air Ministry. Its scientific staff has recently made some interesting and successful experiments in this direction, at the experimental station at Farnborough. The tests were made on a day of real fog, which extended 90 feet above the ground.

The apparatus used was simple in character. A small captive balloon was anchored 400 feet above the ground and about half a mile from the landing field. An airplane, an Avro biplane of standard make, carried a pitch, or fore-and-aft level, indicator and a turn indicator. A weight was suspended by a wire a few feet below the landing gear. The pilot left the landing field and flew above the fog, sighted the balloon and returned to the field at the appropriate gliding angle, by using his pitch indicator. When the suspended weight touched the ground, a red lamp gave him the signal for leveling out. Once the airplane left the ground it was not seen from the field until it had again landed. The experiment was repeated successfully five times and certainly adds to our knowledge of fog-flying technique.—*A. K.*

New Industries from Natural Gas

THE most remarkable development of industrial chemistry within the past decade has been the large-scale production of scores of entirely new chemicals from natural gas. Chemists have learned that they can juggle the constituents of natural gas around in a great variety of ways. The decomposition of natural gas (largely methane, ethane, and propane) at high temperatures is known as pyrolysis.

When methane is subjected to temperatures of 1800 to 2200 degrees, Fahrenheit, it breaks up, or "cracks." At slightly lower temperatures the parts reunite, but form new products as they combine. The higher hydrocarbon gases also break up and reunite to give various products different from the parent substances. At sufficiently high temperatures the gases will decompose to carbon and hydrogen.

In either type of cracking, hydrogen is always set free and by suitable means can be isolated and used commercially. Its major uses are as a reducing agent in the process industries; the hydrogenation of mineral and vegetable oils and coal; the synthetic production of ammonia and fertilizers; and as a refrigerant.

Other gasses formed in the pyrolysis of natural gas are acetylene, butadiene, ethylene, propylene, and butylene. Acetylene is used in welding and cutting metal, and may be used to prepare acetaldehyde, which is further used in silvering mirrors or in the preparation of medicinals such as chloral, a soporific. Butadiene, under proper treatment, condenses to form an artificial rubber having the same general composition as natural rubber. Ethylene has recently come into use in ripening fruits. It is also finding use as an anesthetic. However, its major use at present is the synthesis of ethylene glycol, an antifreeze for water-cooled motors, and the basis for a series of important lacquer solvents. If desired, ethylene may be converted to ethyl alcohol, widely used as a solvent, and also in the preparation of other compounds such as ether. Again, by proper reaction with chlorine, ethylene chloride is formed. This is a valuable solvent, especially for fats and essential oils, and is also used as an anesthetic. Propylene finds use as an anesthetic, and also in the synthesis of iso-propyl alcohol, which is being substituted for ethyl alcohol with good results in certain instances. Butylene is also used in the preparation of certain butyl alcohols which are finding use as solvents in the chemical industries.

The principal liquids formed in the pyrolysis of hydrocarbon gases are benzene, toluene, and xylene. Benzene is a very valuable product and forms the basis of many chemical processes. Thus are obtained aniline and the entire series of aniline dyes, and many explosives, perfumes, and medicinals. In addition benzene is an excellent solvent and anti-knock motor fuel. Toluene is the basis of the familiar T. N. T. (trinitrotoluol), of dyes, and of saccharin, a sugar substitute 400 times as sweet as sugar. Xylene is similarly used in the synthesis of dyes and other products, and also to a large extent as a solvent.

The solids resulting from pyrolysis are chiefly naphthalene and anthracene. Naphthalene is well known as an insecticide in the form of moth balls. It is also the basis for the important indigo dyes. Anthracene is used in the synthesis of alizarin dyestuffs. Finally, under certain conditions of cracking, there is obtained carbon black, widely used in making ink, in compounding rubber, and as a pigment for paint.—*A. E. B.*

Electrocution

WHEN a human being is subjected for a brief period to a considerable amount of voltage of either continuous or alternating electric circuits, changes are produced in the cells of his body. An engineer, aged 60, depressed because of ill health, made contact with an alternating current at 2200 volts potential. The current passed from his left hand to his left foot, and he may have been in contact for 20 minutes. Physicians in Baltimore made an investigation of the conditions of the cells of his body six hours after death. They found that the cells of the brain were swollen and had been badly injured by the current.

A man, 24 years of age, electrocuted for murder, was submitted to a voltage of 2200 for two minutes. When his brain was examined after death the same type of changes were found.

Rats were then electrocuted and real injuries were found in the nerve cells of the brain and spinal cord. Some of the greatest changes took place in the nerve centers in that portion of the brain which controls the breathing. If the shock is slight, the interference with the breathing is temporary and it is possible by the use of artificial respiration to bring about recovery. If the shock is continued for a long period of time the changes that occur are so definite and prompt that recovery is not possible.—*M. F.*

Artificial Silk from Peanut Shells

RAYON from peanut shells is under investigation by the Farm Wastes Division of the Department of Agriculture at Arlington Farms, Virginia, with results which seem to promise a large raw-material supply for viscose producers. Over 70,000 tons of peanut hulls are collected annually in southern shelling plants, but little use is made of them except as fuel for plant power. The fact that the hulls are collected is a point in their favor, since many other types of waste which might be used could not be made available in bulk without heavy collection costs. Research

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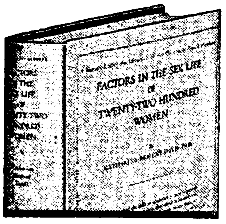
FACTORS IN THE SEX LIFE OF 2200 WOMEN

By KATHARINE BEMENT DAVIS, Ph. D.



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shows that a product up to 90 percent alpha cellulose content can be derived from peanut shells, the requirement of good rayon material thus being satisfied. Experimental fibers have been produced.—*A. E. B.*

Yeast for Cows Instead of Cod-Liver Oil

YEAST, which has been exposed to ultra-violet rays, is better than cod-liver oil for increasing the rickets-preventing properties of cows' milk, Dr. Harry Steenbock, Flora Hanning, and E. B. Hart of the Wisconsin Agricultural Experiment Station at Madison, Wisconsin, have found.

These investigators have been trying for some time to find a way of increasing the anti-rachitic property of cows' milk. The majority of infants fed on it get rickets. Earlier observations showed that summer-time milk had slightly more vitamin D, the rickets-preventive, than milk produced in winter. Experiments showed, however, that it was not because the cows were getting more ultra-violet light in summer that their milk had more vitamin D in it.

Next, experiments with the cows' diet were made. Cod-liver oil, which prevents rickets in man, was not satisfactory when fed to the cows. Fed in large amounts, it lowered the secretion of butter fat. Fed in small amounts, it produced little, if any, effect of an anti-rachitic nature.

Excellent results were, however, obtained from irradiated yeast. Two hundred grams fed daily to cows producing from 30 to 40 pounds of milk increased the vitamin D content of the milk many fold. Even 50 grams furnished enough vitamin D to make the milk highly anti-rachitic.

Apparently by the use of irradiated yeast one of the most outstanding deficiencies of cows' milk can be corrected in a practical way. With the present cost of yeast production, it should be possible to give milk all the vitamin D required for normal nutrition at a cost of a fraction of a cent per quart.

The use of yeast has a further advantage in that the amount of vitamin in the milk can be controlled by the feeding of a standardized yeast preparation in amounts adjusted to the milk production.

The applicability of the use of irradiated yeast for the enrichment of human milk still remains to be worked out.—*Science Service.*

Cleansing Chemical Is "Safe" Alkali

UNTIL recently sodium metasilicate (Na_2SiO_3) had not been available commercially because of the difficulty of preparing the crystals from the sticky mother liquors and the consequent inability to prepare a granular product which would not adhere or form a hard cake on standing. Chemists have now succeeded in overcoming these commercial barriers and sodium metasilicate is available as a dry soluble powder, which keeps indefinitely in a tight container at temperatures below 60 degrees, centigrade.

Sodium metasilicate yields strictly alkaline solutions which remain effectively alkaline until they are almost completely neutralized. The solution is efficient as a cleansing agent without the disadvantages met in certain other solutions of the same high alkalinity. The material seems well adapted to cleaning all sorts of material, including glass, metals, and alloys. It also has interesting applications in the laundry. —*A. E. B.*

Shelled Nuts Form Soap Deposit in Glass Jars

THE mystery of the frostlike deposit frequently seen on the inside of glass jars containing shelled pecans, or other nuts, has been solved by E. K. Nelson and H. H. Mottern, chemists of the United States Department of Agriculture. The deposit is soap, the chemists say, and it is formed by the action of the acid fat of the nuts on the alkali of the glass. It causes considerable financial loss in the sale of the product.

The unexplained presence of the soapy deposit has long been a source of annoyance to packers of shelled nuts and to some housewives in the south who put up shelled pecans in glass jars when the nuts are plentiful and inexpensive. Although the soap does not impair the quality of the nuts, it presents an unsightly appearance and reacts against the sale of the product.

The chemists first thought that the acid fat of the nuts had come in contact with minute amounts of alkaline cleaner left in the jars but this theory proved incorrect.

Further investigation showed that shelled nuts packed in ordinary glass containers formed the white deposit, whereas nuts put up in hard-glass containers at the same time and under the same conditions formed no deposit. It was concluded, therefore, that the soap was formed by the action of the nut fat on the glass.

Our Point of View

(*Continued from page* 253)

in their vigorous attacks on the treaty. But most Americans felt that, taking all matters into consideration, it was a good treaty. We think they reconciled themselves to this treaty in the firm belief that President Hoover would put the whole force of the administration behind a building program that would give the nation the maximum navy it is entitled to have under the treaty. In as much as the ratification of this treaty is a personal triumph for Mr. Hoover, the vigorous prosecution of the building program becomes a personal obligation of the President and his administration.

CONGRESS AND PARLIAMENT CONGRESS and Parliament adjourned almost simultaneously and neither had succeeded in accomplishing its major objectives. Despite the earnest efforts of the Congressionally-created Farm Board, the price of wheat and cotton is lower than last autumn, and the Labor Government in Great Britain, although unhampered by either the Conservatives or Liberals, has not only entirely failed to reduce the number of unemployed but has seen them increase by over 200,000. These two failures should warn the peoples of both countries that there is definite limitation to the powers of government to interfere with economic laws. There is truth in the homely old adage that God helps those who help themselves, and nothing so becomes a nation as the sturdy self-reliance of its industrial citizens.

BRITISH EMPIRE FREE TRADE AMONG the panaceas urged for its commercial depression is a tariff wall for the British Empire. To avoid offending the Free-Traders, this new proposal for an empire preferential tariff is euphoniously called "Empire Free Trade," but the essence of the system is a tariff against the rest of the world. The difficulties in creating such a system can be estimated by recalling the difficulties encountered by the Republican leaders in passing the last tariff bill through our Congress. All the struggles between the industrial and agricultural parts of the United States are foreshadowed on a larger scale between the industrial United Kingdom and her agricultural dominions. To obtain a preferential market for the products of her factories in her dominions, the United Kingdom must give them a compensating preferential market for their agricultural products. This means a food tax. And neither the Labor nor the Liberal party is prepared for such a departure from traditional British policy.

Even if the United Kingdom were willing to submit to a food tax it is doubtful if the Dominions would be willing to give British factory products much preference, for Canada, Australasia, and the Union of South Africa are all seeking to protect and expand their own infant industries. A Canadian leader expressed this idea very vigorously when he said in substance "A factory in Montreal strengthens the British Empire as much as a factory in Manchester."

In spite of the difficulties to be encountered in establishing reciprocity throughout the British Empire, many British readers, mostly among the Conservatives, are convinced that it offers the only solution for British unemployment. Much will be heard on the subject in the near future. As Canada and the United Kingdom are among our leading customers, our interest in the outcome is apparent.

OCEAN LINER COMPETITION WHILE the Naval Conference has placed definite limitations on naval competition, the struggle between the leading merchant navies of the world is proceeding at a faster pace than ever. It is noteworthy that in every case the governments of the competing countries are solidly supporting the private companies building and operating merchant vessels. Great Britain, Germany, and Japan have long subsidized their merchant marines; more recently France has also. Italy and the United States have come to the assistance of their commercial fleets. At present the British Cunard line, especially aided by the government, is planning a vessel that will be speedier than the German *Bremen*, and the French Government recently increased its aid to the French company that is engaged in building a liner, especially designed to add new luster to the French Line.

These wonderful liners, the western terminal of which is and will be New York, directly and indirectly add to the commercial prestige of a state and, in time of war, can readily be converted into auxiliary cruisers, or in some instances into aircraft carriers. Small wonder then that, in these days when governments realize they must help their own citizens in the competition for world markets, they willingly assist their own merchant marine. Somewhat tardily we have realized that we must give governmental aid to our merchant marine; a determined continuation of this policy will do much to regain our long-lost position of sea-traders.

As a result of our government's assistance, American private enterprise, naturally chary of competing with foreign lines, with their cheaper built and operated vessels, are consolidating and enlarging their maritime interests, and while they will encounter stiff foreign competition, we believe they can succeed as did their forbears during a similar competition in the first half of the last century. Already in the Pacific, American vessels are holding their own against foreign vessels; we confidently expect a like result in the Atlantic.

THE CHAOS IN CHINA RECENTLY the U.S.S. *Palos*, a small river gunboat doing patrol duty in the Yangste River, was fired upon by one of the numerous insurgent armies now laying waste their unhappy country. This incident may focus the attention of Americans for a moment on China, and it would be decidedly to their interests to give that wretched country a brief thought. China takes a large part of our silver, some wheat, and some cotton goods. With Chinese trade demoralized, naturally the demand for these articles disappears. And by so much we suffer. When to the Chinese situation is added the unsettlement of India, the other large silver market, the present low price of silver is understandable. Most of the world's silver is produced in Canada, the United States, and Mexico, and when the price of silver falls, our own silver producers and those of our two nearest neighbors and excellent customers suffer, so commercially we lose three ways.

No one can offer an off-hand solution to the problem of China, but it is plainly obvious that there will be no miraculous remedy. If the Great Powers continue to stand aloof and let the Chinese brigands calling themselves Generals continue their indiscriminate fighting and unholy looting of their own country, poor China may stew in her own juice but the supineness of the Great Powers will be somewhat punished by their reduced Chinese trade.

In these post-war days it is the fashion to condemn everything connected with pre-war diplomacy, but the old European Concert of Powers would not have tolerated the conditions that have existed for almost a decade in China. Our responsibility in China should no longer be ignored; by our insistence on the Open Door policy, quite proper in itself, we have effectually discouraged any independent European or Japanese intervention in Chinese affairs. We should, therefore, take the lead in offering some form of outside help to this distracted country which so plainly can not extricate itself by its own efforts. Our previous record of refusing to seize Chinese territory or even to accept concessions, has given the Chinese people confidence in our good will, so that they will be more inclined to accept advice and help under our sponsorship. Certainly we should not continue to watch with folded hands the ghastly struggles of our tormented neighbor across the Pacific.

Candidates for the
MEDICINE BALL DEGREE

Now is the time to start a course in Medicine Ball. No, it isn't like drinking catnip. It's a genuine sport, and, if you haven't played it, you are entirely out of style—healthfully and politically speaking. For aside from being a sport much approved by President Hoover, it is one of the most muscle-building, circulation-toning, fat-removing, blues-killing, back-yard or front-walk games ever invented for sedentary man. Read all about it in the October issue of HYGEIA, the Health Magazine of the American Medical Association. Minnie Martin, who has been a Medicine Ball addict for twelve years, gives in her vivid, humorous style, a set of suggestions for making Medicine Ball a wholesome zestful recreation for exercise-starved men and women. Working for your M. B. Degree is real fun.

WHOM
shall you consult

Many people who have trouble with their eyes trot off to the jeweler, who is also an optometrist, and have a pair of glasses fitted. They never dream that the trouble with their eyes might arise from complications in other parts of the body, or that the eye, itself, might require medical attention. *Optician, Optometrist, Oculist, Ophthalmologist,* or *Ophthalmic Physician,* which one is the man you need? You know that each one has something to do with the treatment of the eyes, but——. Dr. McCoy defines these titles for you in the October HYGEIA, helping to direct you to the right person for you eye troubles.

Other Health Topics
of vital interest to you

"Warm Water Healing" tells of a new treatment for paralyzed limbs; "The Antiquated Coroner System" explains a blunder in the legal processes of certain cities that is injurious to health and personal welfare; "Simple Lessons in Human Anatomy" is a "get-acquainted-with-your-body" series of articles that will help in health preservation; "Questions and Answers" is a monthly section of HYGEIA that clears up the health problems of its readers—these are only a few of the health problems treated in HYGEIA. Every topic is written by an authority who talks to you through HYGEIA as he would talk to a friend—in a personal heart-to-heart style that makes the reader want more and more of HYGEIA. Every issue is a gold mine of health information. Clip the coupon, fold a dollar bill in an envelope and start your subscription to good health now.

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Books Selected by the Editors

An Introduction to the Study of Wave Mechanics—*By Louis de Broglie*

A COMPLETE account of the new wave mechanics, including the Heisenberg theory, written by the original theorist de Broglie (see Scientific American, March 1930, p. 183) who suggested the wave atom. This 246-page book, translated from the French, contains an unusually well rounded discussion of the subject, is not popular, but involves college mathematics throughout. $4.50 postpaid. —*A. G. I.*

The Fundamental Theory of Electrical Engineering —*By A. L. Albert, Asst. Prof. E. E., Oregon State College*

BECAUSE of the recent developments in vacuum tubes, photoelectric cells, et cetera, a text of this kind was needed to cover completely present practice in fundamental electric phenomena. This presentation is equivalent to college or university courses and will be of value as a reference for non-electrical students. $3.40 postpaid.

Fundamentals of Architectural Design—*By W. W. Turner*

HERE is a dependable text and a ready reference for architects. It presents a concise treatment of all the fundamental principles of architectural design. The plates give both the module and part system of measurement. Dealing with five major fields of architectural design, each of which ordinarily commands a volume for itself, this text really comprises five books in one. The vital elements of each of these fields are presented along with well-rendered drawings and a full glossary of architectural terms. $6.20 postpaid.

English for Engineers—*By C. A. Naether and G. F. Richardson*

THERE is without a doubt a strong trend in engineering and industrial circles to set higher standards in the use of characteristic English. The various colleges and universities, particularly in the large centers of population, are offering courses specially prepared for the adult student. Prominent engineers are using every effort and opportunity to advocate some sort of standardization. This work is ably conceived and most carefully executed. It is a broad course readily adapted to manufacturing business generally and postulates that accuracy in any line should extend to expression as much as it is essential to the subject matter. $3.20 postpaid.

Ingenious Mechanisms—*By F. D. Jones, Editor*

ONE hundred and ten designers have contributed to this collection of the most ingenius mechanisms which are commercially practical. Designers and inventors will find the classification and description of this important work of 536 pages of invaluable aid in their work. As a reference it should be kept in every technical library. We quickly placed it on our shelves. For 15 years these devices have been collected, many of them having received prizes in competition. A needed and welcome work amply illustrated. $5.25 postpaid.

> INFALLIBILITY is not one of the characteristics of an editor, although many of our readers apparently compliment us with this attribute. No one person, in fact, no single editorial staff, can answer every one of the diversified group of questions that come in our mail. Usually we can give some authoritative reference; sometimes on minor, unimportant queries, we must simply say we have no information, but here is one which should have an answer: "What literature is available on the dynamics of small boat sailing?" Our own references failed us. We wrote to our good friend, the Editor of *Yachting* and he replied that the older texts we ourselves located were somewhat antiquated; that a revised edition of one of the standard works would appear shortly, but at present there was nothing but the older issues.
>
> Have patience, therefore, if we cannot always serve you, but do not hesitate to send your book queries to L. S. Treadwell who edits these pages.

How To Become A Radio Amateur

A VERY complete little booklet of 30 pages describing in detail how anyone interested in radio can take an active part in the fascinating pastime of amateur radio communication. First, something is told of the ease of constructing amateur radio equipment. Then follows a short dissertation on learning the code. A very simple yet complete vacuum tube receiver and a low powered transmitter, both for use on the "80-meter" band, are described in minute detail so that the reader can at once start construction. The latter part of the booklet is devoted to telling how the interested person can pass the necessary examination for obtaining a first grade amateur's license. For this booklet write direct to the publishers, American Radio Relay League, Hartford, Conn.—10 cents—*A. P. P.*

Science in Soviet Russia—*By J. G. Crowther*

THE author of the unusually interesting article "Super Magnetic Fields," in the June Scientific American, himself a scientific man, recently visited each of Soviet Russia's scientific research institutions, testing and other laboratories and institutes, and has given his readers a clear, graspable picture showing just what actually is going on—and there really is quite a little—in science pure and applied in that strange civilization. $3.00 postpaid—*A. G. I.*

The Skeletal Remains of Early Man—*By Dr. Ales Hrdlicka, U. S. National Museum*

A NEW and noteworthy scientific treatise containing lengthy detailed descriptions of all the famous finds of ancient man: Foxhall, *Pithecanthropus*, Piltdown man, Heidelberg man, Rhodesian man, all the Neandertal skeletons, and others, by a famous authority. Suitable for the general reader. Because of its origin with the Smithsonian Institution, the volume is priced about at cost, $2.25 (unbound), otherwise it would be at least a five-dollar book. It is suggested that purchasers order it direct from the Smithsonian Institution, Washington, D. C.—*A. G. I.*

Sound Pictures—*By J. R. Cameron and J. F. Rider*

"THE purpose of this book is to acquaint those coming in contact with sound equipment with sufficient fundamentals pertaining to sound motion picture equipment involved at the recording and reproducing end, to enable them to assume freely the responsibilities of operation and maintainance"—so runs the foreword. It contains 1074 pages, abundantly illustrated, starting with the structure of matter and proceeding through the whole field to the very latest adjuncts and accessories. There was real need for such a work and one will quickly realize that it has been amply met here. Both authors are experts and authorities and yet the treatment is so clear and comprehen-

From Recent Publications

sive one can readily assimilate the technicalities by a little application. A most creditable accomplishment. $7.70 postpaid.

THE CONDENSED CHEMICAL DICTIONARY—*Thomas C. Gregory, Editor*

A SPLENDID reference for people not educated along chemical lines but who seek information regarding chemicals and other substance used in manufacturing and laboratory work. This second edition is completely revised, reset, and enlarged and gives a surprising amount of information in most condensed form. Many useful tables comprise the appendix. $10.20 postpaid.

READINGS IN PSYCHOLOGY—*By R. H. Wheeler, Univ. of Kan.*

CAREFULLY selected passages written for the purpose of giving student beginners access to experimental investigation, selected first by what seems to be the dominant interest in psychology, and second by accessibility for publication. This is a sort of laboratory manual, with editorial notes, glossary, and index. There are seven groups in all, with a total of 28 readings. 568 pages of text. $3.95 postpaid.

WHEN I WAS A GIRL—*By Helen Ferris*

WELL told short biographies of Schumann-Heink, Janet Scudder, Marie Curie, Jane Addams, and Etsu Sugimoto, all of whom achieved success in spite of almost insurmountable obstacles, in the fields of music, art and social service, or science. Inspirational and most readable. $2.65 postpaid.

EVOLUTION OF THE FLYING MACHINE, BALLOON, AIRSHIP, AND AEROPLANE—*By Harry Harper*

WITH the background of 25 years of flying, giving as it did unusual facilities for acquiring material of special interest, the author has assembled more incidents of early flight than we have yet seen under one cover. English and Continental flying is particularly well covered and a most complete chronology, especially of early attempts at flight, casualties, et cetera; completes a thorough work. $5.20 postpaid.

TWENTY THOUSAND MILES IN A FLYING BOAT—*By Sir Allan Cobham*

THE very entertaining and sometimes thrilling experiences of this celebrated pilot during his circuit of Africa in a large seaplane. As a messenger of goodwill, he did much to open up many hitherto inaccessible places. $2.65 postpaid.

MANUAL OF FLIGHT—*By Ienar E. Elm, Capt. U. S. A. (Ret.)*

KNOWN as the author of several successful technical books, here he has recorded the fundamental knowledge that should be part of the equipment of every man or woman who intends to fly. Elementary and advanced maneuvers are covered in detail and the actual hazards and safety of air travel are judiciously set forth. Emergencies are considered together with the best means of escape. An intimate and accurate outline of the art is given in most workmanlike fashion. A very practical and conclusive manual. $3.20 postpaid.

PRACTICAL NAVIGATION—*By Charles H. Cugle*

"THERE are many excellent books on the theory of navigation, but very few that the ordinary man can understand and this book has been published with theory eliminated entirely,"—so runs the preface. Practically everything that is needed at sea is included in this most excellent text of 574 pages—innumerable examples of calculations as well as rules, deck information, examinations, stowage of cargo, et cetera. No short cuts are given, for the author believes these should be used only after thorough familiarity with the old tried and true methods. A most thorough and practical manual. $7.20 postpaid.

EXIT—*By Harold Bell Wright*

FOR three years no novel has issued from this author, the legends of the Papagos Indians being the intermediate title. Somehow one feels that in this present novel some of the mysticism, the intangible, the searching after inchoate realities, aspects which give fascination to Indian lore, has influenced the approach to "Exit." There seems to be less of the joyous forward looking into life which has been so characteristic of this writer; we seem to find more of introspection, spirituality, and the influences of past persons and events. Genuinely interesting from this viewpoint and as fascinating in style and description as ever. $2.00 postpaid.

BLACK SOIL—*By Josephine Donovan*

A STORY of community life on the prairie of northwestern Iowa, consisting of several nationalities which eventually become banded by their vicissitudes and common hardships. The author is well known for her literary work along historical lines and this, her first novel, received the 2000 dollar prize offered by the publisher. Needless to say the story runs with intriguing smoothness and fluency. $2.65 postpaid.

CONTEMPORARY IMMORTALS—*By Archibald Henderson*

WITH the keen insight of an artist and scientist, the author analyzes the lives, both purpose and accomplishment, of 12 of the most productive characters in modern affairs. Swiftly and clearly he delves to the bottom and reveals for us the salient facts which form the fundamental foundation of their impulses, their character, their accomplishment. The analytical mind of the mathematician supplemented by the culture, the language, and manners of many nations has produced one of the most delightful books we have had the pleasure of reading in many a month. Einstein, Gandhi, Edison, Mussolini, Shaw, Marconi, Addams, Wright, Paderewski, Curie, Ford, and Kipling are the sketches given. $2.65 postpaid.

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SCIENTIFIC AMERICAN
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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Adding Machine Inventor Dies

THE ranks of American inventors lost a valuable member when Dorr Eugene Felt passed away recently at his home in Chicago. Born in 1862, his mechanical bent first made itself evident at the age of 14 when he went to work in a machine shop. Early in the 80's Mr. Felt conceived the idea of the adding machine. From an old box, some metal meat skewers and a few rubber bands and staples, he evolved his first model of the machine that was destined to make an important niche for itself in the business world. From this early start Mr. Felt invented and patented numerous mechanical devices. He also found time to interest himself in other phases of science. He was an ardent student of geology and of Biblical history, both of which trends developed during his wide travels in foreign lands.

Central Radio Patent Bureau

WHAT appears to be an important step toward the solution of patent troubles in the radio industry has been taken by the Radio Manufacturers' Association. Establishment of a central patent bureau to collect and disseminate complete information on radio patents was ordered recently by the RMA Board of Directors. The new patent department will be in the New York offices in charge of a competent radio patent attorney.

An extensive library on radio patents, foreign as well as domestic, will be developed in the new patent department. It will collect, digest, and index all radio patents and publications and all information regarding patent litigation. Files of many important manufacturers who are members of the RMA will be centralized in the patent department, which will advise manufacturing members of radio suits and decisions, applications for and issuance of radio patents.

The new patent department will not participate in any patent litigation, but its patent data will be available to all members of the association.

"Gas Saver" Ad Censored

ADVERTISING in connection with the sale of a "vaporizer and decarbonizer" for automobiles that light cars run 57 miles on a gallon of gasoline, is prohibited in an order of the Federal Trade Commission to J. A. Stransky and L. G. Stransky, copartners trading under the name of J. A. Stransky Manufacturing Company at Pukwana, South Dakota.

Among other phrases contained in the company's magazine advertising was the following:

"Five hundred dollars per month selling a new patented fuel vaporizer guaranteed to save up to 50 percent in gasoline: 40 miles per gallon made with Ford car."

Representations made by the company were found to be exaggerated beyond what was possible of accomplishment as a result of the use of the "vaporizer and decarbonizer" device, and statements to the effect that the device would remove carbon, prevent spark trouble and over-heating, and make engines start easier, were found not to be substantiated in fact.

The order of the commission prohibits, among other, such representations as the following:

"Ford runs 57 miles on gallon of gasoline."

"Ford makes 40 to 57 miles to gallon; other cars show equally remarkable gains; increases power 25 to 50 percent."

"Why not buy gasoline for 10 cents per gallon? New invention. Cuts fuel bills 25 to 50 percent.

"An automobile goes 27 miles on air by using an automatic device which was installed in less than five minutes. The automobile was only making 30 miles on a gallon of gasoline, but after this remarkable invention was installed, it made better than 57."

"Makes more miles per gallon than any other device on the market, regardless of the price."

"This wonderful little device cuts the cost of gasoline in half—it made it possible for an auto to go 60 miles on a gallon of gasoline."

"Enables Ford cars to make as high as 61 miles to the gallon of gasoline."

Aircraft Patents Issued

A MISCELLANY of devices, including one design for a super-airplane combining the principles of both lighter and heavier than air craft, is included among the patents issued recently to aeronautical inventors by the United States Patent Office. The "super"-flying craft, the invention of Hugh J. Ross of Cliffwood, New Jersey, comprises a fuselage, gas bags surmounted thereon, motor driven propellers on the sides of the fuselage and means for rockably mounting the propellers on vertical axes for control from within.

Another giant airplane, but not containing the gas bag support, was patented by Bert Messick of Lansing, Mich., and an airplane with wings having air-compressing plates depending from their under surfaces at right angles was patented by George S. St. Louis of Fresno, Cal.

The late Elmer A. Sperry obtained a patent on a beacon system for night flying. Another safety device, a parachute supported by a standard, designed to bring a plane safely to earth, was patented by Frank Arnaiz of Los Angeles. An electrical heating means for airplane wings to prevent the accumulation of ice and snow is the invention of William S. Ingram of Philadelphia.

Patents covering a "means of controlling the angle of incidence of aero revolving blades or wings and propellers" were issued to David Kay of Blackford, Scotland. Martyn Clissford MacPherson of Hayes, England, obtained a patent on a "braking of the under-carriage or landing wheels of airplanes." Hugo Junkers patented a dock for flying machines, and a patent on a floating dock for seaplanes was issued to Paul Degan of Kiel-Dietrichsdorf, Germany. Another German, Otto Krell of Berlin, patented a rotable movable hangar for dirigibles.

Increasing interest in the development of lighter-than-air craft is evidenced by the number of patents pertaining to dirigibles recently issued.

Wolfgang B. Klemperer, for example, procured three patents covering a stabilizing apparatus for airships, a tensiometer, and a bulkhead for airships, collaborating on the last with Paul Helma, also of Akron, Ohio. Their patents and one issued on a gas container for airships to Karl Huerttle, together with another on a wire netting for airships to Paul Helma and Kurt Bauch, all of Akron, have been assigned to the Goodyear-Zeppelin Corporation. These technicians are among those working on the construction of two giant dirigibles for the United States Navy.

Ralph H. Upson, famous balloonist of Brooklyn, New York, procured patents on a dirigible and a type of airship fin which he has assigned to the Aircraft Development Corporation of Detroit. Charles Guidice, also of Brooklyn, designed and patented a new type of dirigible, and a patent on a device for protecting balloons from lightning and other atmospheric disturbances was granted to Alfred Crossley, Washington inventor, who has assigned his rights to the Federal Telegraph Company.

Patents on new types of parachutes have been issued to Charles H. Castagne of Chicago and Captain Edward L. Hoffman of Dayton.

Lloyd Stearman of Wichita, obtained patents on a dolly for airplanes and an air-intake heater, both of which inventions he has assigned to his Stearman Aircraft Company.

Cologne Trademark Void

IN a recent decision by the United States Circuit Court of Appeals, Judges Manton and Swan concurring and Judge Hand dissenting, it was ruled that Muelhens and Kropff, Inc., 25 West Forty-fifth Street, American manufacturers of 4711 eau de cologne, cannot have exclusive right to the use of "4711" as a trademark because the concern does not possess the original formula for the manufacture of the article.

Since 1792 the Muelhens family in Germany has been manufacturing eau de cologne at 4,711 Glockengasse, Cologne, Germany. The formula has remained a secret.

In 1878 William Kropff came to this country as the family's agent. Later a member of the Muelhens family formed a partnership here with him. The trademark "4711" was registered as belonging to the firm, but the secret formula was never revealed to Kropff.

During the World War the Alien Property Custodian seized Muelhen's interest in the firm and later sold it to Kropff. The sale included good-will and the trademark. Kropff then incorporated as Muelhens & Kropff and made and sold a cologne under the trademark "4711."

After the war, Muelhens established Ferd. Muelhens, Inc., and began selling "4711" cologne made according to the old formula. The result was that Muelhens & Kropff brought suit to prevent Ferd. Muelhens, Inc., from using the trademark.

A majority of the court decided that "assignment" of the receipt is essential to give the assignee the exclusive right to a mark which denotes a product manufactured thereunder. Otherwise the public will be unable to procure the genuine product under the name by which it has always been known.

Those who insist upon the genuine 4711 eau de cologne are not the prospective customers of the plaintiff, for he cannot supply it.

"Special" Book Editions Curbed

A BOOK publishing partnership signed a stipulation with the Federal Trade Commission agreeing, in connection with the sale of a special edition of a book, to cease and desist from using such representations as "The Authentic Text," "The First Authentic Text," or "The Complete Text" as descriptive of the edition, when in truth such statements are not supported in fact.

This firm also agreed to discontinue use of the words "authentic" and "complete" in any way that would imply or deceive the purchasing public into believing that its edition is an authentic one of Edgar Allen Poe's story entitled "The Gold Bug," or that the edition is an authentic or complete text of this story containing all of Poe's alterations and additions, when such is not the fact.

Patent Office Rules Revised

AMENDMENTS to the trademark rules and to the rules of practice of the Patent Office, made to conform to the new law (act of Apr. 11, 1930), relating to fees, and certain recommendations of the committee of the American Bar Association were announced recently by the Commissioner of Patents, Thomas E. Robertson.

"That part of the new rules which includes fees," Mr. Robertson stated, "has been changed to meet with the requirements of the new law approved Apr. 11 providing that the fee for issuing original patents shall be 25 dollars and 1 dollar for each claim in excess of 20, instead of the present fee of 20 dollars and 1 dollar for each claim in excess of 20.

"Amendments to the rules of practice of the Patent Office were made to carry out the recommendations of the patent committee of the American Bar Association. These changes are, first, an amendment to Rule 41, which provides that more than one species of invention, not to exceed three, may be claimed in one application if that application also includes an allowable claim generic to all the claimed species.

"The changes in rules 109, 114, 122, 123, 124, 128, and 130 provides that all motions in interference cases shall be heard by an examiner of interferences instead of by a law examiner as at the present time.

The American Bar Association, it was pointed out, believes that this will expedite work in interferences, lessen the trouble and expense of interferences and bring them to a speedier conclusion.

In the first sentence of rule 109, "An applicant involved in an interference may, at any time within 30 days after the preliminary statements (referred to in rule 110) of the parties have been received and approved, on motion duly made, as provided by rule 153, file an amendment to his application containing any claims which in his opinion should be made the basis of interference between himself and any of the other parties," has been taken out of the rule and supplanted by the following:

"An applicant involved in an interference may, within a time fixed by the examiner of interferences, not less than 30 days after the preliminary statements (referred to in rule 110) of the parties have been received and approved, or if a motion to dissolve the interference has been brought by another party within 30 days from the filing thereof, on motion duly made as provided by rule 153, file an amendment to his application containing any claims which in his opinion should be made the basis of interference between himself and any of the other parties."

The rules from 109 to 130 provide for the substitution of the word, "examiner of interference" for "law examiner."

Rules 162 and 163 contain changes relating to the filing of typewritten instead

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring official copies of patents herein listed may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

AEROPLANE—Having a single wing extending longitudinally of the fuselage at a sufficient height and angle to dispose the load forwardly and so balance it, as to cause the plane to come out of a fall and glide safely to earth. Patent 1769320. Henry C. Thompson.

AIRCRAFT—Having an arrangement of supporting and flying control surfaces, by which the usual form of tail assembly can be dispensed with, and yet the craft maneuvered and maintained on a desired course and under perfect control. Patent 1766390. Charles V. Lapin.

AEROPLANE—Of the amphibian type, equipped with a landing gear, well adapted for water or ground, having novel features of material advantage in taking off from water, and means for preventing sleet and snow collecting upon the wings. Patent 1769393. John T. Rydberg.

Pertaining to Apparel

GARMENT—So constructed that when worn by a patient undergoing treatment for certain diseases, parts of the garment may be adjusted so that only that part of the body effected, need be exposed to view. Patent 1766272. Samuel W. Vallier.

Chemical Processes

PROCESS OF STABILIZING CEREAL BEVERAGES—Containing less than 0.5% of alcohol, by treating the beverage, at any stage of the brewing, with tannin and a siliceous clay, to precipitate the undesirable albuminoids which render the finished beverage turbid when chilled. Patent 1766428. Donato Cozzolino.

Designs

DESIGN FOR A DRESS—Patent 81493. Dorothy Long.

DESIGN FOR A COAT—Patent 81494. Dorothy Long.

DESIGN FOR AN ENSEMBLE SUIT—The inventor has been granted two patents, 81495 and 81496. Dorothy Long.

DESIGN FOR A RADIATOR-CAP ORNAMENT OR SIMILAR ARTICLE—Patent 81530. Guy de Vall.

DESIGN FOR A COAT—Patent 81545. Dorothy Long.

DESIGN FOR A READING CABINET—Patent 81568. Charles J. Abeles.

DESIGN FOR AN ENSEMBLE SUIT— The inventor has been granted two patents, numbers 81589 and 81590. Dorothy Long.

DESIGN FOR LACE—Patent 81616. Ben. A. Ball.

DESIGN FOR A DOLL OR SIMILAR ARTICLE—Patent 81638. Adolph Gramlich.

DESIGN FOR A TOY ANIMAL—Patent 81646. John S. Hooks.

DESIGN FOR A DRESS—Patent 81711. Dorothy Long.

DESIGN FOR A CARPET SWEEPER—Patent 81669. Earle R. Smith.

Electrical Devices

CIRCUIT-CONTROLLING DEVICE—Whereby special mechanism actuated by the steering apparatus of an automobile keeps the circuit of the indicating lights closed so long as the front wheels of the car remain turned in either direction. Patent 1766993. Masao Hasegawa.

THERMOSTATIC ELECTRIC SWITCH—More particularly designed for controlling the illumination of one or more incandescent lamps such as are used in direction signals, in a manner to produce an automatic flashing. Patent 1766430. Clarence K. Davis and Arthur Dick.

RADIO RECEIVER—Having means whereby the volume of output may be easily and accurately controlled from a point remote from receiving set to give desired softness or loudness, adapted for use with any type of receiving apparatus. Patent 1769256. Allen S. Clarke.

of printed briefs and records providing the brief or record does not exceed 125 pages.

"The Bar Association Committee requested that this be done to cut down printing expenses since they are now very high," Mr. Robertson said.

Bottle Trademark Denied

IN a recent decision, First Assistant Commissioner Kinnan held that the Obear-Nester Glass Company of East St. Louis, Illinois, is not entitled to register, under the Act of 1920, the words "Individually Wrapped," as a trademark for prescription bottles made of glass.

The ground of the decision is that the words could not function as a trademark.

In his decision, the First Assistant Commissioner said:

"The words sought to be registered as a trademark would have no trademark significance to the purchaser of the goods nor could they have any such significance as they merely convey the plain information as to the manner in which the bottles are packed or arranged for shipment. No one could obtain the exclusive right to use these purely informative and descriptive words in connection with the sale of bottles."

"Bucyrus-Erie" Registrable

AN applicant already owning registrations for the mark "Bucyrus," under the 10-year proviso of the act of 1905, is entitled to registration as a trademark of the word "Bucyrus-Erie" for power shovels and similar articles, the Assistant Commissioner of Patents has held.

While the word "Erie" taken alone is a geographical name and therefore would not be registrable, the opinion states that the combination of the two words, linked together, are to be considered as an entirety, and therefore, the mark does not fall within the provision prohibiting the registration of merely a geographical name or term.

Mis-branded Wood

TWO corporations selling and distributing motor boats have signed stipulations with the Federal Trade Commission agreeing to stop misrepresenting their products as made of mahogany, when such is not the fact. Both companies agreed to cease use of the word "Mahogany" either independently or in connection with the word "Philippine," or in any way which may tend to deceive the public into believing that their motor boats are made in whole or in part of wood derived from trees of the mahogany family, when such is not the fact.

One of the companies also will discontinue use of statements or representations implying that it owns, operates, or controls a factory wherein are built and manufactured the products it sells.

Labels Need Not Be Detailed

THE portion of an order of the Federal Trade Commission requiring a person doing business under the firm names to state the ingredients and percentages of such ingredients which make up a substitute shellac in labels and advertisements of the product has been held by the Circuit Court of Appeals for the Second Circuit to be unwarranted.

The court stated that it would be sufficient to prevent a fraud upon the public if the respondent labels his goods and advertises the same as "shellac substitute" or "imitation shellac," accompanied by the statement that it is not 100 percent shellac, and that it was not necessary to show the ingredients of the product in their percentages.

The Federal Trade Commission had issued an order against the respondent requiring him to cease and desist from using the word "shellac" in labels and advertisements of varnish which was not composed entirely of shellac gum dissolved in alcohol. The order permitted the use of labels and advertisements in the sale of the product if accompanied by words clearly indicating the other ingredients and the percentages used. The appellate court modified the order, by eliminating the latter requirement.

LINE TESTER—For overhead wires, wherein the structural arrangement is of such character that effective contact with the circuits to be tested, will be made regardless of the amount of corrosion, rust, etc., with which the surface may be coated. Patent 1769248. Charles D. Williams.

Of General Interest

WINDOW BOX—Or window refrigerator, which may be easily adjusted to the sill, does not interfere with the opening or closing of the window, provides fresh air while excluding dust, and prevents cold air entering the room. Patent 1769740. John C. Kelley.

CLOSURE CONSTRUCTION — For rubber pouches, hot water bags, and the like, which will be water-tight, less bulky than those in general use, and may serve with a tube so that the article may be used as a syringe. Patent 1769259. Beulah L. Henry.

EMERGENCY SECTION FOR SHIPS—Which will float free if the ship should sink, accommodate all of the people carried by the ship and enough storage of food and equipment to take care of them until rescued. Patent 1768152. Charles F. Rodin.

CIGARETTE CASE AND LIGHTER—In combination, constructed to take up very little more room than that occupied by a standard cigarette case. The lighter is removable for permitting a new refill in the operating mechanism. Patent 1766320. Edward G. Ahrens.

BOAT-SALVAGING DEVICE—Built in as a part of the boat and accessible from the deck, thereby obviating the necessity of passing cables in the mud beneath the ship bottom, for applying hoisting tackle to the sunken vessel. Patent 1769353. Louis F. Long.

LAWN SPRINKLER—Embodying mechanism whereby when the device is placed at the approximate center of a square, the volume of water will be controlled so that the corners will be reached by the spray, and the lawn uniformly sprinkled. Patent 1766514. Henry L. Henry.

SIGN—Constructed for interchangeably holding readable indicia in fixed position on a board, and against accidental displacement, yet allowing when desired an adjustment or spacing of the characters without removal. Patent 1766362. James A. Sears.

ENVELOPE—Which does not require moistening in order to effectually seal it, and in which means is provided for showing at once any attempt to open the envelope. Patent 1768836. Thomas E. Gjorup.

BRUSH—A folding brush in which the bristles are adapted to be received when folded within a protecting housing, the whole forming a compact structure which when unfolded provides a handle and brush. Patent 1770344. Frederick E. Schmidt.

BOX OR CONTAINER—Formed of cardboard and composed of three main parts having flanges projecting from the sides and ends which are joined together by metal staples or other fastening means operating as a protective means against damage by dropping. Patent 1770819. Fred W. Tamke and George W. Boh.

VISIBLE CARD FILE—Having a transparent pocket at the end of each card holder, which will improve the use of the record slip for the permanent items relating to the record matter, and the general operation of the file. Patent 1770793. Luigi Lombardini.

WEED PULLER—Having a pair of pivotally mounted jaws with ground penetrating points adapted to be moved together in gripping relation for removing weeds including their roots, with a minimum displacement of the soil. Patent 1771353. Fred P. Riddell.

1929 French Aircraft Exports Increased

FRENCH aircraft exports during 1929 increased considerably, Automotive Trade Commissioner W. L. Finger, Paris, France, recently informed the Department of Commerce. Land planes with a total value of 209,581,000 francs (approximately 8,207,411 dollars) were exported as compared with 138,898,000 francs (approximately 5,446,190 dollars) in 1928; seaplanes exported amounted to 4,852,000 francs.

The largest markets for French aircraft were Yugoslavia, Belgium-Luxemburg, Turkey, Rumania, Brazil, and Indo-China. In 1929 Yugoslavia imported from France aircraft valued at 40,290,000 francs; Belgium-Luxemburg, 2,713,000 francs, and Turkey, 2,694,000 francs. Although 1929 was the first year that France imported airplanes, the quantity was small. These planes came from Great Britain and The Netherlands.

Fraudulent Implication Stopped

CO-PARTNERS engaged in the sale and distribution of knit goods, such as sweaters, swimming suits, and knit dresses, recently signed a stipulation with the Federal Trade Commission agreeing to stop use of the words "Knitting" and "Mills" in their trade name so as to imply that they own or control a factory in which they manufacture the goods they sell.

They agreed to discontinue any other use of the two words which may have the tendency to mislead the purchasing public into the belief that these partners operate a factory.

Mine Safety

THE possibility of eliminating the use of electrical equipment in coal mines in Utah and substituting compressed air apparatus, will probably be considered by the state industrial commission, according to O. F. McShane, a member, who is investigating coal mine explosions.

It is stated that recent explosions have been caused by ignition of gas by the use of electrical equipment and Mr. McShane is serving notice on coal producers that they must show within a reasonable time that they can control this danger by introduction of new safety devices.

Compact-Holding Ring for Vanity Cases—Wherein spaced fingers are used to resiliently hold the compact plate in position, the fingers being so arranged that an implement may be placed there between for ejecting the plate. Patent 1771337. William G. Kendall.

Adjustable Handle—Whereby brushes, mops and such articles may be releasably held in different angular positions to enable a person to more conveniently carry out cleaning operations. Patent 1771325. John R. Cotter.

Device for Producing and Dispensing Lather—Having means for agitating the soap and water to produce a lather without the necessity of shaking the device, and to insure the dispensing of the lather only, precluding the discharge of water. Patent 1771292. Frank P. Gallipoli.

Ironing Board Attachment—By which those parts of garments which have been pressed, and depend from the board as a result of shifting to press other portions, are effectively supported to prevent contact with the floor and soiling. Patent 1770890. Frank Pons and Levert W. Wilson.

Hardware and Tools

Pipe Coupling and Rotary Tool Joint—In which a plurality of threaded sections are screwed into each other with the threaded sections having a differential pitch, and means for locking certain of the sections against independent rotation. Patent 1769381. Gustavus A. Montgomery.

Safety Spring—Or door closing device, having means for limiting the outward movement of a door or other hinged member, in order to protect the hinges, or any object with which the door might collide. Patent 1771299. Fred E. Justus.

Machines and Mechanical Devices

Washing Machine—Which may be connected by a hose to a house faucet and either hot or cold water used for the operation of the machine and for constantly passing clean water in contact with the clothes. Patent 1769221. Harley A. W. Howcott.

Tension Indicator and Compensator for Warping Carriages—For textile fabric such as rayon, silk, and fine counts of cotton, etc., particularly adapted for producing rayon becase it overcomes the action of jerks on the warp sections when starting and stopping, thus avoiding stretching. Patent 1769244. William G. Trautvetter.

Variable - Speed Transmission — Which makes use of two friction discs and two friction wheels, the construction permitting the gears to be bathed in lubricant while still keeping the discs away from the lubricant, thus operating efficiently at all times. Patent 1766240. Julius L. Allen.

Jig—For separating ore or minerals from rock or lighter material, and more particularly a jig wherein a pulsating column of water is used in conjunction with a grate to effect a classification of a bed of material. Patent 1769287. Asa R. Chase.

Moulding Machine—Wherein dough can be molded into mass of the same thickness throughout, such as pan bread, of a predetermined length, or shaped to provide rolls or loaves known commercially as French or Vienna bread. Patent 17711 (reissue). Frank A. Scruggs.

Wave and Tide Motor—Characterized by a plurality of floats capable of being mounted in a body of water for movement in response to wave action, and means responsibe to variations of levels, such as resulting from tidal action. Patent 1766457. Charles H. Ruth.

Automatic Alarm Clock for Hotels—By which the occupant of any particular bedroom may be rung up at any desired hour, an electric lamp being lighted at the same time in his sight, the alarm is automatically repeated a second time. Patent 1769830. Vlderico Giomi.

Apparatus for Treating Asphaltic Oils for the Production of Asphalt—Whereby asphaltic oils can be treated to produce oxidized asphalt possessing a relatively high melting point and a relatively low degree of penetration, and the time required for distillation greatly reduced. Patent 1766446. Max R. L. Miller.

Bun-Cutting Machine—In which a rotary cutter or knife is employed for cutting buns or other bakery or food products, without marring or making them objectional in appearance, the machine may be adjusted to completely sever or cut partly through. Patent 1766450. John A. Ost.

Sugar Dispenser—For mechanically delivering measured quantities or any multiples thereof, the several quantities being accummulated within the dispenser and all being discharged as a single quantity by one tilting movement, the parts are readily removable for cleaning. Patent 1768091. Gus N. Adair.

Loom Mechanism—A reed-like batten with mechanism for moving the same toward and from the fell, beating up the filling as it is inserted and coincidently effecting a combing of the work shed. Patent 1770269. Benjamin D. Hahn.

Lubricating Device—Including a well from which a capillary feeding element immersed in lubricant leads to the parts to be lubricated, and whereby a constant level is maintained in the well, whereby uniform feed is obtained. Patent 1770036. Albert Johnson.

Grinding Fixture—Capable of accurately grinding the face radius and sides of both large and small milling cutters and backing off to proper clearance in one operation, can be used on any standard machine. Patent 1770318. Andrew McAndrew.

Lock—Of the portable or "padlock" type, having a shackling element formed for general application and capable of assuming different angular positions without presenting an obstruction, but held locked against unauthorized removal. Patent 1770812. Ellsworth F. Seaman.

Vacuum and Pressure Pump—Which after reaching a constant speed will produce a definite pressure or vacuum, and once such pressure or vacuum is attained the pump will not operate to increase it beyond this maximum. Patent 1769257. Ralph G. Demaree.

Boat Davit—In which the use of blocks and tackle are eliminated, is vertically movable with the sides of the ship, maintains the boat at a fixed distance from the ship, and prevents upending of a boat during launching. Patent 1771372. Julian W. Bournier.

Dishwashing Apparatus—Having a plurality of brushes of different characters and configurations, connected for rotation with a motor shaft, whereby plates, platters, glasses and other tableware may be rapidly cleansed. Patent 1771934. Mattia Marangoni.

Washer—Having a steam jacket and heads securely bolted to the grooved rings on the ends of a cylinder, the inner face being entirely lined up with sheet nickel, particularly adapted for use in connection with the dry cleaning of clothes. Patent 1771638. Wallace C. Johnson.

Medical and Surgical Devices

Surgical Appliance—By means of which a constant temperature may be maintained with solutions such as "the Murphy drip" intravenous injections, saline and other solutions, as well as solutions for feeding the human body, and for blood transfusions. Patent 1770832. Donnie L. Bass.

Prime Movers and Their Accessories

Protecting Tray for Valve Chambers—Capable of being readily applied, and in such position as to form a protecting covering to receive and collect the carbon particles, cuttings and other waste matter, in such manner as to prevent contamination of the oil. Patent 1766469. Chauncey H. Stout.

Pertaining to Recreation

Toy—In the nature of a "hobby-horse" but differing by the employment of a structure that will produce a more bouncing motion, as well as a rocking motion, thereby exercising the abdominal, back and leg muscles. Patent 1771920. Benjamin Gordon.

Pertaining to Vehicles

Automobile Door Hinge—Whereby entrance to the front and rear seats is had by way of a single door, capable of being opened on both the front and rear edges, thus facilitating ease of entrance or exit from rear or front seat. Patent 1769273. Jacob A. Penner.

Tire-Deflating Switch—A simple and efficient device which will automatically notify the user of the vehicle that he has a flat tire, or one that is partially deflated, the alarm system indicating the location of the particular tire. Patent 1769427. John B. Garside.

Fuel Meter for Automobiles—An apparatus comprising a receptacle with valves in the top and bottom, and a rod operating the valves and a float, whereby the amount of fuel consumed may be measured and registered. Patent 1766262. Claude Simmons.

Auxiliary Water-Circulating Means for Automobile Engines Using Thermo-Siphon Systems—Which will eliminate all belts, pulleys, gears, packing glands or parts that would wear or leak, and their attendant disadvantages, yet possessing a considerable means of boosting the water circulation and be easy to install. Patent 1766408. Robert F. Stephenson.

Brake Equalizer—For four wheel brakesf adapted for ready application to any type o automobile for applying the brakes while at the same time providing for an equalization of the pressure, and the proper force for stopping the vehicle. Patent 1770030. Ray Freeman.

Lubricating System — Comprising tubes leading to the different parts of an automobile, providing a lubricating system which may be actuated by electrical apparatus which includes the ignition switch. Patent 1769258. Coy C. Goodrich.

Signal Arrangement for Automobiles—Which includes a current switch, signal horn, signal lights, constructed in such a way that all signals, optical and acostic, can be separately connected or disconnected by means of one and the same current switch. Patent 1770835. John F. Bolin.

Tourist Car—With the over-all dimensions of an ordinary truck, but providing a relatively large floor space when stopped for camping, embodying indoor and outdoor sleeping quarters, comfortable transportation for travelers, convertible articles of furniture adaptable for various purposes, and observation quarters. Patent 1771911. Harry W. Bernecking.

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ACROSS THE EDITOR'S DESK

WE were chatting with the editor of another magazine the other day, as together we glanced through the advance page proofs of the feature articles in the present issue. "Why," he asked, "do you place so much stress on industrial subjects in the Scientific American?" "Because," we replied, "industry today is the child of science. Without science, there could be none of the vast industries that are scattered throughout the world. Men of science, in both the pure and applied branches, are constantly bringing to light new facts that make possible new industries and bring about radical improvements in the old ones. Therefore, we keep our finger on the pulse of industry and report its progress, hand-in-hand with science."

And in our answer to the friendly question will be found the why and wherefore of our annual Industrial Number which you have before you. On the surface, the layman may not see the closely woven connection between science and industry. But when he is taken behind the scenes and is shown how industry profits rapidly by the advantages offered by scientific research, he begins to realize the parentage of our so-called Machine Age, and therefore ordinary factors in our daily life take on a new interest.

One of the most significant articles in this issue deals with natural gas, a fuel that is coming into wide use in both industry and the home. Here is a subject that proves most aptly the point which we made above. Natural gas has been known for centuries, but only recently has it started to climb to a real position of importance in affairs of the world. And science is the factor that has provided the basis for this climb, by making transportation of the gas commercially practicable.

Waste, the bug-a-boo of many industries and businesses, is rapidly succumbing to the advance of research. Many manufacturing plants are finding that waste material which was formerly going up in smoke or down to the city sewer can be reclaimed and turned to profit. Science and industry again. Several phases of this work are described on pages 378 and 379.

The business of making motion pictures grew from infancy to a flourishing adolescence within the space of a generation. Then came a period of partial stagnation. For years, inventors had been working on methods to give a voice to the silent pictures, and at a critical point in that period of stagnation, synchronous recording of pictures and sound stepped from the laboratory and revived the entire movie industry. Today the talkie has largely replaced the silent motion picture, but it still has its defects. These are dealt with, and suggestions for improvements made, on another page.

As these pages go to press, we are starting to work on some of the articles which will appear in the December issue. Prominent among them will be one on another phase of Scientific Criminology, by Stanley F. Gorman of the New York Police College, whose first article on this subject, in the October number, aroused so much favorable comment. In the coming dissertation, Mr. Gorman conducts the reader through the ramifications of a murder inquiry, and clears up many erroneous impressions that the public has regarding police routine.

"Blind" flying may seem to be in the class of useless "stunt" flying until the layman realizes that the underlying purpose of instruction in this work is really to prepare the pilot to meet adverse conditions of visibility that are likely to be encountered at any time, even during short pleasure flights. The development of highly accurate instruments which tell the pilot all he needs to know, without the necessity of actually seeing the ground, has made possible rapid strides in safety in flight. "Blind" flying will be dealt with in a comprehensive manner in an article now ready for release.

If you are a manufacturer or inventor, you will not want to miss the descriptive article on a testing laboratory where the characteristics of anything from pins to refrigerators can be determined accurately for you. And if you are a consumer, you will be glad to see how your interests are protected in many cases by the exhaustive tests made in this modern "fault finding factory."

These are just a few of the high-lights that catch out attention as we go over the December schedule. Space is reserved for timely articles—spot news—that come up as the constantly changing panorama of progress unfolds. We also have ready for use articles on the new Raman effect in physics, crude oil, "What is a Quantum?" by Paul R. Heyl, the Mayas of British Honduras, X-ray "fingers" that reveal atomic structures, feeding the crew of a battleship, and other equally absorbing subjects.

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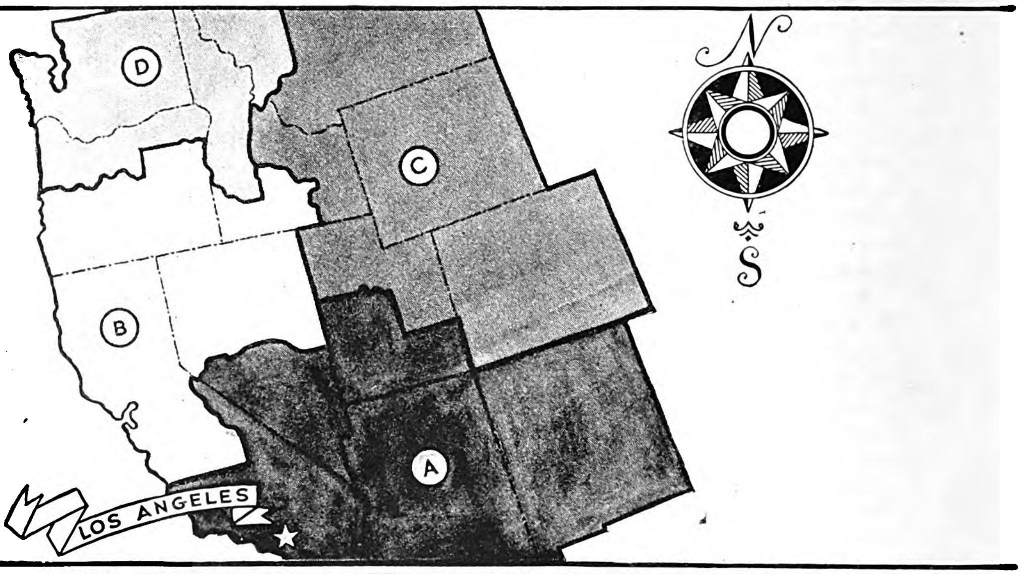
Western Market

12 Million People



— served most economically from Los Angeles County

There is a distinct freight advantage in serving the Western Market of 12,000,000 population from Los Angeles County... its largest metropolitan center.

Zone A —Population 3,982,582... Local market immediately tributary to and including Los Angeles County.

Zone B —Population 3,002,753... Local market.

Zone C —Population 2,239,483... Parity in freight rates enjoyed by Los Angeles County.

Zone D —Population 2,598,129... Served from Los Angeles Harbor by regular steamship transportation, at low freight rates.

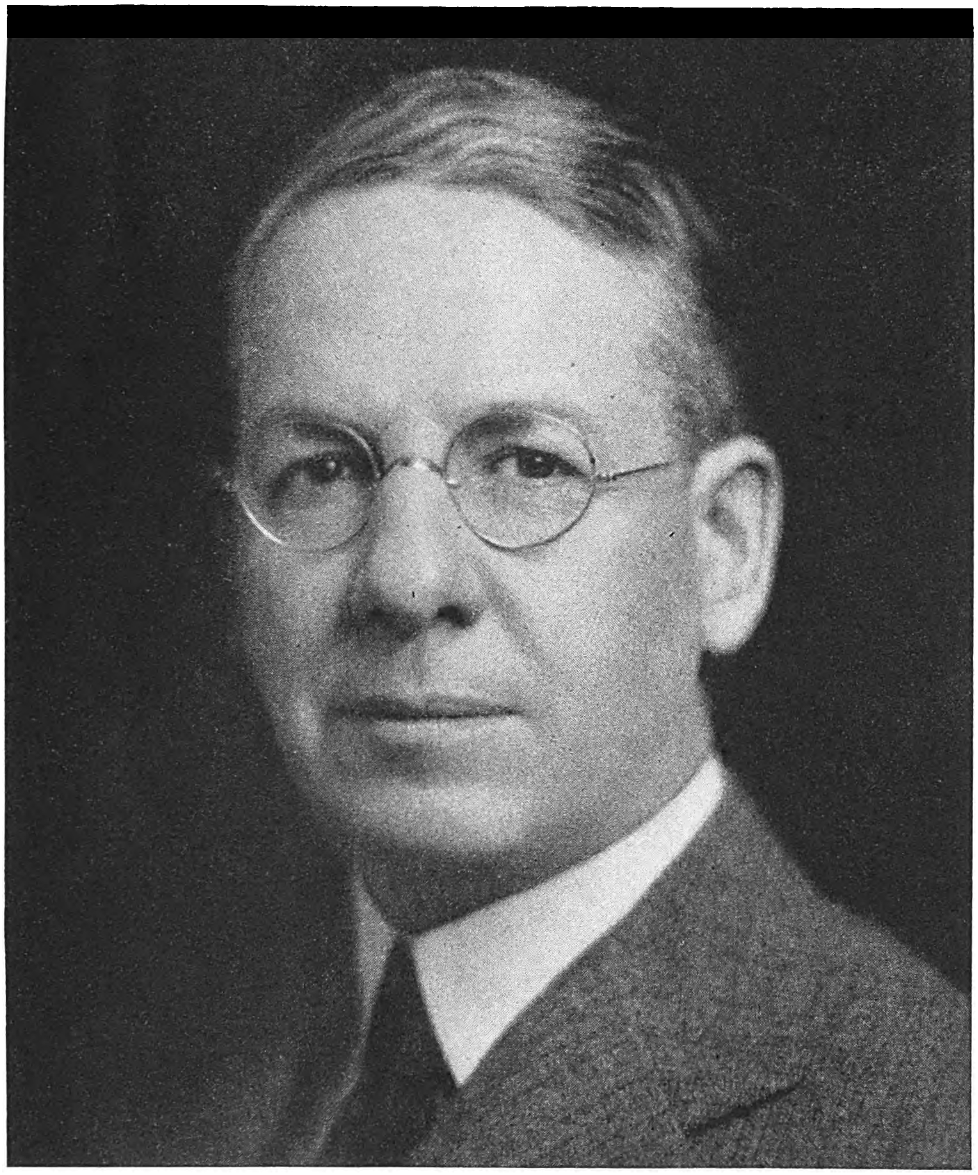
Truck haul delivery is made direct by manufacturers in Los Angeles County to three-fourths of the 4,000,000 people in Zone A... at a freight rate advantage so large as to more than offset slight rate differentials via water route to Zone D.

It will be obvious to the manufacturer who wishes to serve the entire Western Market that he can do so at a great saving by locating his plant in Los Angeles County.

Industrial LOS ANGELES COUNTY

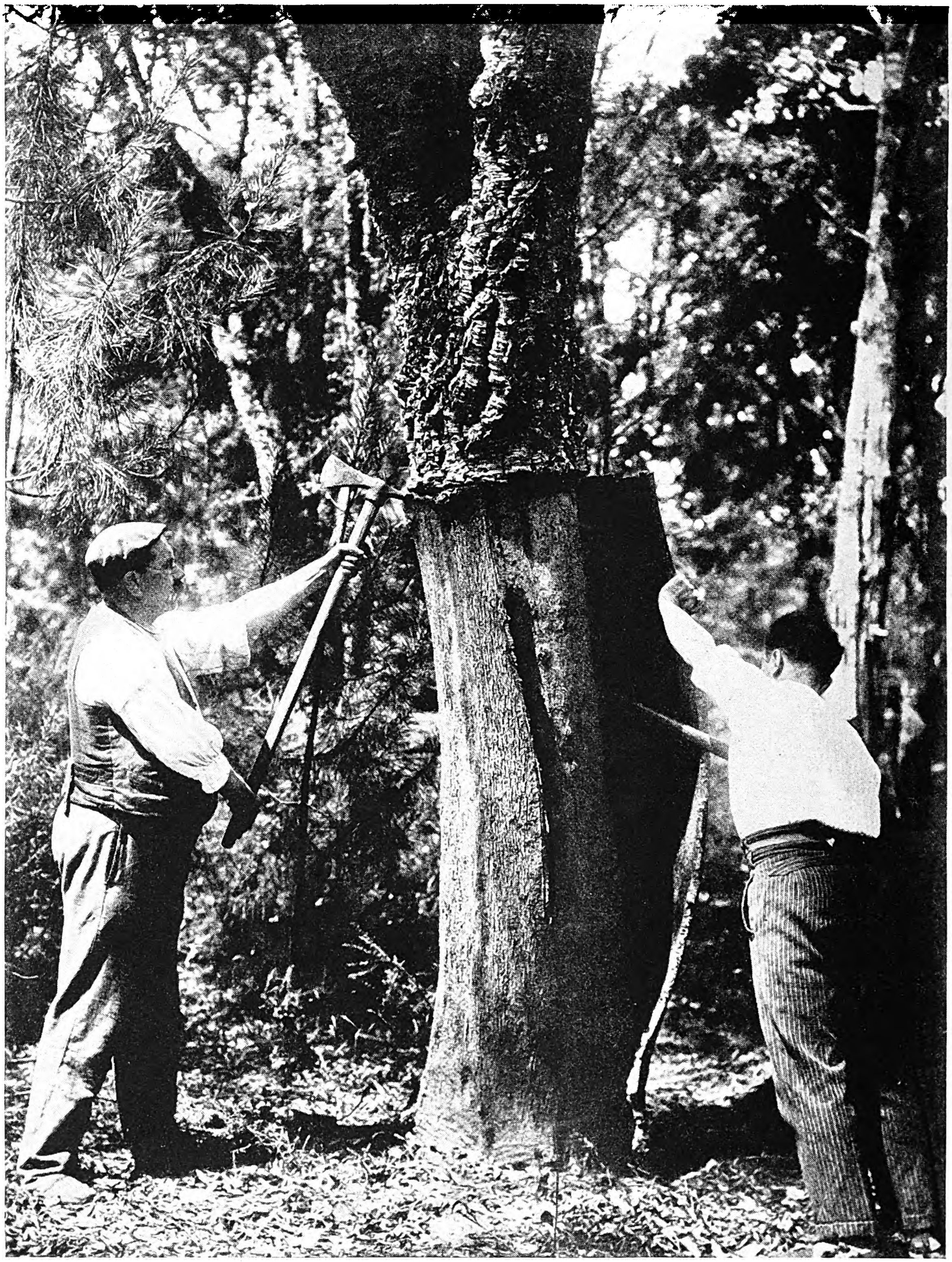
POPULATION 2,199,657

Manufacturing Executives Are Invited to Write to the Industrial Department, Los Angeles Chamber of Commerce, for Detailed Information Regarding this Great Western Market



ANDREW WELLS ROBERTSON

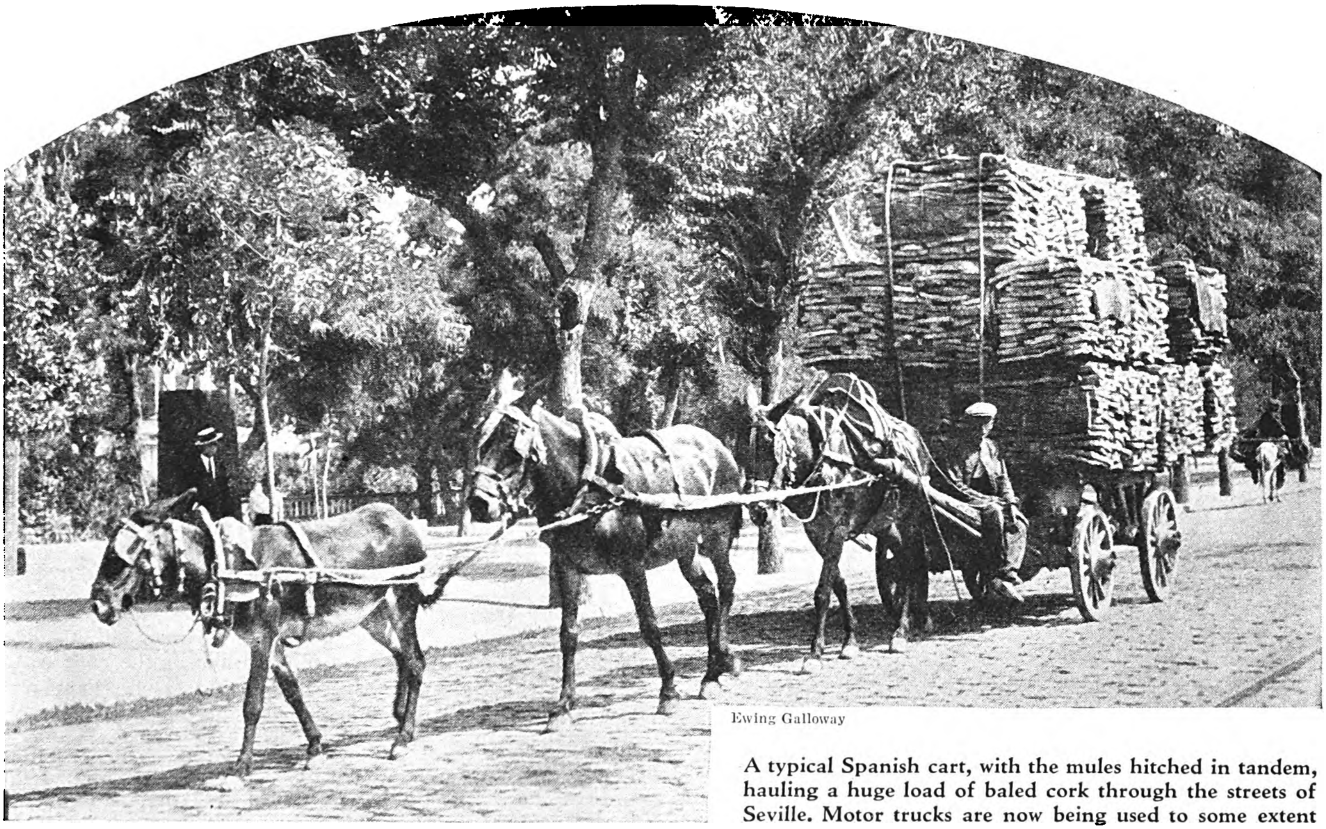
A HIGH SCHOOL principal whose vision saw beyond the confines of school walls and whose understanding of men, fairness, and canny Scot's industriousness have carried him to the high position of Chairman of the Board of the Westinghouse Electric and Manufacturing Company—that, in brief, is the biography of Mr. Robertson. Like many other leaders in American industry, Mr. Robertson's family background is modest. His father, a native of Scotland residing in Panama, New York, was a stonemason by trade. He died when young Andrew was but three years of age but this did not prevent Andrew from getting an education. He was graduated from Allegheny College in 1906 and was principal of a high school for a time. He studied law while conducting a private school for boys and was graduated from the University of Pittsburgh in 1910 with the degree of LL.B. Admitted to the bar, he joined a Pittsburgh law firm, practiced privately for a time, and later became trust officer for a large Pittsburgh firm and attorney for another. By 1918, he had become general attorney for the Philadelphia Company, was made vice-president in 1923, and president in 1926. In 1929, he attained his present position with the Westinghouse company. He is a trustee of his two alma maters, a director of many large corporations and associations, and a member of New York and Pittsburgh clubs. Being an able speaker, he is much in demand on public occasions but has never been attracted to politics—he has been too busy for that.



Ewing Galloway

THE CORK OAK GIVES UP ITS VALUABLE OUTER BARK

THE cork tree is stripped, always during the summer, at intervals of about eight or nine years. After the stripping, the tender inner bark is, of course, exposed for some time until a new layer of cork begins to form. For this reason, the stripping is never done when a sirocco is raging, for the heat of the wind would cause undue drying. In the illustration, an expert cork harvester is shown cutting the bark at the legal height—this must be done very carefully so that no injury is suffered by the inner bark—and his helper is prying off the bark with the handle of his axe. In some localities, the larger limbs are also stripped, but this is not the general rule.



Ewing Galloway

A typical Spanish cart, with the mules hitched in tandem, hauling a huge load of baled cork through the streets of Seville. Motor trucks are now being used to some extent

THE TREE BARK OF A HUNDRED USES

By BURTON DAVIS

WHEN the dry sirocco sweeps up off the Mediterranean and blows its hot breath on the Latin lands that border it to the north, there is one tree that remains gayly green. When the simoons twist north from the parched sands of the Sahara and whirl across Algeria, Tunis, and Morocco, one evergreen oak flourishes. That tree is protected by nature with a thick layer of the finest natural insulation in the world: you know it as cork.

All woody plants have a coating of cork, but this one sort of oak has more than any other. Certain elms and birches elsewhere in the world have outer bark that resembles it, but theirs is comparatively useless to man. The outer bark of *Quercus suber* and its almost identical cousin, *Quercus occidentalis*, known as the cork oaks, is in many ways unique in nature and invaluable in human industry. Nothing natural nor artificial has yet been produced to compare with it, for the *Quercus* bark has seven properties: resistance to the passage of moisture and liquids, buoyancy and light weight, resilience and compressibility, ability to absorb sound and vibration, strong resistance to progressive deterioration, low conductivity of heat, and an uncommonly high coefficient of friction.

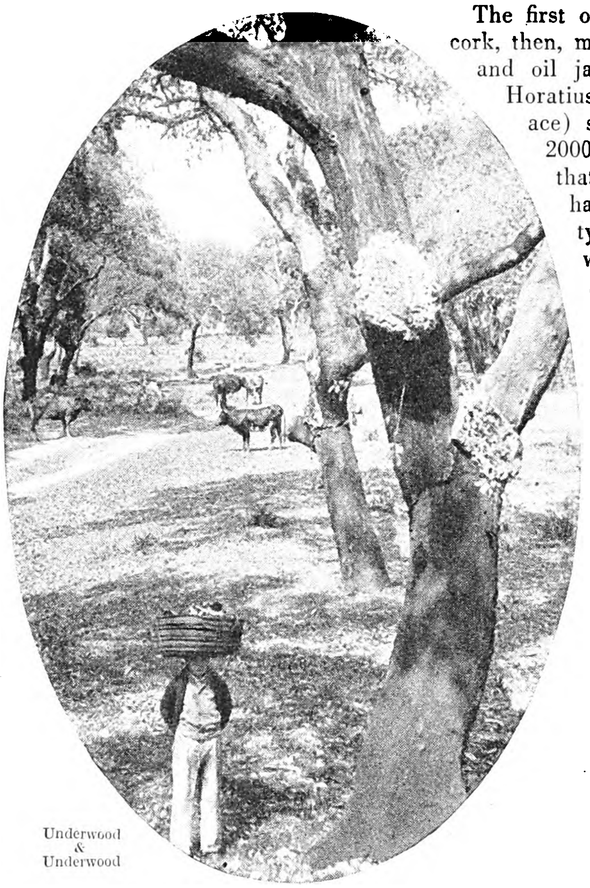
Through at least 2300 years, these properties have successively been discovered and utilized by man. Yet, although cork now has more than 150 distinct uses in the complicated apparatus of civilization, little is known about the physiological, physical, and chemical properties of the odd material.

ALL the literature on the subject of cork, including reports of previous research, could be carried in a small brief case. The men who have handled cork throughout the ages never bothered to find out much about it. A dozen chemists and botanists had worked on the problem of explaining how it grew and of what it was made up, but from 1787 to about 1927, had chiefly developed theories that were later discarded.

There was no accurate information on the number of cork trees in the world and how much cork bark they could supply. Man was using a natural resource and might reach the limit of its supply. Reforestation of cork oak had been largely left to nature and rare private enterprise. Culture of the cork oak was not fully understood. All this had to be studied so that provisions could be made against the future.

And that was what the American cork manufacturers set out to do less than a year ago. Since then another factor has loomed up. Apparently we are about to enter another ice age, this time in food distribution, for huge plants are being built for the quick freezing of meats, fish, vegetables, and fruits to be retailed in packaged form, hard frozen, and kept at sub-zero temperatures. Such low temperatures in freezing plants, refrigerator cars and trucks, storage cases, and household iceboxes will demand cork-board in huge quantities.

Cork, therefore, has rather suddenly become an object of keen industrial interest. The factories called in the research doctors and set them to work to find out how cork is put together, of what substances, and, in exhaustive detail, what its physical and chemical properties and peculiarities are beyond the known and obvious ones. Cork was such a mystery that there was no predicting what they might uncover. To develop a satisfactory substitute for cork is one of the things the scientists hope to do, although at present that


Underwood & Underwood

Cork oaks partially stripped of their valuable bark in a scattered grove at Almorasma, Spain

seems to be a hopeless, impossible task.

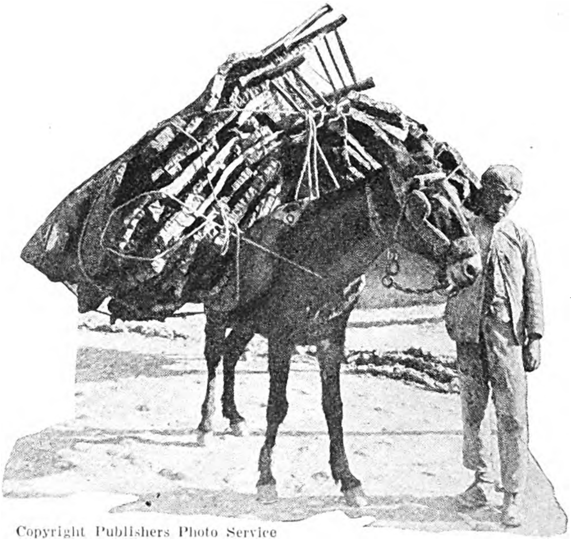
In the research and testing laboratories of a large cork company at Lancaster, Pennsylvania, only lately a photomicrographer took the first picture of the individual cork cell. The research, by scientists attached to the company, that led up to the taking of this picture—as well as the picture itself which is reproduced on page 347—showed that the cell has the geometric form known as tetrakaidecahedral.

This difficult word is from the Greek and means "having 14 faces." Lord Kelvin, years ago, found that units of 14 faces solved the problem of dividing all space, without interstices, into uniform bodies of minimal surface. In 1928, Dr. Frederic T. Lewis, of the Harvard Medical School, conducting independent research into cell structure, demonstrated that cork cells are tetrakaidecahedrons, each making contact with an average of 14 others.

EVEN though there are minute interstices between cork cells, these are filled with resin that is impervious to water and most liquids. Obviously a substance, the cells of which fit so snugly, is going to baffle the passage of any fluid which is unable to eat its way through. Thus the word for cork is the word for stopper, also, in most languages—a "stopper" is a "cork."

The first of the seven properties of cork, then, made the stopping of wine and oil jars one of its first uses. Horatius Quintus Flaccus (Horace) spoke of that in Ode III, 2000 years ago. Earlier than that, doubtless, the ancients had used the second property: buoyancy and light weight. Pausanias (not the Spartan admiral, but the traveler and geographer of the 2nd Century, A.D.) recorded that cork bark was used for anchor boards and on fish nets. Since each cork cell is more than half filled with air, the mass is buoyant. Its specific gravity is between .15 and .20, making it one of the lightest of solid substances.

The cell walls of cork are of tough, highly elastic material—much more so even than rubber—hence its resilience and compressibility. At Lancaster a one-inch cube of natural cork was recently put under pressure of 14,000 pounds to the square inch. The sidewise spread under that load was only a quarter of an inch. Released, the cork in a few hours regained between 90 and 95 percent of its original height, while the horizontal edges of the cube returned to exactly one inch. The secret of cork's unique behavior appears to be that only the air in the cells is compressed, hence the lack of side spread and the unequalled regain. Corks jammed in champagne bottles for 10 years will regain three-quarters of their original volume shortly after being withdrawn from the bottle.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Sure-footed burros, top-heavy with huge loads, transport cork in the mountainous sections

Since dead air, in finely divided spaces, is, next to a vacuum, the best insulator known and the poorest conductor of sound and vibration, the fourth and sixth properties of cork are easily explained.

What will keep out heat will, in the popular phrase, "keep out cold"—which means it will keep heat *in.* Hence the use of cork-board insulation, which threatens to outstrip every other use of the cork in a few years, not only to insulate refrigeration units but also to insulate buildings against the winter's cold and the summer's heat. That last-mentioned use may have been the first to which cork bark was put, for the peasants all over the cork oak country still roof and wall their huts with slabs of the crude cork.

THE known chemical inertness—except to a few acids and strong alkalies—of the walls of the cork cell and the intervening resin explains cork's uncommon resistance to deterioration.

The fourth and seventh properties in the list have been the last to be utilized. Cork has only lately come into general use to absorb sound and act as a corrector of acoustics in echo-haunted halls and rooms. The first use in this respect was of cork tile as flooring for libraries and hospital halls. Now whole auditoriums are lined with a fine-grained cork-board. Radio broadcasting and sound film studios are using cork to exclude exterior noises, reduce interior sound and vibration, and break up echoes. Lastly, cork, long applied to reduce vibration and clatter in machinery of a hundred kinds, is now being used in slab form to insulate machines, from light fans to enormous engines and dynamos, against the transmission of vibration and noise.

The seventh property of cork—its high coefficient of friction—has been put to use only since the machine age came in. When cork bark is sliced cleanly, a surface is created exposing tens of thousands of hexagonal open cells to the square inch, each acting as a tiny vacuum cup. This, and the unusual resistance of the cell wall to frictional wear, gives cork the gripping and polishing properties now widely utilized. Plate glass mirrors and windows, fine glass and crystal, and optical lenses are polished on cork wheels. Leather and rubber both wear slick in short order, for their cell material has little of the toughness of cork's mysterious material, called "suber," which is neither cellulose nor wood fiber.

In the Lancaster testing rooms, one-inch squares of cork, belting leather, and rubber, all designed for the same use, were equally weighted and placed on an inclined plane. When the plane was inclined 18 degrees from the horizontal the leather slid down. At 28 degrees the rubber went coasting. Not until the plane was slanting 42 degrees did the cork creep down.

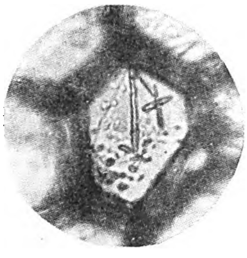
THE temptation in discussing the seven properties of cork is to wander off into fascinating bypaths to tell of the applications of cork that derive from these seven traits. They range from the tiny pieces in the pincers of pince-nez eyeglasses to the acres of cork-board, up to 12 inches in built-up thickness, in the walls of the quick-freezing meat packing plant of 1930; from the cork-lined cap of the tooth-paste tube to the newest and most uncommon use of cork in a planetarium. The first of these in America, recently completed in Grant Park, Chicago, has 9450 square feet of cork-board insulation on the dome.

The story of how and where cork grows, how it is gathered, prepared, transported, manufactured, and used, can only be sketched, for a full description of these fascinating phases would overflow this issue.

With a cork oak acreage of 550,000, Portugal leads the world with a production of 80,000 metric tons of cork; Spain is second with a production of 75,000 metric tons from 637,500 acres; Algeria is third with a production of 27,000 metric tons; while France, Tunisia, Italy, and Morocco come next in order; and even Japan produces about 400 tons of inferior cork yearly.

When part of a grove of cork trees has attained an age of about 20 years—for the first cutting—the expert cutters, each helped by apprentices, start to work. The expert makes a careful cut, with a tomahawk-shaped hatchet, around the trunk just above the exposed roots—in Algeria he may use a circular saw—and another just under the lowermost branches. These he connects with two vertical cuts, following the biggest natural cracks. The assistants help him pry off the bark. All this is done with the finesse of a surgeon, for any injury to the inner bark, or *phellogen,* which builds up the cork, results in a scar area over which no new cork will ever grow. This first cutting of bark, called "virgin" in Spain and "male cork" in France, will sell for a low price, to be used in the rough for florists' baskets, arbors, ferneries, and to be ground into low-grade granulated cork.

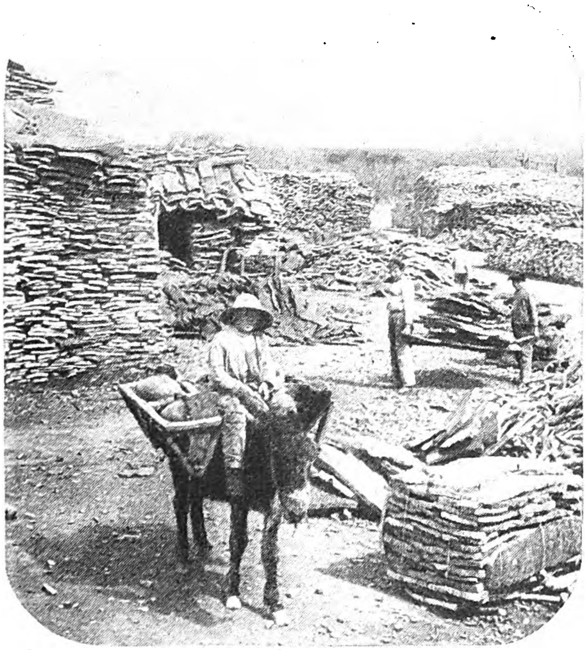
Nine or ten years later, the cutters will be back in that same grove, removing the new growth of cork, of finer grain and in every way more valuable. In some places they will also strip the bigger parts of the chief branches; in others, restrained by law or local regulation, they will wait for about five years, strip the large branches, and four years later denude the trunk again. In the French government forests—about half of those in Algeria and Tunisia—stripping the branches is prohibited. In some private forests of Spain the cutters may go back after eight years. In Portugal the law demands a wait of nine years, and the first crop cannot be removed until the tree is 15½ inches around, three feet above ground. Each crop after the first is progressively better until the tree is about 40 years old. Thereafter it may be expected to continue to produce fine cork until it dies, at from 100 to 150 years.



Right: **Photomicrograph of the cork cell. Six cells are shown touching the central one at the point of cleavage**

Underwood & Underwood

After the cork has been cured and dried flat, it is trimmed and packed in bales for shipment



Copyright Underwood & Underwood

Great stacks of the cork as it comes from the trees. In foreground, a bale ready to be shipped

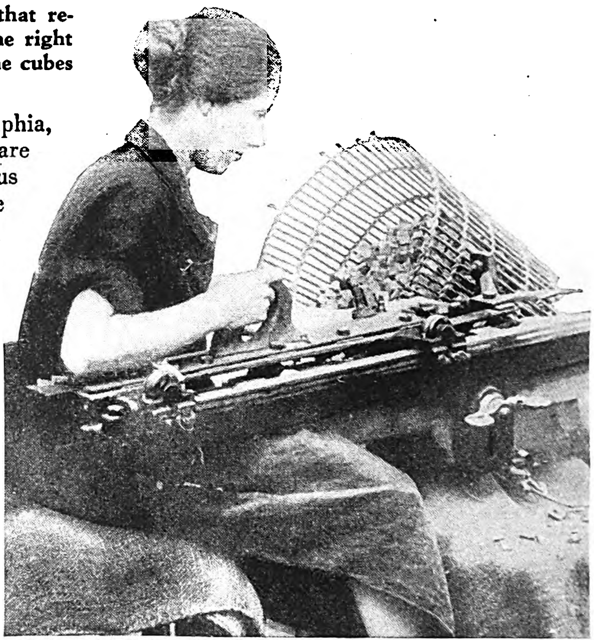
Virgin cork is bought with no particular care, on a weight basis. But from the second stripping on, the value of the cork makes buying a careful balance between buyer's and seller's ideas of its worth. The cork buyer is an important personage, for on his judgment profits are made or lost. He migrates with the cork cutting season, penetrates all manner of country and deals with all manner of cork grove owners, cutting contractors, and government officials.

Arrived at a certain stand of cork, in advance of the cutting season—April to June in North Africa, July and August in Europe—the buyer sends his sampler through the grove on a beeline. With a cylindrical punch, the sampler cuts out a disk of cork from every 5th, 10th, or 20th tree and jumbles these in the huge sack on his back. At the buyer's office these are scrutinized with care, for on the average of them the buyer will base his bidding for so many tons of cork, perhaps for the stripping from a whole mountainside. In the French government forests of north Africa, however, the cork is gathered at stations to be sold at auctions.

To return to the typical scene, say in Spain or Portugal: The stripped cork bark is piled up in the grove and left a few days to dry. Then it is weighed on a "romana," a type of yard scale introduced by the Romans 2000 years ago.

Ewing Galloway

The cork industry in southern France is the same as it is across the border in Spain. Above is shown a girl operating a cork cutting machine that reduces strips into cubes which are later cut into bottle stoppers. At the right a girl is operating by hand a machine that cuts the stoppers from the cubes



Underwood & Underwood

(Cork harvesting methods have changed little in 20 centuries.) The bark is carried on burro back or in carts to the boiling station at the edge of the forest nearest the market or the railroad line.

Boiling the curved slabs in large vats fired with dead corkwood softens the bark so that the rough, creviced, outer layer can be scraped off by hand with a flat tool. This process removes about 15 percent of the weight of the slab, removes the tannic acid from the cork, increases the volume and elasticity, and makes it possible to dry the slab flat. After being roughly sorted for quality and thickness, the dried bark is loaded on sturdy burros, which pick their way carefully down the mountain trails to the railway station, topheavy with a huge pile of the light bark aboard, bigger than the animal himself. As roads in Spain and Portugal are improved, motor trucks are replacing the picturesque burro.

ARRIVED at the warehouse and manufacturing center the crude bundles are opened and the rough edges trimmed off the slabs. Another grading for quality takes place, dividing the cork into about 25 classes. The bark for export is baled in a hand or a hydraulic press, bound tightly with iron straps, and stenciled. The bale is then ready to be loaded into the hold or on the deck of a steamer. Philadelphia, New York, or Baltimore will be the destination of nearly all of the exported crop; the rest will have gone to the stopper cutting shops nearby, the trimmings and "waste" from which will also be baled for export to the cork composition or linoleum factories overseas.

One manufacturing company has its own receiving plant at Gloucester, New Jersey, just below Philadelphia, where the various grades are separated and sent to various plants. At Pittsburgh, where the finer grades are made into bottle stoppers and other natural cork products, the final sorting puts the bark into as many as 80 bins, the grades differing so little that only the expert can detect the difference.

At this point the story of cork divides into four stems: the business of making bottle stoppers and natural cork products; the distinct processes used to make cork composition products out of scrap and grinding grades; the process carried on elsewhere which turns out cork-board for insulation, machinery isolation, and corkoustic; and the complex business of making linoleum, linotile, and other flooring material.

The key to this maze is the utilization of waste. Automatic machines punch bottle stoppers out of the best of the bark. The punched-out strips are ground into flour for linoleum or granulated for making cork composition. The coarser cork is ground into larger granules to be pressed, at high temperature, into cork-board slabs, the natural resin forming the only binder used.

Natural cork is used for pistons for plunger fountain pens and for wind musical instruments; seine and gill corks for fishing nets, and bung corks and artillery practice wads. From natural cork are also made disks for bottle crowns and patent caps, bulletin boards, penholder grips, cork balls for games, plasterers' floats, and many other products.

CORK composition is used for box toes, counters, insoles, heel lifts and pads, and bottom filler in shoes; also, in all manner of gaskets to stop leakage of gasoline, oil, or water; in churn strips, bobbers or floats for fishing lines, and so on.

In the automobile, cork and cork composition may be used in as many as 50 places, most of them unsuspected by the owner.

Linoleum is made from cork flour, as described in the October issue of SCIENTIFIC AMERICAN. Linotile, a tile of linoleum composition, is laid in special patterns by hand and produces marble and tile effects. Cork brick, non-skid, almost impervious and resistant to acids, is used in dairy barns and modern pigsties for better sanitation.

Cork carpet, made of coarser cork, is used particularly in public buildings where sound deadening is important.

Granulated and regranulated cork is used for packing fine china and glass, grapes, and other fruits. Despite modern industrial advances, cork holds its own as one of the most useful of natural substances, although it is still one of the most mysterious after 2300 years of use; in fact, it is playing an increasingly larger rôle in the drama of industrial progress.

OUR POINT OF VIEW

ACROSS THE ATLANTIC

NO transatlantic flight or attempt to make an airplane crossing of this stormy ocean since the unsurpassed flight of Colonel Lindbergh, in May, 1927, has so fired the imagination of the world as the three successful westward flights this summer. A Briton and a German made the first two flights, each with one or more stops, and the climax came when a Frenchman, already famous and a hero among his people, made a non-stop flight from Paris to New York in a plane that was also already famous for its share in his exploits.

In June, Wing-Commander Charles Kingsford-Smith, with E. Van Dyk, Captain J. Patrick Saul, and J. W. Stannage, flew from Ireland to Roosevelt Field, Long Island, in the *Southern Cross*, making one stop in Newfoundland. His flight marked the completion of a spectacular 'round-the-world air trip which had started over a year previously. In August, Captain Wolfgang von Gronau, with Edward Zimmer, Franz Hack, and Fritz Albrecht, made an unheralded flight from Germany to New York Harbor, with stops at the Faroe Islands, Iceland, Greenland, and Nova Scotia. His flight was praiseworthy for two reasons: first, because in this day of blatant exploitation of air feats, his was a surprise trip, few knew anything of it until it was over, and, so far as we know, he has not commercialized it; and secondly, because his route may prove the most feasible when transatlantic airplane services are inaugurated.

When Dieudonné Coste and his copilot, Maurice Bellonte, landed the red *Question Mark* at Curtiss Field on September 2, the final chapter in the long and tragic story of the conquering of the stormy north Atlantic by airplane was written. They had taken off from Paris 37 hours 18½ minutes previously. To these two daring fliers go, therefore, the laurels for the first non-stop crossing of the north Atlantic by airplane from the continent of Europe to the United States. They have accomplished what many others before them had tried and what they had unsuccessfully attempted in 1929.

Aviation owes much to these pioneers of 1930. When and if airplane service is started across the Atlantic to and from the United States, the lessons learned by their flights will have much influence in the choice of routes, modes of operation, and so forth. But we consider that the pioneering has now been completed except in cases where totally different types of planes—such as the Dornier *DO-X*—may be involved, and will frown upon any further individual attempts to conquer the Atlantic. Such transatlantic flights will seem to us to have the taint of commercialism or to be inspired by individual desire to exalt an already inflated ego.

GAS FROM THE EARTH

ON page 380 of this issue we publish the story of the amazing growth of an industry about which little is known: that which has been and is being built up around natural gas. Possessing about twice the heating value of artificial, or manufactured gas, this natural mixture from the earth's reservoirs has been used commercially for over 60 years but has only recently become an industry of huge proportions because of recent technical developments that have shown the way to discovery of large natural gas reserves and have made possible long distance pipe-lines.

During the current year, the natural gas industry has expanded at a greater rate than perhaps any other industry of importance—and that despite world-wide business depression. Its increase in pipe-line mileage from 80,000 to 90,000—including pipe-lines put into operation and also those on which construction has been started—represents an increased capacity of more than 12½ percent. *The Lamport Review* estimates that this 10,000-mile increase adds "at least 250 million dollars to capital investment" in the industry.

Truly this is the bright spot on the business horizon. It puts to shame many other industries that have not progressed this year—yes, despite the depression—and teaches a lesson of research and development, far-sighted belief in the future and rapid expansion. The confidence of the men behind it is worthy of the highest praise.

FUTURE AIRSHIPS

SHORTLY after the successful flight of the *R-100* from Cardington, England, to Montreal, Sir Dennistoun Burney, its designer, outlined a new proposal to establish a transatlantic airship service in which he attempted to prove that a company possessing four or six new ships twice the size of the *R-100* could operate with profit.

Such proposals are not new, but the fact that this one takes such definite form indicates that the time when a transatlantic airship service of some kind will be a commonplace thing draws rapidly nearer. In the face of this fact, American vision apparently does not see as far ahead as does Sir Dennistoun. We have under construction two airships that will be far larger than any heretofore built but beyond construction of these two we have no plans for the future—unless they be deep, dark secrets. And even for each of these two dirigibles, we are importing eight Maybach engines from Germany. This may have no very great significance but to us it is indicative of the passive interest of American engine manufacturers in the development of American airship engines.

One of the many criticisms of the dirigible is that it is bulky. True, but *The Engineer* (London) points out that its weight per passenger is only 1.56 tons as contrasted to nearly 24 tons per passenger of the liner *Mauretania*. Fuel consumption is not considered excessive; and transatlantic passenger and mail rates little in excess of steamer rates are to be expected.

But aside from all such arguments, the airship is with us and we believe it will stay, although no one can predict its ultimate status. Why, then, American apathy toward developing it to the fullest extent? Much experimental work is yet to be done but we should like, particularly, to see some intensive research done toward developing an American airship engine.

INTERNATIONAL AFFAIRS

Navy Day

OCTOBER 27TH, Theodore Roosevelt's birthday, is Navy Day, and at every Navy Yard and on every man-of-war the Navy personnel will be at home to the American people. All who can should take the opportunity to visit the nearest ship or station, to show their interest in the officers and men who are our first line of defense.

In time of war we lavish praise on our Navy; in time of peace we are too likely to forget it. We take the efficiency

(Please turn to page 409)

RADIO CHARTS THE UPPER AIR*

By JEROME D. VAN BRAKLE

SIGNAL CORPS engineers of the United States Army have devised a means by which radio can be used to determine air conditions several miles above the surface of the earth, and after more than seven years of experimentation they have perfected, at the Signal School laboratories at Fort Monmouth, New Jersey, equipment by which the direction and velocity of the winds at high altitudes may be computed with a high degree of accuracy regardless of visibility.

Visual observations of upper-wind conditions are impossible at night and when visibility is reduced by low-lying clouds or fog. Since many war operations are carried on behind smoke screens or after dark, it became necessary to devise a method of obtaining the desired upper-air information under these conditions for Army use. The radio method was the answer to the problem.

THE radio device, perfected at Fort Monmouth, consists of a miniature continuous-wave transmitter which is sent aloft by means of three hydrogen-filled balloons. Its flight is followed with a loop direction finder, a process known as "tracking" or making a "balloon sounding." Long research was necessary before an efficient direction finder was perfected, as it was found that the commercial instruments used in radio compass work were not sufficiently accurate for meteorological use.

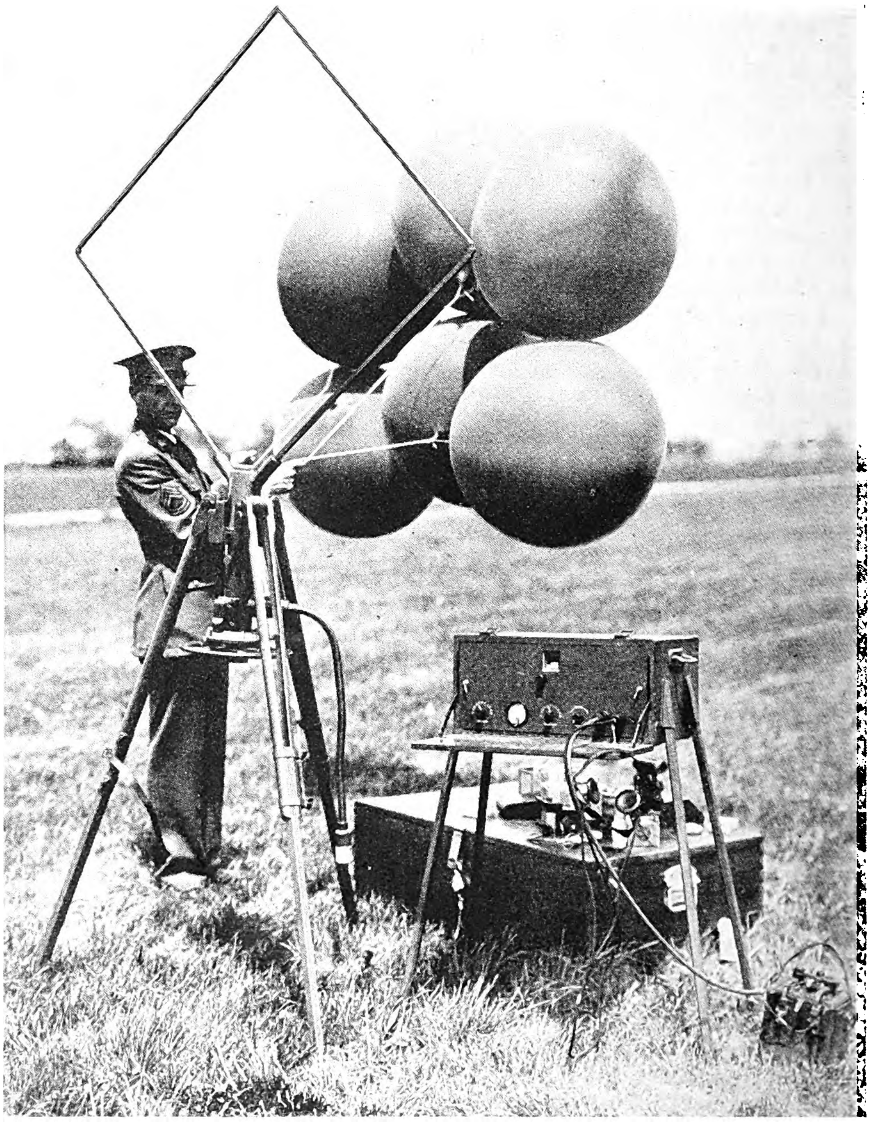
The loop direction finder consists of a specially-built radio receiver of rugged construction connected to a loop antenna composed of a single tube of copper, mounted on a tripod base. To the shaft of the loop is connected a calibrated dial, graduated in degrees and fractions. This dial is used to measure the angles through which the loop turns. Except for the fact that the receiver is of the regenerative type, Signal Corps authorities refuse to divulge the details of its construction.

The transmitter which goes aloft with the balloons is compact and sturdy and weighs less than a pound. It consists of a small vacuum tube, an inductance coil of enameled wire, a small transformer, and a small flashlight battery, the whole outfit costing about five dollars. When the battery is snapped into place at the bottom of the device, continuous-wave oscillations are started which will continue for more than two hours. This wave has been picked up from a distance of 15 miles.

The length of wire which connects the transmitter to the balloon cluster acts as an antenna. Signals are sent at a constant frequency of 2300 kilocycles or 130.5 meters.

When the balloon cluster, carrying the transmitter, is liberated it ascends vertically, because of the hydrogen gas, but at the same time it is blown about by the winds it encounters. This lateral motion is recorded by observers and from the data obtained, the speed and direction of these winds may be accurately determined.

It has been found that the cluster will rise at the rate of approximately two hundred yards a minute and that this rate of ascension will continue until the internal pressure of the hydrogen gas exceeds the outer pressure of the rarefied atmosphere and one or more of the balloons burst. Usually only one bursts and then the others act as a



Signal Corps photographs

The direction finder receiving set and the balloons for carrying the radio transmitter, used in the newly developed method of determining upper air currents

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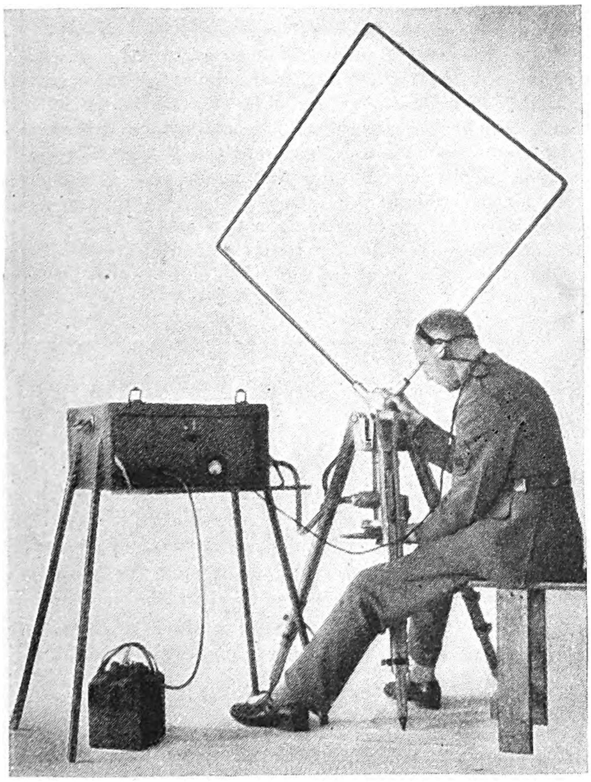
*Published by permission of Major General George S. Gibbs, Chief Signal Officer, United States Army.

parachute and gently lower the apparatus to earth with little damage.

While the balloons are in flight, observations are taken by two direction finders set up on a base line of known length. Experiments have shown that this length should be three miles for the best results, although shorter distances have been used with a high degree of accuracy. Sometimes three instruments are used; then they are set up in the form of an equilateral triangle of known sides. The third instrument, however, is used principally as a check on the others.

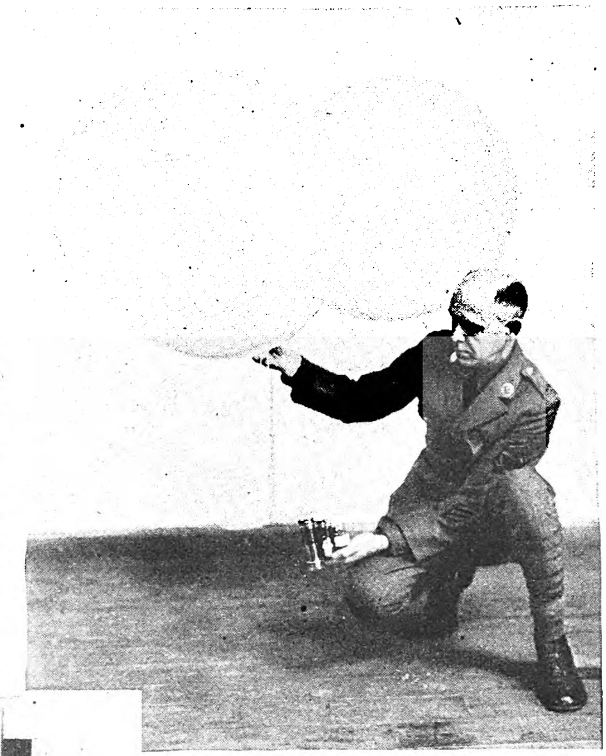
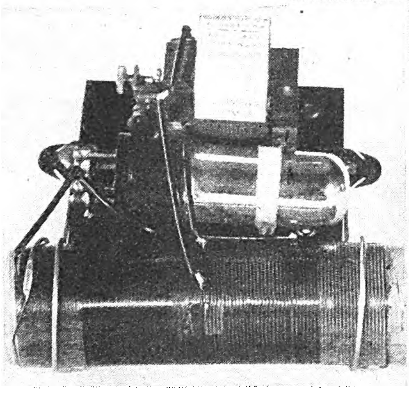
AFTER the release of the balloons, operators obtain bearings on them every minute. Accurate time is given by a clockwork device which emits a howl at the end of each minute and a warning buzz ten seconds before the minute. The bearings are telephoned to an observer at a plotting board where they are entered on a scale map. The point of intersection of each set of two bearings shows the exact position of the transmitter at any minute. From these data it is simple to determine the horizontal flight of the apparatus and by means of a special protractor and a wind scale, the required velocity and direction of the wind at each level of altitude is computed. Balloons may thus be tracked for several miles.

The observers at the loops base their calculations upon the zero point, where the signals from the transmitter are not heard. The loop is revolved until the signals disappear and the angle is read from the scale on the shaft of the loop.


The direction-finder loop in use. The operator swings the frame, listens to the signals, and reads the angle

At the zero point, the plane of the antenna is at right angles to the direction of the transmitter. One of the points of high efficiency of the Army receiver is that the zero point does not vary until the transmitter is more than three miles from the receiver, then the variation is so small that accurate results may be obtained for seven miles and usable results for several miles further. Experiments have shown that the zero point in commercial sets splits before the transmitter is a mile away, greatly lowering the efficiency.

While the new system was undergoing preliminary tests at Fort Monmouth, simultaneous readings were made by radio and visual methods. These experiments showed that the radio method gives more accurate results as the continuous signal can be more easily traced. The visual method is more commonly used, however, because of the greater distance possible and because of the economic phase.



Above: The one-pound short-wave transmitter attached to balloons. *Left:* A close-up of the transmitter. The battery is behind the instruments

In the Atlantic seaboard states, where the prevailing winds are easterly, most of the instruments sent aloft are lost in the ocean, but in the Middle West, 95 percent of the transmitters are recovered. To insure the return of as many of the transmitters as possible, a notice is attached to the set offering a small reward to the finder if the instrument is sent back to the base station.

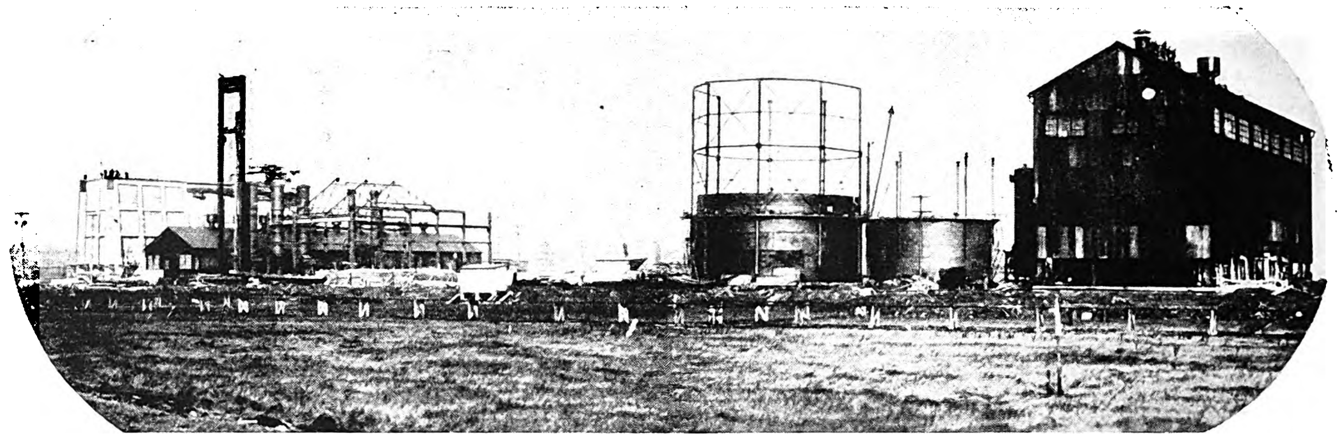
At Fort Monmouth, one day recently, a farmer drove up to the reservation in a dilapidated farm wagon. He walked up to the meteorological officer and handed him one of the transmitters which had fallen on his farm.

"You came mighty near not getting this contraption back," he declared. "When it came fluttering down in my cornfield I thought it was some new kind of bird and I almost wrecked it with my shotgun."

Although many of the instruments are returned in peace times, few recoveries would be expected in time of war. The cost of the apparatus in comparison with its utility and the value of the information it gives is so small that little thought would be given to the loss.

AT the present time, radio officers at Fort Monmouth Signal School are experimenting to find a method of determining upper-air temperatures by radio. A bi-metallic plate of variable capacity at different temperatures has been inserted in the circuit of the transmitter just described. It is designed so that the wavelength will vary as the air temperature increases or diminishes and these wavelength changes will be noted on the ground by means of suitable instruments.

Now that the common wind vane has been lifted high into the air by means of radio, it is the ultimate aim of these agents of Uncle Sam to use the radio device, with variations, to unfold many other secrets of the upper air currents.



Hydrogenation plant of the Standard Oil Company of New Jersey under construction at Bayway

A GALLON OF 'GAS' FROM A GALLON OF OIL

By HENRY W. HOUGH

"OIL DIPLOMACY" is the title of a long chapter in Ludwell Denny's arresting new book "America Conquers Britain" (Knopf), a remarkable record of economic war which is taking place today on a worldwide front in the form of bitter struggle between America and Britain for world markets in major commodities. The struggle takes its most violent form in oil. The most powerful world participants in the great contest are the vast Deterding interests (Shell) of Great Britain pitted against the Standard interests of America. The oil reserves of the smaller nations—Persia, Mexico, Colombia, Venezuela, and so on—are the rich fruits of battle. The accounts of some of the dealings between the rival giants make fascinating if somewhat grim reading; the international oil war is not a game of tiddleywinks. Ostensibly the oil war between America and Britain is conducted by private interests but Mr. Denny reveals that both governments have taken a hand. And why not? Oil is a national asset; without it no nation today can remain a first class power. Britain is not losing the oil war; we are. She has largely outwitted us, gaining control of the best resources. We are left holding the bag. "The public has been in no mood to champion the cause of any oil company at home or abroad," Mr. Denny writes, "but this sentiment is changing. The danger point will be reached when a near-shortage drives prices upward and American automobile owners are told the British have cornered most of the world supply." Britain is keeping much of her own oil supply intact and cleverly finding ways to exhaust ours. The Bergius processes, described in Mr. Hough's article, are German in origin and Standard has obtained them, but the cheapest oil at present comes from the ground. When the American people finally wake up about the oil situation will it be too late?—*The Editor.*

LAST season, or perhaps it was the preceding season, a thrilling drama was witnessed by theatergoers. It involved a young genius who had made a scientific discovery of startling significance. He proved that he possessed the power to blow the world to smithereens. His secret was known only to himself. Anxiety and apprehension resulted—until the closing scene of the play.

Another drama almost equally exciting although somewhat less sinister now is being enacted before a much larger audience. The opening scene was in a laboratory in Germany, and centered about the research of the noted investigator, Dr. Friedrich Bergius. The scientific world was amazed by the news concerning his hydrogenation process for converting wood into coal, coal into oil and gasoline, and so on.

NOW the scene has shifted to America. About a year ago the rights to Dr. Bergius' process were acquired by the Standard Oil Company of New Jersey, in affiliation with the I. G. Farbenindustrie or "Dye Trust" of Germany. With the news of this merger, which followed three years of co-operative examination of the technical and commercial possibilities of the process, there came another startling announcement: "It now is commercially practicable to produce 100 gallons of gasoline from the running of 100 gallons of crude oil, by the addition of gaseous hydrogen under high pressure and high temperature in the presence of certain catalytic agents."

These developments have aroused rather than allayed the fears of those who anxiously await the outcome. Will the next scene show chaos in the petroleum industry? With over-production of oil constantly worrying the producers, must they now face a flood of cheaper "artificial" gasoline?

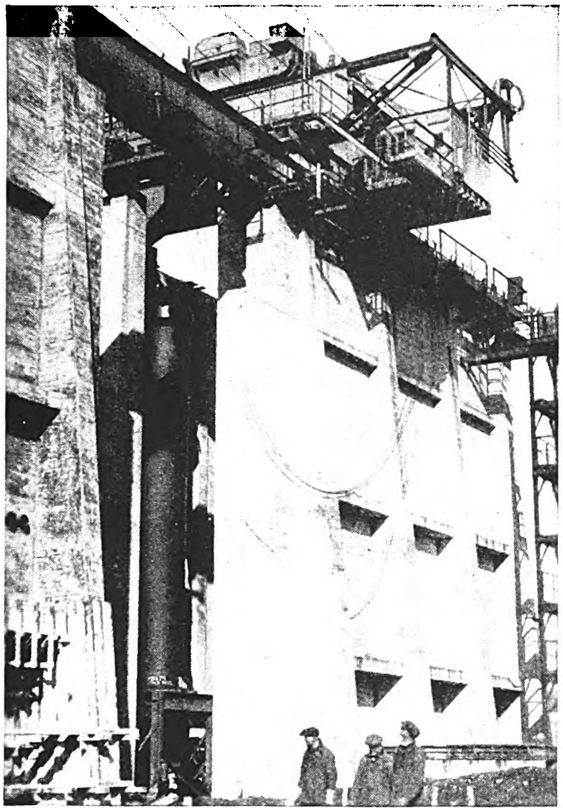
The petroleum industry has waited rather impatiently for further progress reports. The general public has exhibited similar interest, for today "the man in the street" is not only a consumer of gasoline and oil, but also is on the lookout for investments which seem to have great potentialities.

With the opening, a few months ago, of the first of three 5000-barrel-a-day hydrogenation plants, it seems that the Bergius process at last is ready to become an important factor in the petroleum industry The first commercial plant is located at Bayway, New Jersey. Two others are to be built soon, one in Louisiana at Baton Rouge and another in Texas at Baytown. These plants are more than experiments, for each is a large-scale commercial unit based on the results of several years of intensive research and development. No effort has been spared to perfect the conversion apparatus and the methods of operation best suited for commercial production of gasoline and light oils.

To the layman, who may have grown weary of hearing about over-production in the oil industry, it may seem that hydrogenation has been born too soon. Even in the face of solemn warnings that the world's supply of petroleum can last only a few more generations, there are many who feel that at present there is no place for any revolutionary method of producing motor fuels. However, the situation takes on a different aspect when one is familiar with the other great developments which have led up to the present state of affairs.

When the oil industry was very young, there was a well-distributed demand for all of the important products of petroleum. Then the market for illuminating oil stepped ahead of the others. While meeting the demand for kerosene, the refiners found that something had to be done about disposing of the rest of the products.

The solution was found in a new process, by "cracking" the heavier fractions of the crude oils in such a way that a larger proportion of kerosene was obtained. Crude oils which normally yielded 20 to 30 percent of kerosene were made to yield from 50 to 70 percent by this revolutionary step.



The retorts (inside the concrete structure) in which the hydrogenation takes place at Bayway

SOME time later, the situation took a new turn. Gasoline became the most valuable fraction, and the demand for kerosene declined. Again something had to be done about utilizing the less valuable products, and again the solution was found in improving the process. It proved to be considerably more difficult to increase the gasoline yield, but the result was nearly as good as when effecting the decomposition into kerosene fractions. At the present time about one third of the world's total demand for gasoline is met by "cracking" or conversion, rather than by refining.

With this background, it is easy to see where hydrogenation fits into the picture. With the ever-growing demand for gasoline and light oils, there has been constant over-production of the less valuable products, the heavy oils. The market has shown that it does little good to lower the price of this class of fuel. There simply is little demand for it.

Careful examination of the cracking process does not give any grounds for presuming that the problem can be met by an improvement in technique with the present production methods. Attempts are being made to perfect the Diesel engine to so great an extent that it will operate satisfactorily on the inferior grades of fuel oil, as it now does on the better grades. Research in both of these fields is yielding some very commendable progress, but there seems to be no justification for high hopes. Meanwhile, the world has an enormous over-supply of heavy fuel, and the market for the more valuable motor fuels has not yet neared the limit of its elasticity.

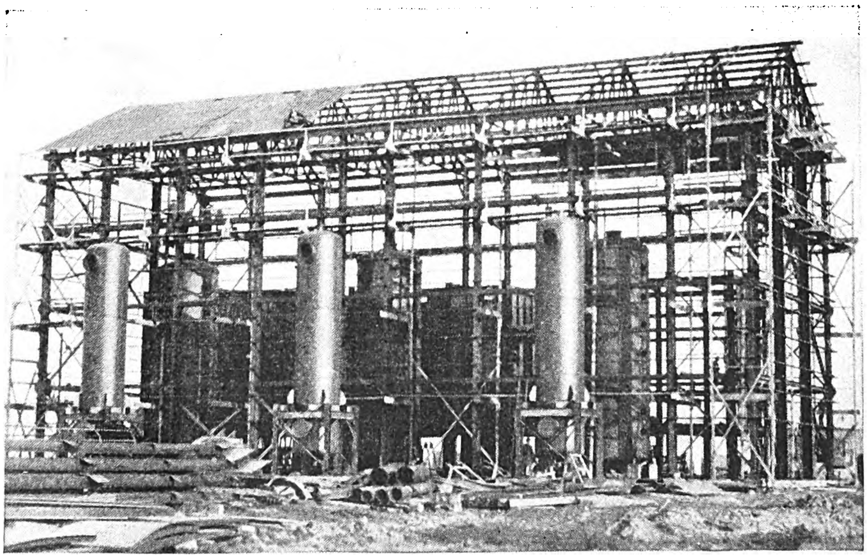
From this it is clear that there is need for a new manufacturing process which can make profitable use of the petroleum products which now are a drug on the market. The hydrogenation process, in its present state of development, is more than capable of meeting this need. This process has shown its ability to do greater things than convert heavy oils into gasoline.

Dr. Bergius took several steps at once when he worked out a method for converting wood into gasoline. First he duplicated nature's "incoaling" process, by which he quickly transformed wood or other vegetable matter into coal. Then he went on with the same process, converting the artificial coal into oil. It was found that the same thing could be done with natural bituminous coal. The hydrogenation of heavy oils into gasoline and light oils is but a page in the story of Dr. Bergius' achievements.

After enumerating that remarkable series of advances, the writer scarcely dares mention Dr. Bergius' one great purpose, an unfinished performance which may yet make these others seem like mere side-shows. Underlying all of his research is the greatest objective of all—to perfect a practical process which will enable man to make his own food, and food for his animals, by utilizing apparently worthless materials which now are burned as rubbish.

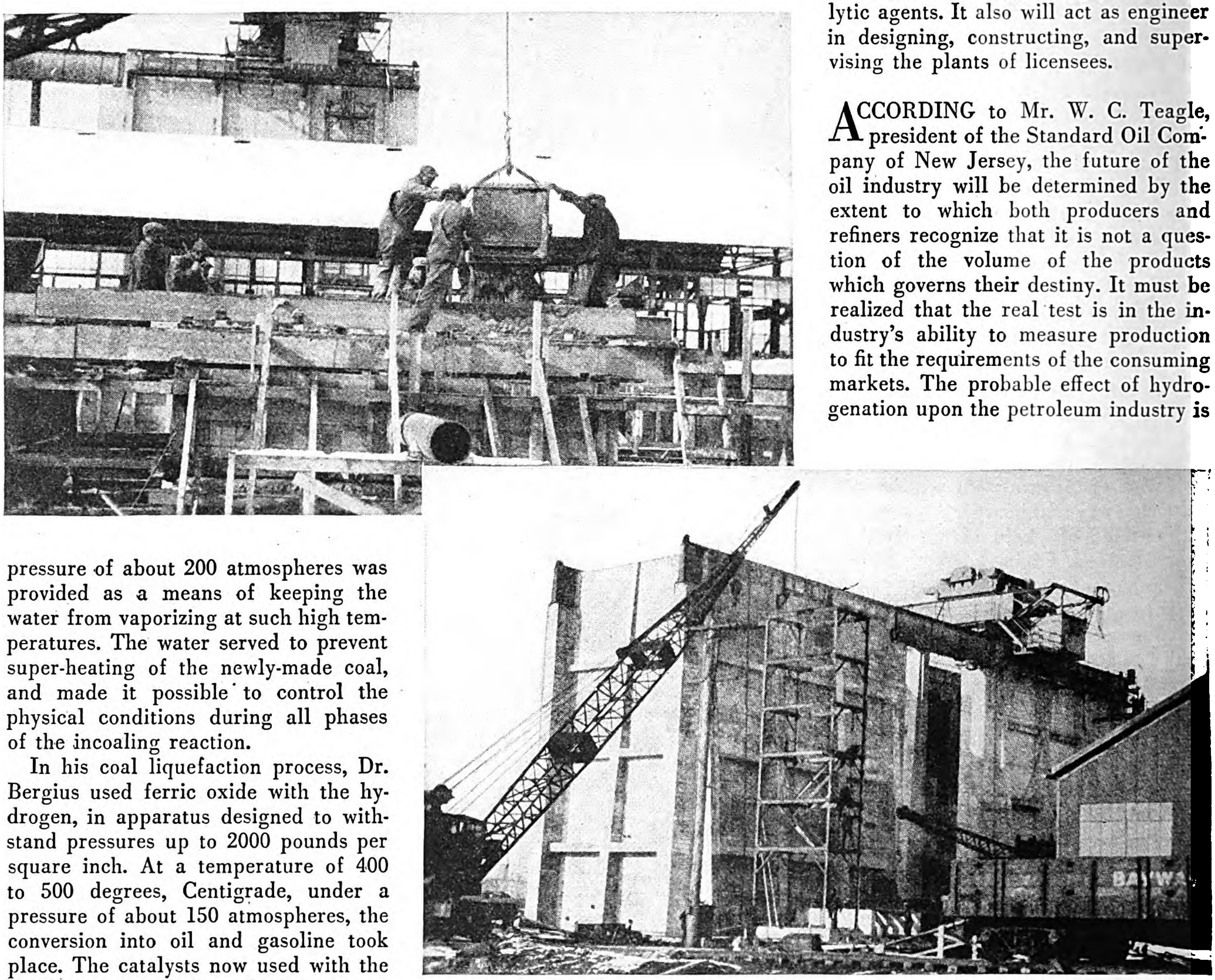
RETURNING to today, after this glimpse of the day-after-tomorrow, we can look more deeply into the process which now is being used to produce gasoline from almost worthless heavy oils. Of paramount importance in this conversion process are the toxin-proof catalysts. These make it possible for the gaseous hydrogen, which is introduced into the high-temperature conversion apparatus under exceedingly high pressures, to transform the molecules of the heavy oils into molecules of gasoline and other light fractions.

It might be well to add a word of explanation about catalysts, for the benefit of those who find the term an unfamiliar one. In chemistry, a substance which serves the useful purpose of stimulating or facilitating a reaction, without adding to or detracting from the



Where the hydrogen will be manufactured—the gas plant building under construction. The new process consists essentially in adding hydrogen to the oil materials involved, is known as a catalyst. In matrimony, a person who plays a similar rôle is known as a matchmaker. In both instances, they may be very helpful.

Years ago, Dr. Bergius effected the conversion of wood into coal, at a temperature of about 340 degrees, in the presence of water in liquid form. A pressure of about 200 atmospheres was provided as a means of keeping the water from vaporizing at such high temperatures. The water served to prevent super-heating of the newly-made coal, and made it possible to control the physical conditions during all phases of the incoaling reaction.



Upper: **Pouring some of the 4700 cubic yards of concrete that went into the Bayway hydro plant.** *Lower:* **Huge concrete slabs enclosing the reaction towers in which hydrogenation actually takes place. Overhead is a traveling crane**

In his coal liquefaction process, Dr. Bergius used ferric oxide with the hydrogen, in apparatus designed to withstand pressures up to 2000 pounds per square inch. At a temperature of 400 to 500 degrees, Centigrade, under a pressure of about 150 atmospheres, the conversion into oil and gasoline took place. The catalysts now used with the Bergius process, as it has been improved for the commercial production of gasoline and light oils, are considered a secret. There also is great secrecy about the exact temperatures and pressures used, and other features such as the design of the high-pressure conversion apparatus.

OTHER investigators, Satatier and Senderens, had found that a nickel catalyst aids in the production of methane gas from coal. The Fischer process of hydrogenation produces benzine by using iron and cobalt as the catalytic agents, and high pressure is not required. In this instance, the catalysts tend to inhibit the formation of methane, and when caustic alkalis are added the conversion continues on down to solid paraffins.

The Bergius process now is being adapted for the conversion of gasoline from heavy crude oils, such as that produced in Venezuela. By present methods of refining and cracking, only a small proportion of gasoline can be extracted from these heavy crudes. Most of the residue is heavy fuel oil, for which there is practically no demand at present.

In the hands of almost any other industrial organization, it might reasonably be feared that the exploitation of the hydrogenation process would bring about chaos in the petroleum industry. However, because of the Standard Oil Company's enormous investment in the oil industry, it is felt that the owners of the hydrogenation process will move with extreme care in order to avoid changing the *status quo* to any great extent.

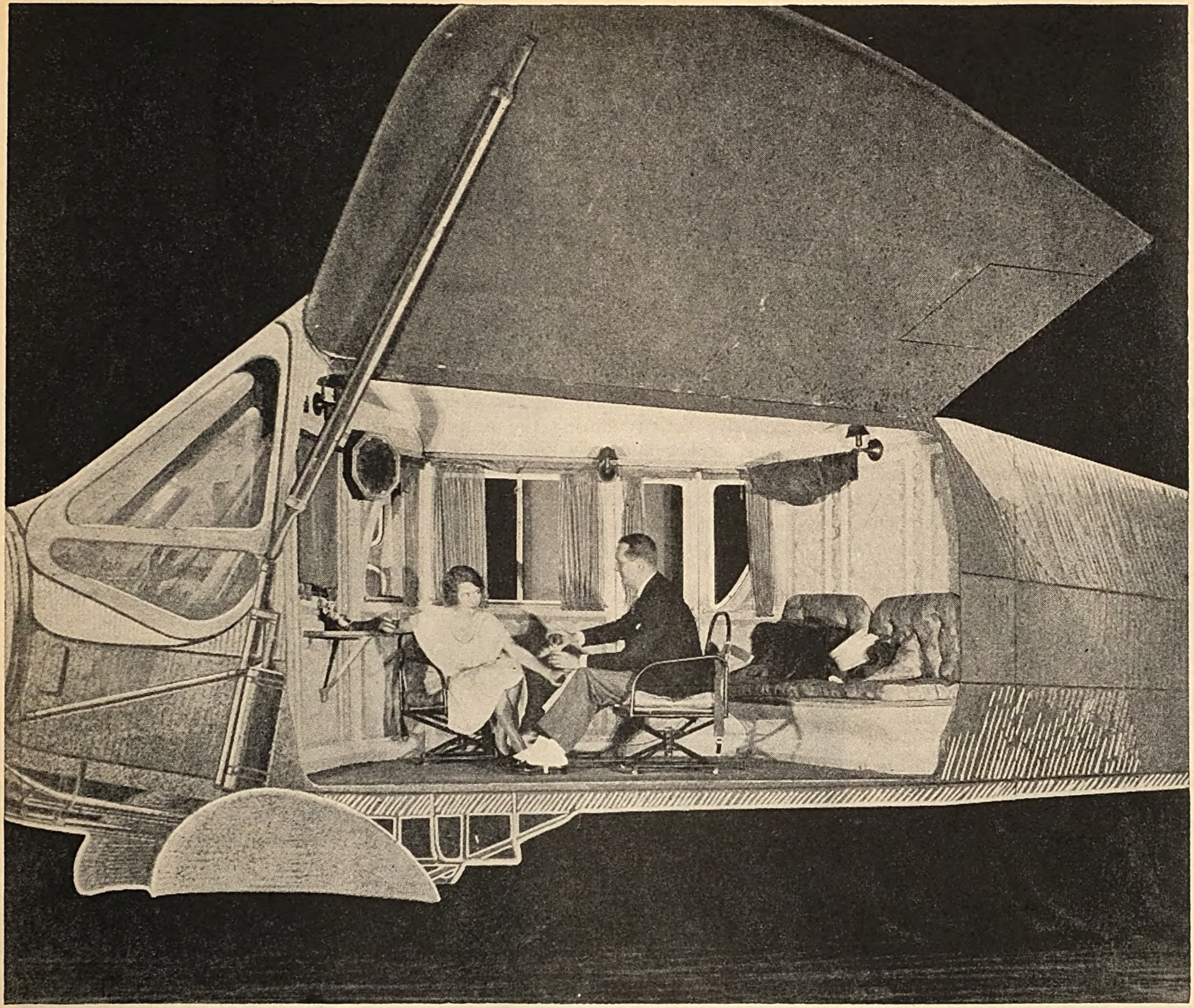
The rights to use the new process in the United States will be leased to other oil companies. Licensing companies will purchase stock in the Hydro Patents Company, a subsidiary of the Standard-I. G. Company, at the rate of one share of stock for each barrel of daily hydrogenation capacity. For example, a firm desiring to establish a plant to produce gasoline at the rate of 20,000 barrels a day will buy 20,000 shares of stock in the Hydro Patents Company.

These outside firms also will be required to align themselves with another subsidiary corporation, the Hydro Engineering and Chemical Company. This organization will furnish the technical information and will supply the catalytic agents. It also will act as engineer in designing, constructing, and supervising the plants of licensees.

ACCORDING to Mr. W. C. Teagle, president of the Standard Oil Company of New Jersey, the future of the oil industry will be determined by the extent to which both producers and refiners recognize that it is not a question of the volume of the products which governs their destiny. It must be realized that the real test is in the industry's ability to measure production to fit the requirements of the consuming markets. The probable effect of hydrogenation upon the petroleum industry is best expressed in Mr. Teagle's own words:

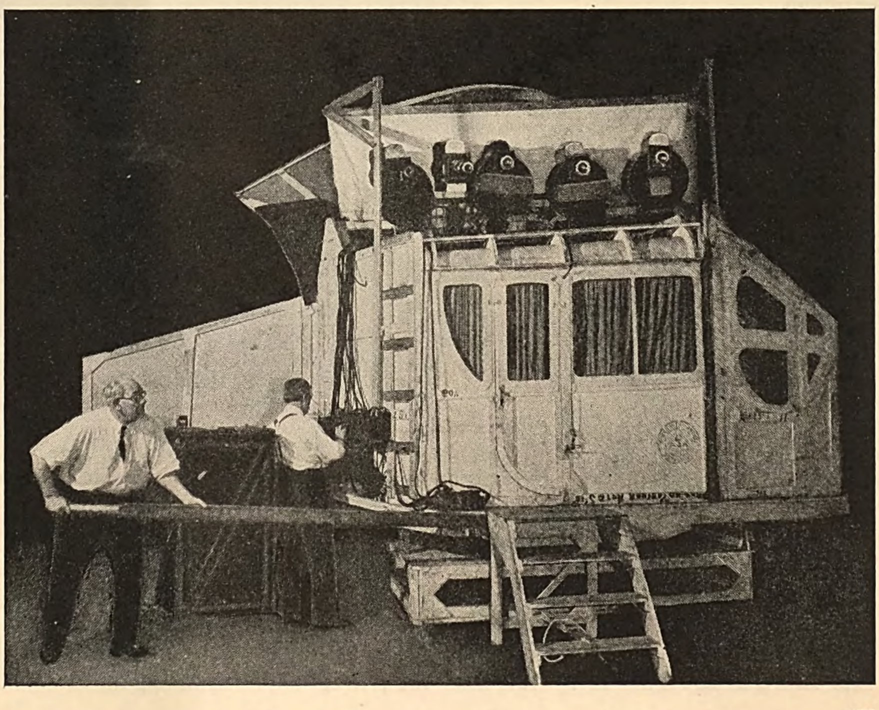
"Through hydrogenation it now is shown to be practicable to convert coal into liquid hydrocarbons at a cost which, although above prevailing oil prices, is not prohibitive. Thus, the coal reserves of the world become supplemental to the crude oil reserves.

"Because of the innumerable new technical problems, solutions of which are required for the practical and profitable use of the hydrogenation method in the oil industry, and because of the relatively large investments required, progress toward its general application will probably be slower than was the case with the cracking development. The ultimate effect, however, should be even more important."



THE STAGE GOES "AIR-MINDED"

ANY play which goes through the hands of David Belasco is sure to be elaborately staged with a fine feeling for detail by this rare artist. His latest production, called "Dancing Partner," has a scene where the lovers are taken aloft in an airplane which cavorts around while fleeting terra firma, clouds, and the starry heavens are viewed through the cabin windows. These illusions are produced by means of projectors carried on the top of the airplane, hidden from the audience by a wing and projecting directly on to the back drop. The electrician controls these effects from the side of the airplane. The huge loudspeaker for the engine effects is located at the left behind the operator who is giving motion to the plane. Another speaker in the dummy cockpit simulates the noise of the propeller and, together with the motions of the landscape and clouds and the sliding passenger seats, serves to give realism to the scene.



EARTHQUAKES

By G. AUSTIN SCHROTER

MANY bizarre theories are prevalent in the popular mind as to the origin of earthquakes and many other unrelated phenomena have been attributed to them, yet they are quite ordinary and commonplace natural processes originating within the outer crust of the earth.

The great Japanese earthquake of 1925 was probably the greatest catastrophe of modern times, and since its advent, Japanese scientists have been among the leaders in seismic studies as well as pioneers in the science of earthquake precautionary measures. Aside from the purely geologic phase of their studies, the Japanese have inaugurated a hitherto undreamed of architectural era in which beauty and safety from crustal movements have been combined.

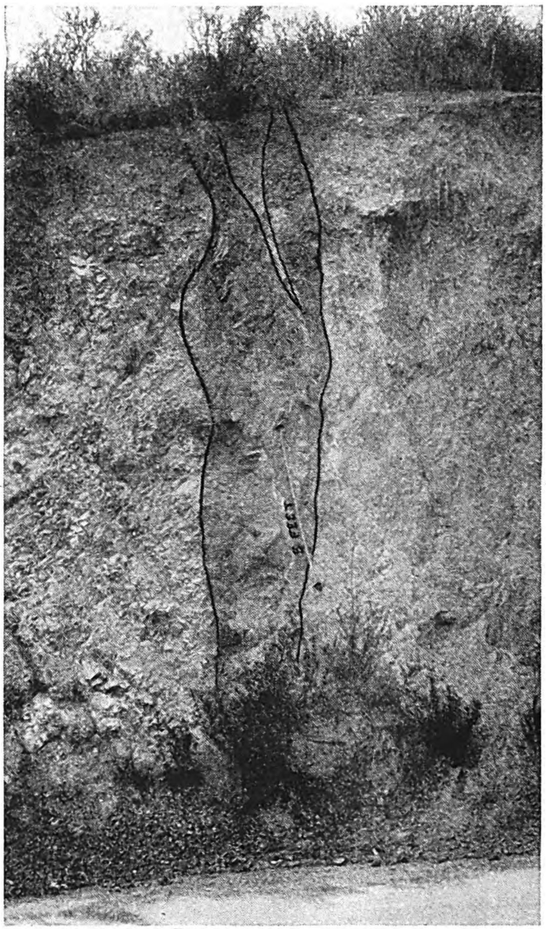
FOR innumerable years scientist and layman alike believed the source of all seismic activity to be in volcanic activity. Although it is quite true that many sharp local shocks owe their inception to volcanic action, in the aggregate volcanism is rather a subordinate cause of major earthquakes.

There are several types of volcanoes whose classification is dependent upon the types of their eruptions.

The quiescent type, of which Mauna Loa and Kilauea in Hawaii are typical examples, completely lack the catastrophic phenomena of the volcanoes mentioned below. The quiet types give rise to outflows of intensely hot lava, without violent projection of gases or solid material; much as a pot of mush will quietly overflow its container and run down upon the stove top. Quite frequently the pent-up lava content will break through the sides of the vent and peacefully roll down the sides of the volcano until it comes to rest on the slopes below. This type of volcano is of relatively slight importance from the seismic standpoint.

The intermediate (Vesuvius) type of volcano stands midway between the quiet and explosive varieties, and quiet outpourings of lava may be preceded by or alternate with periods of violent explosive activity. This is by far the most common type of volcano, and although local tremors may have their birth in this type of eruption, they usually are of unimportant magnitude.

The explosive type of volcano is, as the name implies, marked by violent explosive activity during the eruptive stage, and sudden ejection of gases, dust, and rock fragments is typical. The most outstanding example is Krakatoa, located in the Straits of Sunda near Java. In the eruption of 1883, Schuchert says that "after premonitory outrushes of gas for some time, the great explosion occurred which blew away over a cubic mile of material from the volcano! The vast cloud of ejected material arose over 17 miles into the atmosphere, completely hiding the sun . . . over a vast area. The noise of the detonation could be heard for over 150 miles, and the atmospheric disturbance affected barometers all over the world!"



All photos by R. C. Bowes

A fault showing at a road cut. The black lines were drawn in, as the materials were poorly distinguishable in the photograph. They delimit the zone of crushed, ground-up granite. Note the uncrushed pendant within the crushed zone

Small wonder then, that some violent volcanic outbursts give rise to sharp, disastrous, local shocks. These may be due to the effect of the actual detonation on the surrounding rocks, or they may be due to collapse of the crust due to extravasation of underlying lava, just as a building will be weakened and finally collapse if the foundations are gradually removed. Still another explanation of earth tremors in connection with volcanic activity is the sudden violent shattering of hot rock in contact with steam or cold water. This process is similar to the old trick of shattering rocks by heating them in a fire and suddenly quenching them in water. There is little or no proof for this theory of rock-bursts.

IN the year 1811, the lower Mississippi valley was visited by a series of shocks, many of them catastrophic in magnitude. New Madrid in southern Missouri was demolished, and this earthquake was named after the town. Much of this region is an area of limestone rocks which are relatively soluble in circulating ground waters, as indicated by the many limestone caves which abound in the region. It has been suggested that one of the contributory causes to the New Madrid earthquake may have been the sudden collapse of the roofs of certain of these caverns due to the weight of overlying rock masses. It is, however, obvious that other factors must have entered into the case as the shocks were too heavy and too widespread to have originated in this manner alone.

This leads us to a consideration of the most outstanding and common cause for earthquakes, especially of the more sudden, heavy, and frequently disastrous shocks.

That the outer crust of our old earth is constantly undergoing alteration and modification is a fact patent to the most unskilled of observers. The mighty forces of nature seem to be forever in a state of unrest, and they are constantly at work in their task of altering, shifting, and disintegrating the strongest of rocks and the mightiest of mountain ranges.

The sea reaches eager fingers to the land, and the sea waves with their burden of sand and littoral material wear away the land, under-cutting the strongest of cliffs, and piling the waste material in spits and bars. Tiny drops of rain fall upon the earth and, as each follows the path to the sea, does its finite bit in wearing and transporting the small products of rock decay. Rills, rivulets, and rivers scour their channels and sweep away portions of the banks, ultimately to deposit their load of silt and sand in the ocean or on some lower flood plain. Winds loaded with dust and sand abrade the toughest of rocks and carry the products of the disintegration many hundreds of miles before they are dropped. Glaciers pluck away whole mountains and move them away. Thus, even the mighty continents themselves are in motion! Throughout the vistas of geologic time mountain chains are worn away and new ones are thrown up to take their places. All of nature is at work in the age-old processes of tearing down and building up.

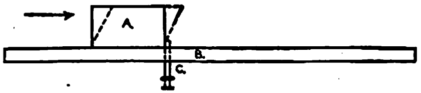
AN attempt to discuss the details of the stupendous forces of mountain making or of the uplift and subsidence of land masses, would require much space, but it becomes increasingly obvious that, when millions of tons or hundreds of thousands of cubic miles of rock are moved from one portion of the earth's crust and deposited upon another portion, adjustment of the crust must ensue to support the gigantic loads thrust upon it.

Every beam, bulwark, or foundation must have an ultimate breaking point when the loads upon it exceed its strength. And so we find that the crust of the earth must give way in places when the load placed upon it exceeds its strength. In short, a rupture or break is bound to occur, and the broken segments in turn will adjust themselves to the stresses which are acting upon them. Such ruptures or fractures in the outer crust along which appreciable movement has occurred are "faults," and it is to them that we must turn in looking for the most common cause of earthquakes.

Proof that the great crustal blocks do readjust themselves to the loads thrust upon them is apparent on every hand. Sea shells and the remains of marine organisms are found on the highest mountains, thousands of feet above sea level, old marine strand lines and beaches are elevated far above the reach of the nearest sea waves. Man-made monuments and temples that were constructed within historical times on perfectly dry land are now found to have sunk beneath the sea and been resurrected, not once, but many times. It does not seem so strange, then, that proofs of this constant crustal unrest frequently manifest themselves as shocks, tremors, and ghostly sounds, apparently arising from the very bowels of the earth.

Movements along faults are constantly in progress. No one region is free from them, and if they happen to occur suddenly or with much friction, they are manifested to our senses, but if the slip be slight or gradual, only the most sensitive of seismographs can detect it.

No hour in the day, no day in the year, and no region on earth is free from earthquakes. They are as common as life itself, but by far the largest number are not apparent to the senses. The idea that any given region is free from earthquake danger is fallacious. In New England, for example, in the 230 years following its settlement, Schuchert says that over 230 earthquakes have occurred.



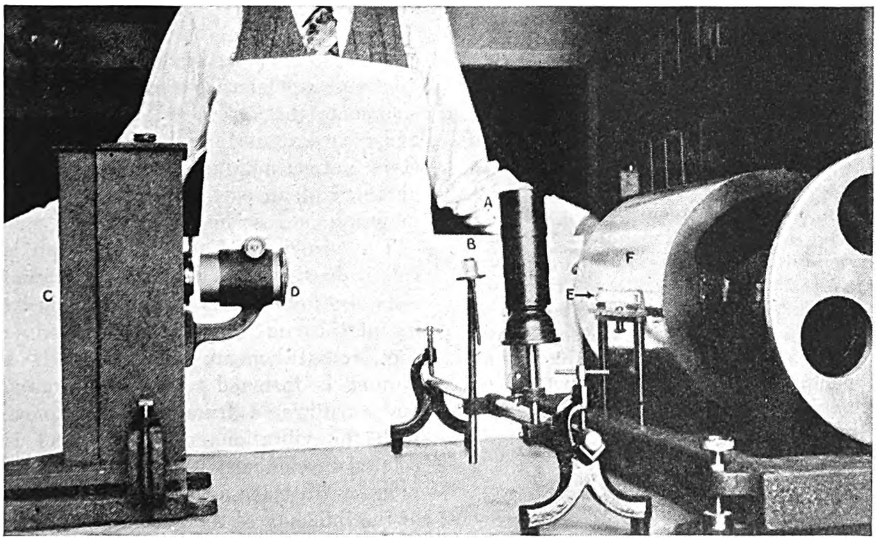
A model to illustrate the principle of elastic rebound. An India rubber block (A) sliding over a table top (B) is impeded by an upward projecting nail (C) until it tends to undergo elastic distortion. If the nail is quickly removed while the force is in operation, the elastic properties of the cube will cause it to snap into its original undistorted shape, causing an "earthquake"

Displacement along faults may be horizontal, vertical, or both vertical and horizontal, the latter being the most common type of movement. One of the most recent theories to be held regarding the origin of earthquakes is known as "Reid's theory of elastic rebound," and it may be explained somewhat as follows.

SUPPOSE that a block of India rubber is moved over a table top, as shown in the figure, until the bottom of the block is intercepted in its movement by a nail or peg driven up through the table. If the moving force continues to act, the top of the block will continue to move forward, but the bottom of the block, by virtue of the obstruction will cease to move. As a result, the elasticity of the rubber block will tend to snap it back to its original undistorted position when the obstruction is removed, and the block will assume its former shape and gliding motion with a sudden snap due to the molecular forces within it.

This process is exactly what may occur in two contiguous blocks of the earth's crust. If they are slowly moving past each other due to the stresses of readjustment, and the movement is impeded by a force tending to stop it, stresses will immediately be set up in the two blocks. The stresses will continue to grow until the moving force or the elastic tendency of the blocks overcomes them, or the rock shatters.

When either of these two phenomena occurs, it will manifest itself by a sudden sharp jar or shock, the intensity of which will depend upon the amount of deformation overcome, and upon the in-



Torsion seismograph perfected by Dr. J. A. Anderson of the Mount Wilson Observatory staff, and Dr. H. O. Wood, Research Associate of the Carnegie Seismological Laboratory at Pasadena, California. A beam of light is sent from the lamp (A) to the prism (B) from whence it is refracted to the mirror of the seismometer within the case (C). The rotating mirror of the seismometer reflects it through the telescopic attachment (D), thence through the cylindrical lens (E) to a strip of light-sensitive paper mounted on the revolving drum (F). The entire apparatus is mounted on a concrete pier within a light-proof cabinet. The optical recording system does away with many difficulties encountered in a mechanical one

tensity of the moving force. The jar will be transmitted instantly to the surrounding crust and waves will be sent out from the point of origin. These are the earthquake waves, and their physical characteristics will determine the amount of damage which they are able to do.

Some faults, quite naturally, are undergoing no movement at present, and are known as "dead-faults." Those which are at present undergoing readjustment are "live-faults." Likewise, some faults are undergoing more rapid readjustment, or are subject to greater stresses, and hence are more pregnant sources of violent shocks.

The great San Andreas rift of California has been studied more in detail, probably, than any other earthquake fault in the world. It has been traced for over 600 miles and forms the boundary between two great crustal blocks, one moving south and the other north relative to each other. It was the San Andreas rift which was the source of the California quake of 1906. In connection with this temblor, it underwent displacement for over 290 miles. Fences and roads crossing it were observed to have been broken and moved apart as much as 20 feet.

MANY earthquakes are due to vertical movement along the source-fault. For example, the great Mino-Owari earthquake in Japan showed a vertical displacement of 20 feet in one place, while the Owens Valley earthquake showed a maximum uplift of 23 feet.

Awe inspiring stories without number have been related by the survivors of great earthquakes, of the fearful sounds accompanying the shock, which were scarcely less terrifying than the quake itself. Tales of unbelievable groaning and grinding noises, of whole forests obliterated, of new streams and waterfalls formed where none before existed, of gaping fissures and dried-up wells, are commonplace and, stranger still, in the aggregate they are true.

For purposes of study, most of the sounds accompanying an earthquake are referred to the Davison sound scale, which is given below:

(1) Sounds resembling wagons, carriages, engines, or trains passing, generally very rapidly, on hard ground, over a bridge, or through a tunnel; the dragging of heavy boxes over the floor.

(2) Thunder; a loud clap or heavy peal, but most often distant thunder.

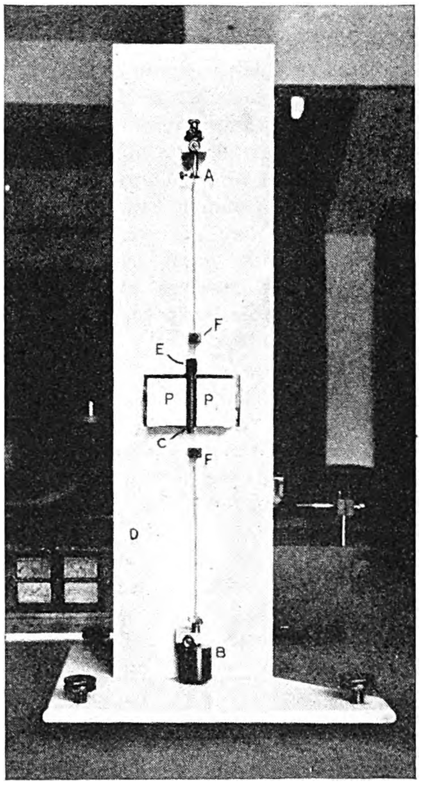
(3) Sounds resembling a moaning, roaring, rough, strong wind, a rising wind, or a heavy wind pressure against the house, a chimney on fire, and so on.

(4) Sounds of great loads of brick, coal, or rock being dumped.

(5) The fall of heavy bodies, banging of a door, pounding of the surf on the shore.

(6) Distant blasting, explosives, firing of artillery.

(7) Miscellaneous sounds such as the roaring of a waterfall, rending or tearing sounds, or the sounds of an immense covey of partridges on the wing.



Enlarged model of the torsion seismometer. A fine tungsten wire is suspended from the screw clamp (A) to the tension attachment (B). A copper cylinder (C) is mounted eccentrically on the wire. When the standard (D) vibrates, the cylinder, due to its inertia, tends to remain at rest. Torsion is set up in the wire causing rotation of the tiny mirror (E) about the suspension. A beam of light can be reflected from the mirror to a sensitized paper on a revolving drum, thus obtaining a photographic record of the shock. A magnetic field from the poles (P) damps the vibrations of the torsion pendulum. The vibration of the wire as a whole is damped by the reservoirs (F) filled with castor oil. This instrument is for use with the horizontal components of the waves. The vertical components are measured in the Carnegie Seismological Laboratory at present, on a seismometer perfected by Mr. Hugo Benioff, Research Associate

The different sounds of the Davison sound scale vary, of course, with the distance of the observer from the source of the earthquake. They may resemble the roar of a train through a tunnel in one place and the low moaning of wind in another. They may be audible to one person and entirely inaudible to another, depending upon the individual's sense of hearing. The author has many times detected the sound of thunder or heavy explosive blasts in connection with seismic activity.

The most outstanding characteristic of these seismic sounds is their extreme lowness or depth of tone, which helps to explain why they may be difficult for some persons to hear. The accompanying sounds owe their origin, of course, to the vibrations set up in the rock by the quake, just as an organ reed vibrates and causes different sounds by different intensities of vibration.

So-called "tidal waves" are another phenomenon accompanying earthquakes, especially in those of submarine origin. These waves have no relation to the tides, but are caused by the elastic rebound of submarine rock masses. In strong submarine earthquakes, the effect on ships is much as though they have struck on a rock or grated over a reef. Seismologists call these vast sea-waves *tsunamis*, from the Japanese, or when they are observed in bays or inlets, as *seiches*, especially when they are stationary waves. They may be as much as 100 or 200 miles from crest to crest, 40 feet high at the point of origin, and they may sweep across the seas with a speed of from 300 to 500 miles per hour. Such *tsunamis* may be unperceived in the open ocean, but upon reaching the land they may pile up as great waves and sweep far inland with great loss of life. Such were the waves that played havoc with Lisbon in 1755, Japan in 1854, and Peru in 1868.

EARTHQUAKES may dislodge loose masses of earth or rock, cause landslides or avalanches, and thus completely denude forest slopes, or dam streams and rivers giving rise to new lakes and "sag-ponds."

The study of earthquakes and earthquake phenomena is seismology, the instruments that are used for detecting and recording earthquakes are seismometers and seismographs, and the record obtained of an earthquake with a seismograph is a seismogram.

The principle of the seismograph is relatively simple. The instrument consists of a heavy mass of metal which by its inertia tends to remain at rest while the ground beneath it vibrates. If a pointer is fastened to the inert mass, and a calibrated drum which will move with the vibrations of the ground is rotated in contact with the pointer, the pointer will leave a record on the drum of the intensity of the shock, and of the frequency, amplitude, and period of the accompanying waves.

The classic example of the seismograph, and at the same time, one which is easily constructed, is a heavy steel ball or bearing placed on a smoked glass plate. If a shock occurs, the ball will tend to remain at rest while the glass plate under it will vibrate to and fro, and a record of the "quake-tracks" will be left on the soot.

The ideal seismograph should be able to record the wave motions in three dimensions; that is, north-south, east-west, and up and down. So far, no such ideal instrument has been devised and in practice it is necessary, if accurate results are required, to use two types of instruments, one for vertical, the other for horizontal components.

The movements of the ground during an earthquake shock may be of two kinds: (1) in large earthquakes, there may be a sudden, large displacement, or a violent lurch of the crust, either horizontal or vertical, or in both planes, or (2) as in all earthquakes, there is a vibratory motion of the ground. The measurement of the former, the great lurches or sudden displacements, can not be accomplished by seismographs. When they take place the ordinary seismographs are thrown out of action or damaged. For recording the vibratory movements, the latter, it is necessary to have two sets of seismographs, one for near, and the other for distant, shocks.

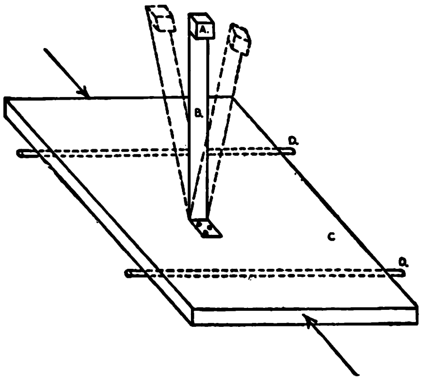
A STUDY of seismograms has indicated that the main shock is preceded by smaller, so-called "fore-shocks," and followed by slighter "after-shocks." The fore-shocks are due to the waves which have taken the shortest path from the source of the temblor to the instrument *through* the earth. The waves of the main shock are those which have traveled *around* the periphery of the earth. After-shocks are usually the result of final readjustment to stresses along the fault. In the Italian earthquake of July 23, 1930, the after-shocks continued for several days after the main, destructive shocks, and did much damage to buildings already weakened.

If three or more stations accurately record the shock, it is a fairly easy matter to calculate the origin of the earthquake. The greatest difficulty is to record the exact time of arrival of the quake at any one station so that the relative time may be determined.

The Seismological Laboratory of the Carnegie Institution of Washington, which is situated at Pasadena, California, is connected with a network of seven recording sub-stations located at Tinemaha, Haiwee, Santa Barbara, Riverside, Pasadena, Mount Wilson, and La Jolla, California. The time of arrival of a wave at any station is co-ordinated with the other stations by means of a dot-dash radiogram from a powerful, long wave, radio station. Thus, if a wave arrives at Pasadena at the beginning of a dash, and at Santa Barbara at the end of a dash, the relative time of arrival between the two stations can be calculated, and the ultimate source of the quake located.

Although, as has been mentioned, no locality is free of earthquakes, certain regions are more liable to dangerous tremors than others. These large well-defined tracts are known as seismic belts. One of them borders the Pacific Ocean, and follows the west coast of South and North America, Alaska, the Aleutian Islands, and the islands off the coast of eastern Asia. The other seismic belt borders the Mediterranean, the Alps, the Caucasus, Himalayas, and so into the East Indies.

The seismic belts follow in general the great zones of weakness in the crust of the earth. For example, off the west coast of the Americas the land is rising with respect to the ocean floor. In regions of active mountain making, great river deltas, rising or subsiding land tracts, and so on, the danger of heavy shock is more imminent.



A model to illustrate the motion in tall buildings or high stacks. The heavy metal bob (A) is mounted on the flexible brass pendulum (B) which in turn is screwed to the base (C). The base is free to roll over the rollers (D). A slight back-and-forth motion of the base will cause the pendulum to swing through a constantly growing arc

In accordance with what has been said regarding the origins of earthquakes, it would seem that in a region where many recurrent slight shocks are prevalent or common the danger of heavy damaging shocks is less. Conversely, in regions of seismic activity, periods of long quiescence may be the forerunners of a violent earthquake.

To the American people, perhaps the most horrific example of an earthquake in the rôle of a destroyer was the great California earthquake of 1906, which resulted in untold suffering, property loss, and a casualty list of close to 1000 lives. The city of San Francisco suffered the greatest loss, due in large part to the destructive fire which swept unchecked over the city following the quake, owing to destruction of pipelines by the tremors.

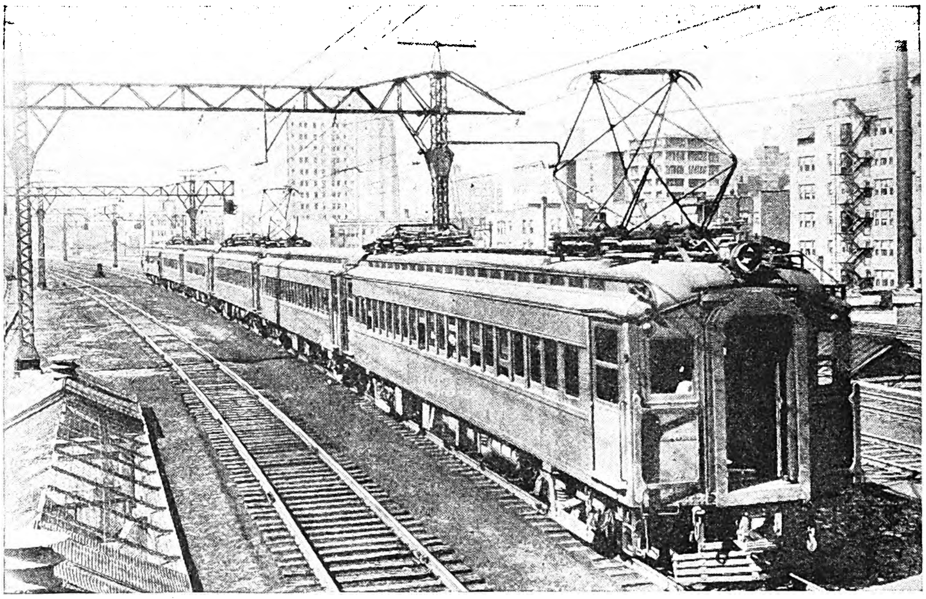
On the 28th of December, 1908, the two cities of Reggio and Messina in southern Italy, were completely destroyed with a loss of life of approximately 200,000 souls. The more recent Italian earthquake of July 23, 1930, probably had its inception in the same region, which is an active seismic one, and had the proper precautionary measures been observed, the loss of life in both of these disasters would have been very greatly reduced. In general, the least risky part of the earthquake cycle is the period after a quake; while the stresses once more accumulate after several years. Yet, such is human nature, much attention is given to precautionary measures at the former part of the cycle, but the least at the later time of increasing risk.

THE greatest danger to the populace during an earthquake arises out of poorly constructed buildings and the tendency to become panicky. By referring to the accompanying figure, the danger to be expected from very high buildings becomes obvious. A high building during a shock may act as an inverted pendulum, so that a very slight oscillation of the ground will be greatly amplified in the upper portions of the structure. Notice a clock pendulum at the point of support. The arc through which it swings is slight. At the bob, however, the arc of swing is greatly amplified, and it is in this principle that the danger from high buildings lies.

In an active seismic region the heights of buildings should be, and frequently are, limited. The danger from falling cornices, high smoke stacks, and perched water tanks can not be stressed too much. In a metropolitan district, it is far safer to run into a Class A building than into the street during a tremor, as the greatest danger lies in falling objects rather than in collapse of walls. Buildings on filled or made ground, likewise are in more danger of collapse than similar buildings built on bed rock.

Movements are now under way, in many of the larger cities, to pass ordinances requiring that buildings be designed to withstand horizontal stresses as great as the stresses upon their foundations. Large buildings, dams, and similar structures should never be built over or close to a live fault, as the danger is imminent. Brick buildings, unless highly reinforced, should be avoided in active seismic regions.

The science of seismology is still in its infancy, so that it is difficult to predict just what strides in earthquake prognostication will be made within the next few years. It is certain, however, that at present, no person can predict the time of occurrence of an earthquake in advance. The old superstitions that earthquakes are more apt to occur during the summer in preference to other seasons, or that they are preceded by "earthquake-weather," is so much rubbish. No good can ever come of such fallacies. They should be relegated to oblivion with the old superstitions of witchcraft and astrology.



Multiple unit cars in service on the Illinois Central in Chicago. Passenger cars of this type are widely used in suburban and urban service

RAILROAD ELECTRIFICATION

By FRANCIS H. SHEPARD

Director of Heavy Traction, Westinghouse Electric and Manufacturing Company

WIDESPREAD opinion has it that automobiles, buses, and airplanes are taking the business of the railroads and that, therefore, they are being electrified for economy's sake. Neither the postulate nor the conclusion is correct. While railroads admittedly are not now operating on a high-profit basis, there is a steady increase in freight shipments and even an increase in long-distance rail travel and far-sighted authorities are very optimistic for the future. Economy has no place in the American scheme of electrification, for the operating economy on electrified American roads is practically nil. Mr. Shepard has, in the accompanying article, given us the truth, as an expert sees it, about rail transportation, its relation to the electrification problem, and the full significance of the latter—what it means to railroads, to the investor in railroad securities (who will read between the lines), and to the country at large.—*The Editor*.

RAILROAD electrification in the United States is entering into an era of increased activity. Several of our railroads are now beginning to electrify their main lines and others are actively considering plans to the same end. The cost of projects at present actually under way exceeds a hundred million dollars, and the total for those contemplated is many times that amount.

Much the same tendency is noticeable throughout the world. All of the nations listed in the accompanying table are either extending or planning to extend their electric service, and, in addition, electrification work is under way in seven or eight other countries.

No single cause is responsible for all this interest. Electricity as a tool for moving traffic has a number of advantages, some of which may be the determining factors in one case while totally different ones may govern in another.

IN many instances, especially outside the United States and Great Britain, the fuel situation provides the underlying motive for electrification. When a nation lacks abundant supplies of first-class coal but is favored with ample waterpower or some form of low-grade fuel, the use of electricity for railroad operation not only may effect a large saving in operating expenses but means independence of coal-producing countries in times of emergency. Switzerland, which has already electrified almost half of her route mileage, furnishes a typical example of this condition, and in the same category are Austria, Brazil, Chile, Italy, Norway, Sweden, and, to a lesser degree, France and Germany.

In this country, on the other hand, where the cost of coal and oil is comparatively low, little or no operating economy would result by saving fuel through electrification; the fixed charges of the electric installation would, in general, be greater than the cost of fuel saved. In the decision to carry out one American electrification—that of the Chicago, Milwaukee & St. Paul—the use of waterpower played an influential part, but all the other installations in the United States were due to other considerations, which can be summarized as follows:

Tunnels. The original application of

IMPORTANT ELECTRIFIED RAILROADS OF THE WORLD

	Electrified Route Mileage	*Total Route Mileage*
United States	2500	251,000
Argentina	68	23,000
Australia	230	22,300
Austria	450	4370
Brazil	251	18,700
Canada	40	40,000
Chile	210	5400
Cuba	155	3800
Czechoslovakia	30	8800
France	875	33,000
Germany	975	36,000
India	150	38,000
Italy	1070	12,000
Japan	200	13,000
Morocco	150	900
Norway	115	2000
Spain	370	9700
Sweden	730	9800
Switzerland	1550	3600
South Africa	200	11,800
United Kingdom	450	24,000

electric power for main line haulage was made in 1895 by the Baltimore and Ohio Railroad for the purpose of avoiding smoke conditions in its long tunnel under the city of Baltimore. The success of this undertaking and subsequent development led to the use of electricity by the New York Central, the New Haven, and the Pennsylvania railroads for their tunnels into New York City, by the Boston & Maine for the Hoosac Tunnel, by the Grand Trunk for the St. Clair Tunnel, and other installations.

SUBURBAN and Terminal Service. The development of the electric street railway and, especially, the use of electrically-operated trains on the elevated railways of Chicago and other cities, showed that electric operation was superior to steam in many respects for heavy suburban service. Electric motor-car, or "multiple-unit," trains accelerate more rapidly and hence can make better time than steam trains, even if the maximum speeds of both are the same; on running into a terminal they can be run out again without further switching, whereas several car movements are needed to reverse a locomotive-hauled train, which not only require time but may congest the tracks outside the terminal; they can run through residential districts without seriously affecting real estate values; and, of course, they can move freely in tunnels of any length.

For these reasons, electric operation was adopted by the Long Island and the New Haven railroads in the vicinity of New York, the Pennsylvania at Philadelphia, the Illinois Central at Chicago, and the railroads around London, Paris, Melbourne, and other large cities.

Mountain Grades. Of a group using electric operation for totally different reasons, the Virginian Railroad is typical. The chief business of this road is to haul coal from West Virginia to tidewater at Norfolk, Virginia. Its line crosses the Allegheny Mountains and at one point some very heavy grades against traffic are encountered. Under steam operation, these grades formed the "neck of the bottle" for the railroad. Even with the use of the most powerful of steam locomotives, traffic slowed down here and the capacity of this portion set the limit to the entire road.

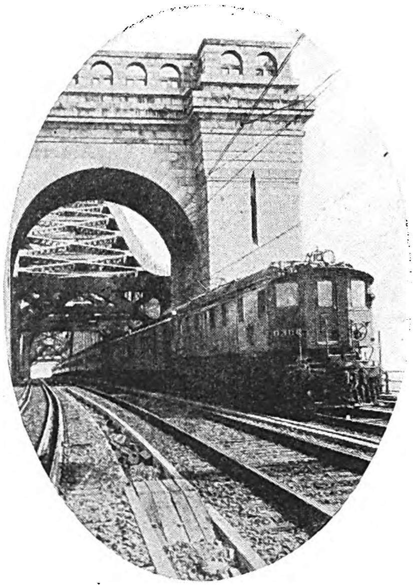
In order to increase this capacity, which was becoming more and more necessary, there were two alternatives: to retain steam operation and increase the number of tracks, or to increase the power for each train by using electricity. Owing to local conditions, the cost of additional tracks would have been exceedingly high, so electric operation was decided upon. Today, locomotives applying at times more than 20,000 horsepower per train are in use on this road, and trains are being moved up the steep grades at twice the former speed. The net result has been to increase the capacity of the road by more than 100 percent, with even greater capacity available if needed.

Other railroads using electric power for mountain-grade divisions include the Norfolk & Western and the Great Northern.

IT is obvious, however, that if these reasons alone influenced electrification in this country, we would see no general use of electric power here. The electrified areas would be confined to the great cities, the mountainous districts, and some special localities, but steam would be employed everywhere else. This, indeed, was the situation until very recently—until, in fact, the Pennsylvania Railroad announced its plans to electrify its entire system of all services from New York to Washington and as far west as the vicinity of Harrisburg, Pennsylvania.

In order to appreciate the full significance of this electrification, which is the most extensive and comprehensive one in the world, it must be considered in relation to our transportation situation as a whole.

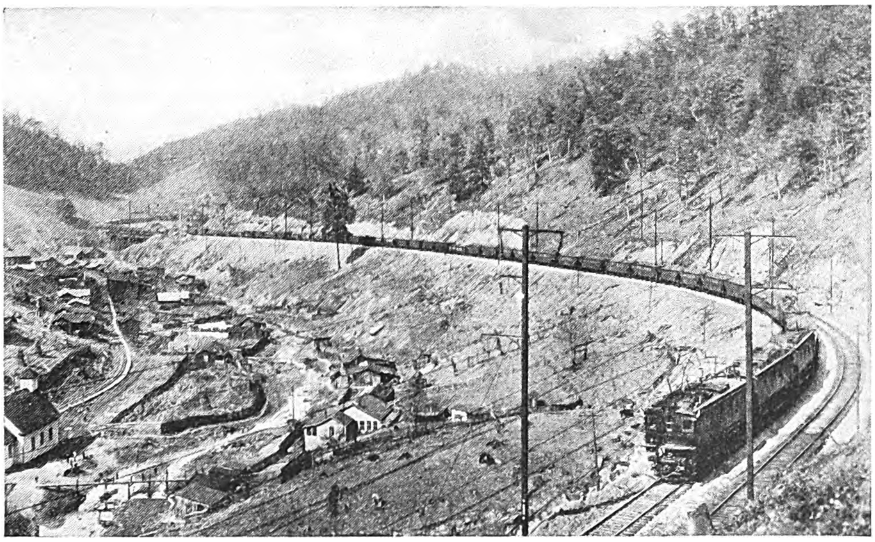
Railroad transportation is vital to the United States. Because of it, our vast territory has been developed and our people have been held together as a single nation. The moment our transportation service fails to meet our needs—as it did during and immediately following the war—everyone suffers: the price of everything we purchase and the cost of everything we produce promptly rise.



Crossing Hell Gate Bridge on the New Haven: The Colonial Express with its 178-ton electric locomotive

OUR demand for rail transportation far exceeds that of any other people. We require 4000 ton-miles per capita, whereas the British requirement is about 500 ton-miles. And this demand has shown marked growth: our ton-mileage for 1900 was 100,000,000,000, and today it is 440,000,000,000; and although with the present trend the aggregate is not increasing, this may be assumed to be only a temporary condition. It is true that a decrease in passenger movement has taken place recently due to the advent of the automobile, but this applies mainly to local and branch line service. On the other hand, there has been a pronounced increase of passengers traveling long distances and between populous centers. The automobile is, in fact, creating traffic by increasing the general movement of our people, by opening up areas for residence which were previously inaccessible, and by making us more travel- and speed-minded. The airplane is also acting in this same direction.

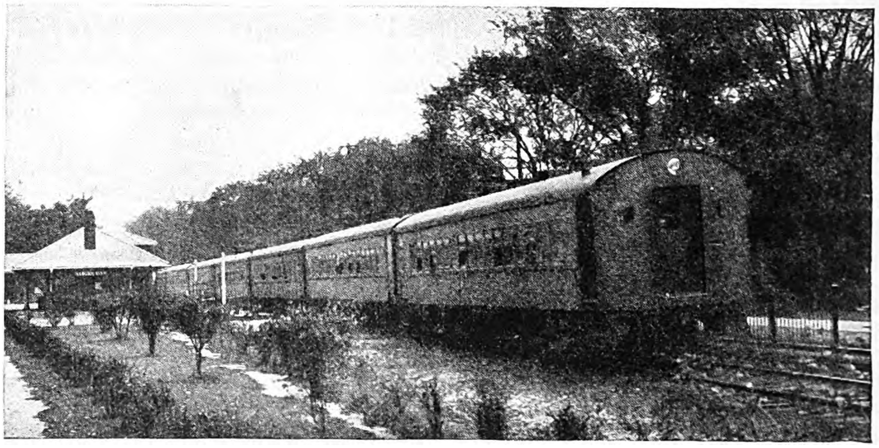
In spite of increase in the demands upon our transportation system, there has been practically no increase in the



A 6000-ton coal train on a 2 percent up grade of the Virginian Railroad, hauled by three 215-ton, 11,000 volt, single phase, Westinghouse-equipped power units number of freight-train-miles or in the number of locomotives for the past 20 years. This means that our train units are becoming progressively heavier, and trains are being moved at higher speeds. The increase in ton-miles per hour has been nearly 50 percent in less than 10 years. The size of the locomotive has likewise grown, and the trend is conclusively toward more and more horsepower per train.

A crack silk train of the Chicago, Milwaukee, and St. Paul drawn by a 300-ton, 3000-volt direct current, Baldwin-Westinghouse electric passenger locomotive

Rail traffic, like automobile traffic, seeks those highways which are most advantageously situated. Half of our route miles carry about 90 percent of our traffic; while the great trunk lines, which constitute only about 10 percent of our route mileage, handle at least half the traffic. There is, therefore, an increasing pressure of traffic on these major routes which has been met by increasing the size and speed of the trains.



Multiple unit operation in heavy duty suburban passenger service on the Long Island Railroad. This is a familiar type of car in many metropolitan localities

So far, the steam locomotive, which has recently undergone conspicuous and notable development, has kept pace with our needs and will continue for many years to be the mainstay for most railroad mileage; but there may be serious question if it can meet the demands of intensive trunk-line operation after the next 20 or 30 years. Double and even treble the present movement may conceivably be the requirement.

With electric operation, on the other hand, the amount of power that can be applied to each train is practically unrestricted, and electric trains of any size can be operated at any speed within the limits set by the road-bed, draw-bars, and other mechanical equipment. Hence, an electrified railroad has greater capacity than the same road under steam power. To electrify a rail highway is to broaden it.

Behind the great electrification undertaking of the Pennsylvania Railroad, therefore, may be seen a recognition of our future transportation needs, a vision of an unhampered and ever-expanding flow of traffic, and the desire to give the public the utmost in railroad service.

Important also is the inauguration by the Reading Railroad of the electrification of its lines radiating from Philadelphia; and it is understood that ultimate extensions will be made for high speed and through service. Increasing interest is also being manifested by other railroads in electrifying sections of their main lines.

Parallel to the progress in developing the utility of railroad electrification, has gone on an evolution in the kind of electric power employed. All the early systems followed street railway practice and used direct current at 500 volts supplied by a third rail. In 1902, B. G. Lamme, Chief Engineer of the Westinghouse Company, announced the results of his experimental development, sponsored by George Westinghouse, of an alternating-current motor which could operate at all the various speeds and under the different conditions required by railway service. This announcement, which indicated the possibility of serving any track with a single working conductor at any desired voltage and of supplying power to trains in any desired amount, instantaneously and effectively, aroused world-wide interest.

In 1905, the New York, New Haven & Hartford, being governed by plans for future extension, adopted the new alternating-current system with overhead conductor at 11,000 volts. This method of operation has since been adopted and made standard by Norway, Sweden, Germany, Austria, and Switzerland, and, in this country, by the Grand Trunk St. Clair tunnel installation, the Hoosac Tunnel of the Boston & Maine, the Great Northern, Pennsylvania, Norfolk & Western, and the Virginian Railroad.

The success of the high-voltage overhead system of the New Haven stimulated the development of high-voltage direct-current equipment, and this current has been applied for various lines at 1200, 1500, 2400, and 3000 volts. Shortly after the war, the French Commission decided upon 1500 volts, direct current, as the official standard for France. The same system is in use in Japan, Java, Holland, and some other countries, while 3000 volts direct current is in use in South Africa, Chile, and Brazil, and by the Chicago, Milwaukee & St. Paul in this country.

The most extensive electrifications now being carried out in this country are with single-phase alternating current, as this system has greater promise for future advantage than any other.

ANOTHER PEKING SKULL DISCOVERED[1]

By PROFESSOR G. ELLIOT SMITH, F. R. S.

AT a meeting of the Geological Society of China in the last week of July, Prof. Davidson Black announced the discovery of another skull of Peking man.

In *Nature* of March 22, 1930[2], an account was given of the discovery of a series of remains of *Sinanthropus*, culminating in the recovery of an almost complete braincase by Mr. W. C. Pei on December 2, 1929, while clearing a sheltered recess of the main deposit at Chou Kou Tien. Some days before this skull was found, five human teeth were recovered from a spot higher up in the shaft, where they were associated with the skull of a large deer and some pieces of fossilised bone and blocks of stone, which were brought to the laboratory in Peking for examination.

This material was "developed" during the third week in June by the technical assistants working under Professor Davidson Black's supervision, and he found that there were enough fragments, which fitted together, to form the greater part of another uncrushed skull of *Sinanthropus*. He waited until the return to Peking of Dr. Wong (Wong Wen Hao), the Director of the Survey, before making the public announcement of his important discovery.

FOR reasons which are not yet clear to those who have not seen the actual specimens, Professor Davidson Black regards the skull found on December 2, 1929, as that of a young woman, and the calvaria, the discovery of which is now reported, is in his opinion that of a young adult male. It conforms to the same general type as the skull previously found, and its proportions are similar. But the braincase is not so thick and the frontal eminences not so pronounced. The most interesting new fact revealed in this discovery is the nature of the root of the nose, which is broad and flat, quite unlike that of Piltdown man.

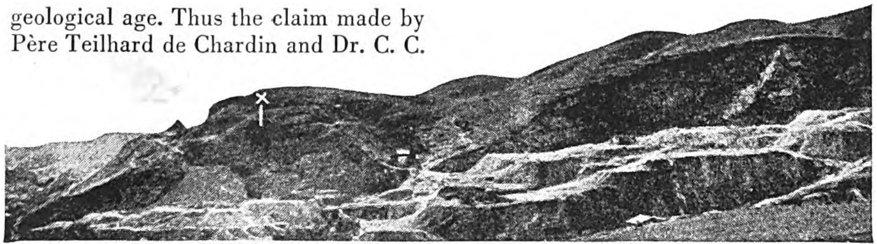
The newly discovered skull was found in association with a number of teeth which can be assumed to have belonged to the same individual. This fact adds to the interest of two mandibles found in 1928 in association with the crushed parts of the respective braincases.

The remains of four skulls of *Sinanthropus* and teeth of at least six other individuals have so far been found. Thus there is available for study in China a much richer material of early Pleistocene man than the fragments of the individual specimens of *Pithecanthropus* and *Eoanthropus* provide. Moreover, the geological age of the Chinese fossils can be established with more certainty than that of the other two primitive genera, which are assumed to be roughly contemporaneous.

The fossils from Java and Sussex were found in gravels, where they had been deposited by running water. Although there is little doubt which of the heterogeneous fossils found in these gravels were contemporaneous with the human remains, in the case of the men of Peking, who left their bones in the cave where they lived, there is less room for doubt that the bones of animals deposited alongside them provide more certain data for the estimation of their geological age. Thus the claim made by Père Teilhard de Chardin and Dr. C. C. Young that *Sinanthropus* lived in Lower Pleistocene times rests upon a surer foundation than the similar claims that have been made in the cases of *Pithecanthropus* and *Eoanthropus*.

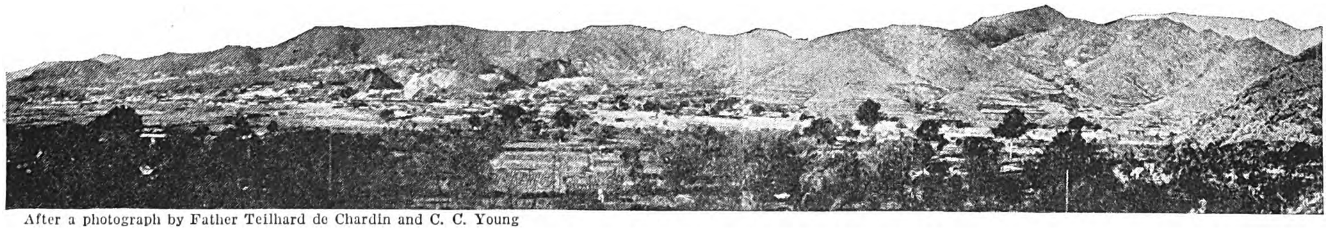
Further, the conditions under which the discoveries are being made at Chou Kou Tien hold out a greater promise of further evidence than in the cases where the fossils have been scattered by running water. Thus a series of fragments have already been recovered every autumn since the type tooth was recovered in 1927, and it is not unreasonable to expect that much more still remains to be found in this cave, and possibly in other fossil beds in the neighborhood. So far no worked tools have been found in the cave; but if such should be recovered, their association with the human remains will be less uncertain than in the case of the other Pleistocene men's implements.

FOR these reasons, in addition to the intrinsic interest and morphological significance of the skulls of *Sinanthropus*, the discoveries in China have an importance which is unique. It is a matter for congratulation that the investigation of this site should have fallen into such competent hands and that ample facilities and skilled assistance should be available for the work, which is being conducted with great thoroughness and insight.



Illustrations courtesy of *Illustrated London News*

Where the remains of *Sinanthropus*, the Peking man, were found—in a cave on the side of a steep hill, at the spot marked X in the picture reproduced above



After a photograph by Father Teilhard de Chardin and C. C. Young

A panorama of the region around Chou Kou Tien near Peking or, as it is now called, Peiping. The small hill at left of the center (with elliptical shaded face) is the one which shows, much larger, in the upper picture which is a close-up view

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[1] Reprinted from *Nature* (London) by permission.

[2] See also *Scientific American*, June and September, 1930, containing other articles on *Sinanthropus* by the author.—*The Editor.*

HOW PLUTO'S ORBIT WAS FIGURED OUT

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

NOW that the new planet has been detected upon photographs taken years ago we can be sure that we have a good idea of its orbit. But doubtless many people still are wondering why it took so long to be sure in what sort of path it was moving.

How astronomers can work out the orbit of a planet which they have been observing but a few weeks is a mystery to most people. Indeed we might go further, for even the graduate student of the science, who has gone through the long chapter of mathematical formulae to be found in treatises on the calculation of orbits and the still longer computations which actually apply them, has often no very clear idea of the *rationale* of the complicated process. He can not see the woods for the trees.

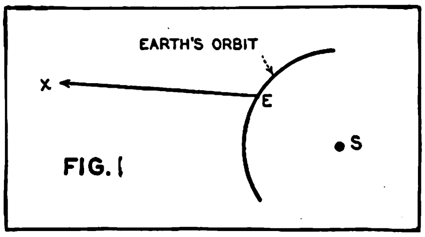

FIG. 1

Yet the thing is not really so hard to understand and, with due apologies to the reader whose tastes do not run along mathematical lines, let us for once consider the reader whose interests do, and try to explain as simply as possible how the apparently impossible thing is done.

FIRST of all we must realize what our planetary observations actually tell us. They give the apparent place of the body in the heavens among the stars; that is, each observation tells us very precisely in just what *direction* the planet lay from the earth (more precisely, from the particular spot on our planet where the observation was made) at an exactly specified moment. But an observation by itself tells us nothing at all about the planet's *distance*. Since the earth's motion about the sun can be accurately calculated we know just where it was at the time of observation (say at E in Figure 1). We can lay off this point on a diagram and also draw in the line EX which runs in the direction in which the planet was seen. (This line would usually run a little above or below the plane of the rest of the picture, but we may leave such details to the actual computer.)

But *where* is the planet upon this line? This is the main problem and it would be very difficult to solve if we did not know the laws according to which the planets move. Suppose that we have two observations, made at the time when the earth was at E_1 and E_2 (Figure 2). If the planet was standing still in space we could locate it at the intersection Y of the lines E_1X_1 and E_2X_2 on which it lay at these moments. But it was actually moving, and so can not have been at Y, wherever else it was.

NOW—to take a simple case first—suppose that the planet's orbit is a circle. We may then make any guess we please about its distance (say SR in Figure 2), draw a circle with this radius and find two points P_1 and P_2 at which the planet must have been if our guess was right. But *was* it right? We can test this by using Kepler's Third Law—that the squares of the periods of the planets are proportional to the cubes of their distances from the sun. We can find by measurement on our diagram, or far more accurately by calculation, what fraction the arc P_1P_2 is of the whole circumference. We know the time taken between these points and so can calculate what would be required to complete the whole orbit at this rate. If the result agrees with Kepler's law our guess was right. If not it was wrong and we try again with a new assumed distance SR′ and get two new positions P'_1 and P'_2. This time perhaps we find a motion slower than Kepler's law allows, whereas the first time it was too fast. The true value then lies between our two guesses and a few more tries will lead us step by step to the correct result.

Such calculations are often made in the case of a newly discovered asteroid to get a rough idea of its orbit and predict where it may be found a month or so later. Most of the characteristics of the general problem are well illustrated by this simple case. In the first place we see how the application of the law of motion turns an apparently hopeless problem into a very simple one. Secondly, we may note that a very small error in our observations may cause a serious one in our results. Suppose that we have got the direction of one of the lines, say E_2X_2, a little wrong. The distance P_1P_2 will then be wrong and, when we compute the time required to make the circuit of the whole orbit from that of this short arc, our error will be greatly magnified; and the same will be true of the final calculated distance. For this reason the computer must assure himself at the start that the observations which he uses have been made with skill and care before he wastes time on useless calculations.

AGAIN we may notice that our problem, as illustrated in Figure 2, admits of two solutions. Instead of starting with an assumed distance less than SY we might have adopted a greater one (SR″ in the figure). We would then have found the planet moving backward about the sun, but by the same process of trial and error we could have hit on an assumed distance at which the rate of motion would agree with Kepler's law. Two quite different planets, then, one relatively near the sun and moving forward, the other farther away and moving backward, each in a circular orbit, might both have been exactly on the observed lines at the correct dates. Later on, of course, their directions from the earth would differ and a third observation would tell which was the true answer (practically, since all of the thousand and more known planets move forward, no doubt would arise).

When the orbit is an ellipse (or a parabola or a hyperbola in the case of a comet) the problem of calculating it is much more complicated but the principles which have just been illustrated still hold good.

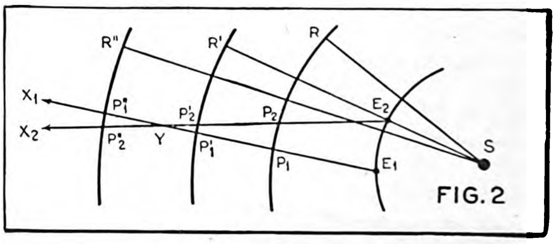

FIG. 2

In this case we must have three observations instead of two—which can be seen from very general considerations. If we have to find the values of a certain number of unknown quantities

—say six—we must have an equal number of equations (or, more generally, of known relations) from which to find them. No algebraical skill can get out the values of all six from only five independent data.

Now each observation of a planet gives us two such independent data, the right ascension and declination. To specify completely a circular orbit we require four "elements"—the node and inclination of the orbit plane, the planet's distance from the sun, and its position on the orbit at a given instant. Two complete observations giving four data to work on should therefore just suffice to work out a circular orbit; as they do. For an elliptic orbit there are two more elements to be found—the eccentricity and the longitude of perihelion, making six in all; and three observations will give us just what we need for a solution.

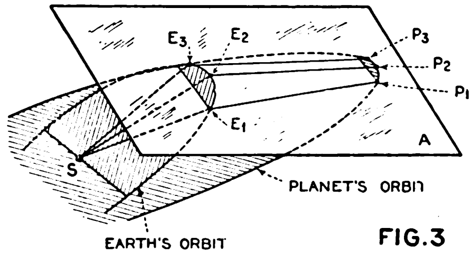

FIG. 3

Once again the principal problem is to find the planet's distance. How it is done may best be explained by going back directly to the law of gravitation. We have now to take account of the fact that the orbits of the earth and the planet are in different planes both passing through the sun, as shown in Figure 3. $E_1E_2E_3$ and $P_1P_2P_3$ are the positions of the earth and planet at the three dates of observation. It is always possible to pass a plane A (the least shaded one in the figure) through the line E_1P_1 in such a way that E_3P_3 is parallel to it (though in the case represented lying higher) and E_3 and P_3 are at equal heights above the plane. Now the sun attracts both the earth and the planet, so that their orbits are curved and E_2 and P_2 lie higher than the other two points on each orbit. But since the earth is nearer the sun than the planet, the sun attracts it more strongly and curves its orbit more, so that E_2 will be farther from the one line than P_2 is from the other, and will be higher above the plane A than P_2 (the more so because the earth's orbit is more highly inclined to A than is the planet's). Hence the line E_2P_2 will not be parallel to A, but will slope downward and meet it at some point beyond P_2.

The angle of this slope may be found from our observations, which tell us just where the three lines are—though not where the points P lie on them.

Now, making any convenient assumption about the distance E_2P_2, it is possible to calculate the influence of the sun's gravitation in curving the planet's orbit (that on the earth's is of course known) and hence to find what the slope of this line should be. Successive trials would then lead us to the correct value. When, as in practice, the arcs E_1E_3 and P_1P_3 are but small parts of the orbit it is possible to set up an algebraic equation which saves the time-consuming process of solution by trial and error and gives the desired distance directly. This equation is of the eighth degree but its solution has been made much easier by the calculation of special tables and presents no great trouble. When once the planet's distance at the time of one observation has been determined, its distances at the other two dates may be found by another equally simple application of the laws of motion under gravity (which, however, we have not space to describe in detail). To calculate the orbit about the sun is then easy enough. It may be noticed that, though the planet's orbit is drawn as an ellipse in the figure, the same reasoning would apply in the case of a hyperbolic comet. In fact the solution leads automatically to a determination of eccentricity of the orbit and the size and shape, whatever they may be.

Once again a small error in any of the observations is likely to be greatly multiplied in the results of the calculation. A "first orbit" based on all three observations is therefore usually of low accuracy. It serves completely, however, for predictions good enough to keep track of the planet until, some months after the discovery, it is lost to observation in the vicinity of the sun. Then by utilizing the data obtained in this interval a better orbit can be calculated, sufficient for finding the planet next year, and sometimes, as has recently been illustrated, on old photographs; and then a still better orbit may be calculated.

The general equation for finding the planet's distance has sometimes one real solution and sometimes three, leading to three different orbits in any of which a planet could move so as to be on the three given lines at the given instants. Charlier the distinguished Swedish astronomer has, however, shown that when a body is observed near opposition there can only be one solution of the problem and this is practically always the case for planetary discoveries. For a comet observed near the sun there may be three solutions, as happened for the great daylight comets of 1843, 1882, and 1910.

For a distant body like the new planet Pluto the apparent motion is slow and the effects of even very small observational errors may be considerable until observations covering several months are available. The delay in calculations and publishing an orbit of this most interesting body is therefore good evidence of the full comprehension which its discoverers had of the problem, as well as their excellent judgment.—

Cortina d' Ampezzo, Italy.

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Editor's Note: In the light of Professor Russell's lucid explanation of the standard method by which astronomers work out a new orbit, some notes on Pluto's orbit, by the astronomers Ernest Clare Bower and Fred L. Whipple of Lick Observatory, published in the August number of the *Publications of the Astronomical Society of the Pacific*, make interesting reading. These astronomers state that, between last January and June, more than 100 accurate observations of the orbital arc described by Pluto were made available by various astronomers, "but," they add, "these alone would not suffice were they not augmented by observations made possible by the identification of the object on plates taken before its discovery." This was because the January-June, 1930, observations would cover only about 1/500 of the full orbit—a pretty short arc from which to work out an accurate orbit. But at this juncture Mount Wilson, Yerkes and one other observatory came to the rescue with some old plates of the vintage of 1919, 1921 and 1927, which they had found in storage. With these "pre-discovery" observations the new arc now represented a span of 11 years or about 1/25 of the whole circumference of the orbit, a respectable base line from which to perform calculations. How closely Pluto now has been pinned down is shown by the fair agreement in the following results of various astronomers' calculations:

	By Bower and Whipple	By Nicholson and Mayall
Perihelion passage due	Feb. 27.473, 1989	June 5.5, 1988
Eccentricity of the orbit	0.253741	0.2575
Inclination of the orbit	17°8′57″	17° 09′
Period of revolution	249.1661 years	251.80 years

TELEVISION NEEDS NEW IDEAS— AND LESS BALLYHOO

The author

By A. DINSDALE, Assoc. I. R. E.

EVER since I reached the hospitable shores of the United States, nearly every person I have met has asked me: "Well, how long do *you* think it will be before we get television?" I never have felt any particular urge to assume the rôle of prophet, and it seems to me that prophesying about television is about as thankless a job as that possessed by the weather forecaster.

To begin with, it depends largely upon what you mean by television and what you expect it to do. In Europe the public, educated by a vast amount of advance publicity designed to boost somebody's over-enthusiastic claims, has acquired definite and rather high standards about television. It has heard so much about being able to "see the world from your own fireside," to watch the finish of the Derby or the final of the Cup Tie (England's star football match), that it expects just that. And as nobody so far is able to provide the necessary apparatus and service, the public has become somewhat apathetic. It has metaphorically rolled over and gone off to sleep again until something startling happens to wake it up. Extensive lecture tours have shown me that there is no lack of interest on the part of the British public, but much disappointment at the non-fulfilment of promises. "Hope deferred maketh the heart sick."

IN America the position seems to be rather more complicated. In the first place, there seems to have been even more ballyhoo about television over here than there has been in Europe. There are more people working on it, some earnestly and scientifically, and some not so scientifically, some with laudable aims, and some with aims not so laudable.

Since I arrived here I have talked with most of the leading workers in the field, and I can find no unanimity as to what television must be able to do. Dr. Alexanderson, for instance, thinks that a limited form of television will be sufficient, while Dr. Ives looks to the time when television will be able to do all that the talking movie can do, and as well. He contends, however, and I think quite rightly, that the system of television as developed by the Bell Telephone Laboratories for use in conjunction with the telephone, is quite adequate for the purpose. But that is a specialized application. The public expects broadcast television.

With television workers themselves at variance as to what television must be able to do, it is not surprising that the general public has no definite notions on the subject. At least, nobody seems to be able to tell exactly what the public wants or expects. Under these circumstances, the obvious thing to do would appear to be to give the public what you have, try to educate them into liking it, and keep on improving on it.

THAT television today is up against an impasse is a fact acknowledged by most authorities, although sporadic articles in the daily press would lead the layman to believe that television is soon to be ready for general use. This impression is fostered by interesting experiments on a laboratory scale which have been heralded as forerunners of practical home televisors. But even the best television equipment available today falls far short of the desired home radio-movie goal, and it becomes increasingly apparent that new paths must be beaten before present-day mechanical and electrical difficulties are overcome. The author of the accompanying article, formerly editor of *Television* (London), presents a point of view that is refreshing after the deluge of misleading publicity of the past few years.—*The Editor.*

The general public, however, will have none of the present limited form of television, which can show only a head-and-shoulder view of some distant speaker or singer, and that imperfectly. The fans, who love tinkering with something, have taken to it, of course, both here and in Europe, but commercial sets just cannot be sold. In England, the Baird Company's attempt to sell machines has met with but scant success. They blame the limited broadcast facilities granted them by the B.B.C.: 11 to 11:30 A.M. five days a week, and midnight to 12:30 A.M. two nights a week. But over here, where broadcast facilities are available on a more liberal scale, I am told that attempts to sell inadequate televisors are meeting with no better success.

The real reason for this failure is not far to seek, and is very simple. There is definitely no entertainment value in the present head-and-shoulder images. Realizing that fact, the Germans have made no attempt as yet to sell televisors; they are devoting all their energies to further experimenting.

THERE are some who disagree with me about the entertainment value of the present image, and point to the fact that something like 75 percent of a talking film is composed of close-ups. True, but the film shows more of the individual, more than one person at a time, has a lot more detail, and the producers have had years of experience with their medium of entertainment and have learned how to make it entertain. On the latter score the television people have reached the point where they say that "a new technique will have to be developed." Nobody knows yet just what form that technique will take. And at this stage they can not be expected to know.

Others who disagree with me contend that a start must be made somewhere, sometime, and point to the crudeness of the art of radio-telephony when sound broadcasting first started. It is difficult to compare two things which are totally different, but I believe that sound broadcasting, when it started, had more power to interest, entertain, and attract than has the art of television at the present time.

Just what the public expects of television is a question nobody can answer. Some go so far as to express doubt as to whether the public wants television at all! I think there can be no doubt that, after what it has been led to expect of television, any serious attempt to stampede the public into patronizing the present limited form of television will not only meet with failure, but will do the youthful art irreparable harm. Some harm has already been done.

Let us, therefore, survey the present state of the art from a technical angle. Let us create a standard of performance and see if present methods will permit of its achievement.

But let me make one thing clear before I proceed further. In reading over what I have written it would appear that I am a thorough pessimist, more of an enemy than a friend to television. Far from it. There is no doubt at all in my mind that television will ultimately arrive. It will eventually be able to do all that has been promised. Televisors will one day be as common in our homes as radio sets are today, and a television industry will grow to the proportions of the present radio industry.

But before all these things can happen we shall have to think up a few new ideas.

It is an extraordinary fact that television has not, so far, developed any brand new ideas for its own exclusive use. All its ideas and apparatus are either borrowed from some other field of scientific endeavor, or they have been in existence, but not made use of, for many years.

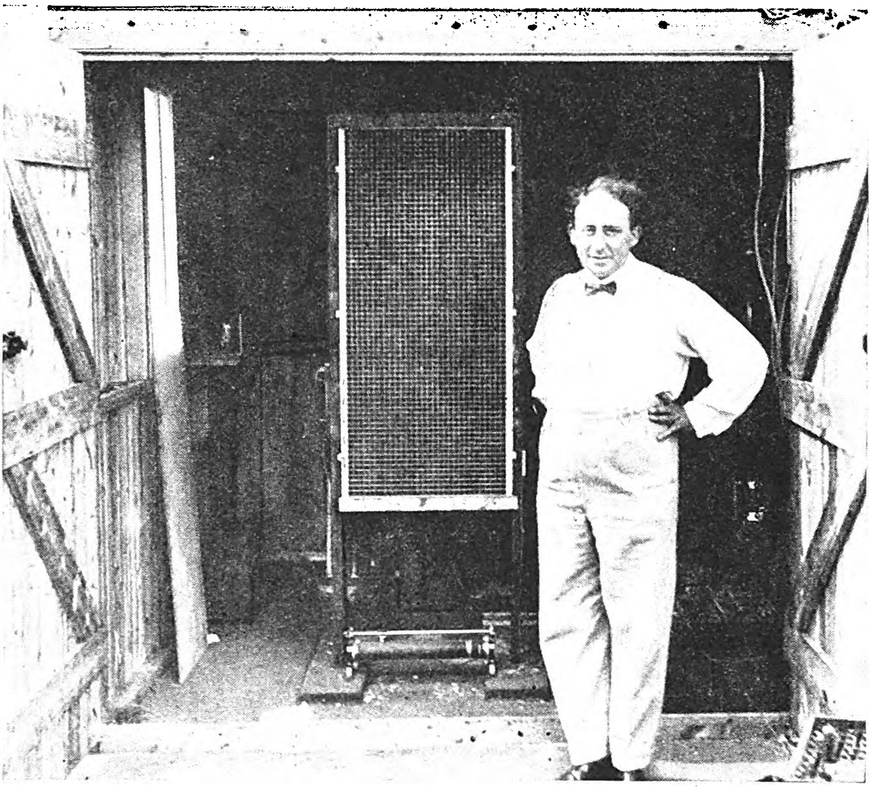
Take the scanning disk, for example. Invented by Nipkow in 1884, it lay idle until it was coupled with such modern inventions (taken from other fields) as the neon lamp, thermionic tube, and photo-electric cell, when television was produced. Nipkow could have done it in 1884 if he had had the use of these modern facilities.

THE large viewing screens of Jenkins, the Bell Telephone Laboratories, and Baird are reminiscent of the walls of selenium cells controlling distant electric bulbs, which were suggested by several early enthusiasts and actually constructed by Rignoux and Fournier in 1906.

The use of cathode-ray tubes was first suggested by Campbell Swinton in 1911, and they were experimented with soon after by Boris Rosing in Russia and Belin in France.

All these things have, of course, been vastly improved upon and made to perform incredibly well, thanks to modern facilities, but they have their limitations. What astonishes one is that all the present-known workers, knowing these limitations, are content to pursue the old methods. Some entirely new principle is needed, and needed badly. And it is quite on the cards that the present workers will get so stale and hide-bound that the new idea, when it does come along, will pop out suddenly and unexpectedly from a source never previously heard of.

Before we can proceed to an examination of the limitations of present television apparatus and methods, it is necessary to set forth some standard of achievement which must ultimately be met, and see how far toward that standard we can go with the means at present available.



Baird's large television receiving screen. The extreme complexity of devices of this nature is an important indication of the need for new ideas in the art

My guess is that television, for home entertainment purposes, will have to be capable of embracing a field of view, either indoors or outdoors, as extensive, complete, and flexible as is at present coverable by means of a motion picture camera, and the detail presented will have to be comparable with that of the motion picture also. After all, as an entertainment medium, television must go into direct competition with the motion picture, or couple up with it so that films can be distributed and simultaneously exhibited all over the country by television methods. It will displace the film for spot news, although the film will always be wanted for record purposes.

The home screen upon which the television images are depicted will have to be, for comfort and convenience, not smaller than nine by twelve inches, unmagnified. The magnifying lenses at present in use are undesirable for several reasons. Many of them are so badly designed and arranged that they distort the edges of the picture. Even if well arranged, they magnify all the defects in the image, cause loss of light, and, perhaps most important, limit the number of observers to two or three, and force even that number to locate themselves, often in discomfort, directly in front of the lens. The standard of comfort of the home movies must prevail on this point.

Having thus set the standards of field of view and size of screen, the next important step is to fix quantitatively the amount of detail which must be provided. Here it is necessary to guess a bit again. If scanning is to continue to be carried out in parallel strips or lines, my guess is that we shall have to provide 100 lines per inch. That means that, for a nine by twelve inch receiving screen, unmagnified, we shall have to resolve the image into $900 \times 1200 = 1,080,000$ picture elements. If we set the transmission speed at 15 images per second—a rather low figure—the frequency of the A. C. picture impulses which we must transmit, either by wire or by wireless, works out at

$$\frac{1,080,000 \times 15}{2} = 8,100,000 \text{ cycles,}$$

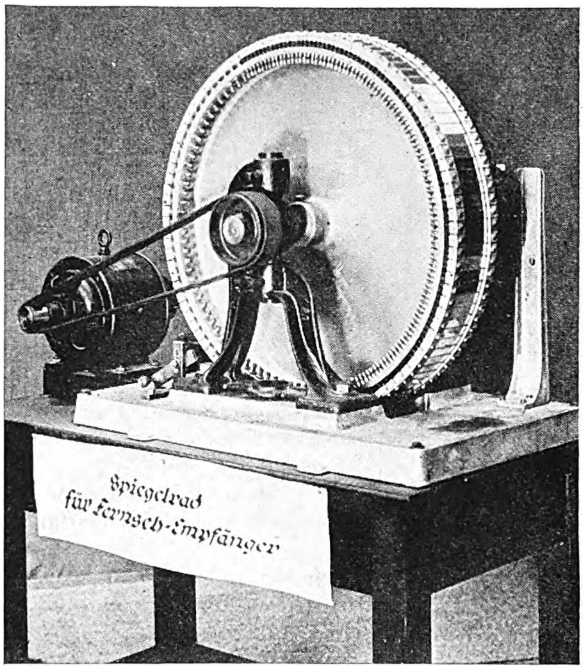
or 8100 kilocycles.

WE are now faced with two major problems: (1) terminal equipment capable of fulfilling the above requirements, and (2) channels of communication which will successfully transmit frequencies up to 8100 kilocycles.

Let us consider terminal equipment first. Remembering that the circumferential distance between the holes of a scanning disk must be equivalent to the long side of the picture, in this case twelve inches, and that there must be 900 of them, we should require a scanning disk nearly 300 feet in diameter to fulfill the requirements set out above! And if we used a flat plate neon tube, we should need one with a plate measuring slightly in excess of nine by twelve inches, and such a tube would require a prohibitive amount of amplifier power to illuminate it. The whole conception is preposterous and ridiculous.

The Jenkins drum scanner provides no solution to the problem; it also would assume unwieldy proportions. There remains the Weiller mirror drum, which would require 900 mirrors, and if these were only one inch wide the diameter of the drum would be something like 25 feet.

That exhausts all known mechanical methods of scanning which have proved at all successful. It is obvious, therefore, that we must either relax our requirements for television or seek other and non-mechanical methods.



The Weiller mirror wheel used in television scanning. For large images, this device becomes unsatisfactory

BEFORE the days of the thermionic tube, we achieved, or attempted to achieve, radio-telegraph communication by just such cumbersome "brute force" methods. Now we have thrown all our unwieldy machinery into the discard, and achieve our object a thousand times better by harnessing electrons. We shall have to discover some method of harnessing electrons to do our bidding in the television field. A stream of electrons travels with the speed of light, it is weightless and therefore inertialess, and it can be controlled electrostatically or magnetically.

The fundamental essence of the television problem may be defined as the time element, or, if you like, speed; so much has to be done in such a limited space of time. As we have already seen, 16,200,000 picture elements have to be dealt with *per second.* Obviously, only electrons are capable of handling such a gigantic number within the time allowed.

The only electron device at present known which seems to offer a ready solution to the problem is the cathode-ray tube. It has been experimented with for many years, and several workers are still busy on it, trying to adapt it for both transmission and reception purposes. As at present made and used, the cathode-ray tube has many disadvantages. It is expensive, both as to first cost and as to auxiliary equipment and operation, its life is short, and there are still difficulties in the way of adequately controlling the scanning movements of the electron stream. It remains to be seen, therefore, whether the cathode-ray tube is the best practical embodiment of the purely electronic method of achieving television.

So much for terminal equipment.

Coming now to channels of communication, one is almost tempted to say that it will never be possible to transmit 8100 kilocycles over either a wire or a radio circuit. But in scientific matters today's impossibility is tomorrow's commonplace achievement. At present it might be possible to transmit such an enormous frequency by radio, but only on wavelengths below ten meters. Obviously we shall have to discover some new technique or principle in radio communication also. That it is already long overdue is evidenced by the fact that the entire spectrum of wavelengths used for all radio communication purposes is already full to overflowing; radio communication cannot develop any further until it is released from its strait-jacket. Personally, I think the new principle discovered by Dr. J. Robinson of England, and incorporated in the Stenode Radiostat receiver, will not only solve the overcrowding problem but also make it possible to transmit the enormously high frequencies required for television.

That is my conception of the problem of television as it stands today. A gloomy picture, you may say. Or again you may ask me: "How long will it be—?" As I said at the outset, I am not going to be inveigled into prophesying, but I feel very optimistic about the future development of television. It is clear that much remains to be done, and it is equally clear that television is going to provide yet another example of the survival of the fittest. So much remains to be done that only those who are backed by almost unlimited resources in the shape of money, brains, and laboratory facilities stand any chance of winning through and reaping their reward.

The work which has been done to date, and about which there has been so much ballyhoo, must be regarded in the light of a preliminary canter over the course. Already there is evidence that the most serious contenders in the race for television are abandoning present methods and working quietly behind locked doors on something different. In Germany, Dr. Karolus, working in conjunction with the Telefunken Company, has been silent, but not inactive, for a year.

IN this country, the television staffs of the General Electric and Westinghouse companies have just been concentrated in the R. C. A.-Victor plant at Camden, New Jersey. That the R. C. A. group really means business is evidenced by the utterances of its executives, and if further evidence is required of the imminence of television on a really commercial and entertaining scale, there is the projected 250,000,000-dollar Rockefeller radio city which Merlin Hall Aylesworth, President of the National Broadcasting Company, says is to be built around television. It is estimated that this building will be ready in three years, and that is as near as I will go to prophesying when television will be ready to make its bow to the public, not in so perfect a form as I have outlined as being ultimately necessary, but at least some way towards it.

And finally, I have been asked who will win the race, Europe or America. Well, one of the essential qualifications of the competitors, mentioned above, has to do with financial resources, and America has more money to spend on television than has Europe, and America seems to be more determined. So with that I will leave the American workers to it, and wish them the best of luck.

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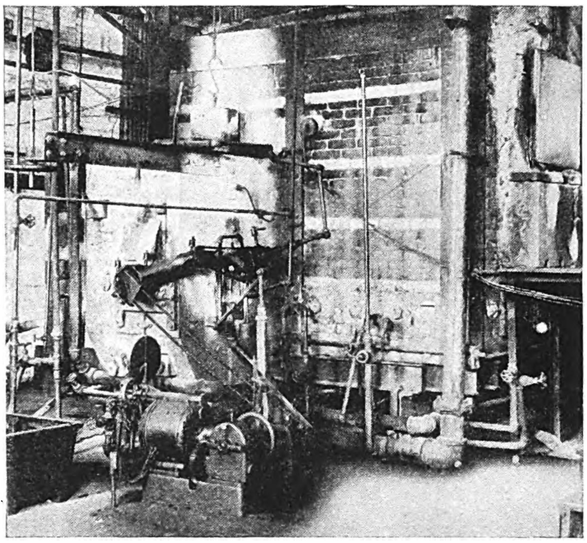
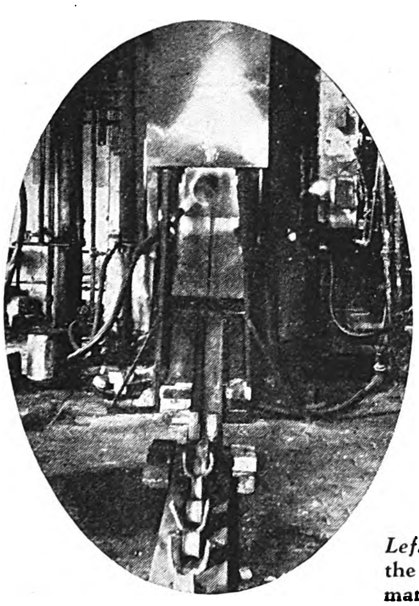
Editor's Note. Although we are in hearty accord with Mr. Dinsdale in the general tenor of the foregoing article, we can not help but take exception to the statement ending at the top of this column. There are thousands of amateurs in this country who are learning the fundamentals of television by experimenting with their own equipment. And it is well known that the radio amateur is never content to follow the beaten paths. His record in the development of the short waves justifies this statement, and we do not feel that we are too optimistic when we express the opinion that the ranks of amateur radio will contribute some of the new ideas needed for the development of television.

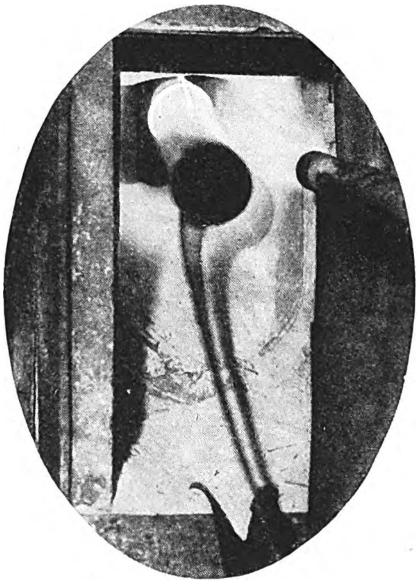
GLASS TUBING BY THE MILE

THE old method of making glass tubing by blowing, while the hollow cylinder was pulled out and cooled, was an exceedingly crude process and the variations in the size of the bore were great. Now, however, by the aid of cleverly designed machinery, although under the principles of the archaic methods, glass tubing is made by the mile. The machines operate continuously, drawing the molten glass from the furnace, cooling it at a distant point and cutting it off in pre-determined lengths, automatically, by a special mechanical device. In this method, as in the hand process, there is a long line of easily broken tubing in constant motion between the blow-pipe and the far end where the cutting operation takes place.


View of the rear of the glass melting furnace

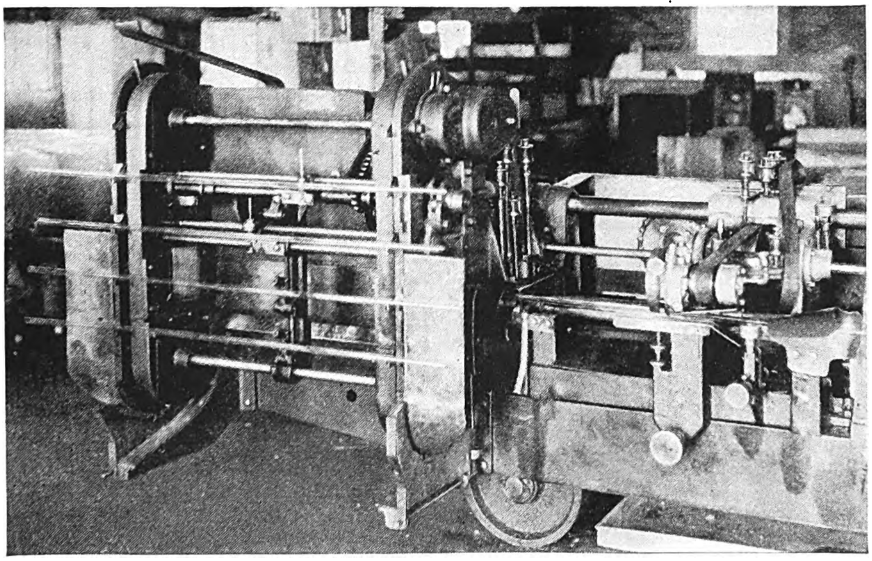
A tank furnace supplies a steady stream of molten glass. As the viscous glass flows to the aperture, it is kept very hot by the glass blow-pipes. The glass forms a tube over a hollow mandrel by the aid of air which is forced through it. The air pressure is slight, being only one or two ounces per square inch. If this air should be cut off, a cylinder of solid glass would form. After the tube is formed comes the drawing process which is dependent on a machine which pulls away, continuously, the rapidly cooling tubes of glass. Two endless chains serve to carry pressure plates which grip the tube without fracturing it. The motion is positive and in one direction. The cooled tube is drawn away from the furnace, dragging away more of the molten glass which is to form the tube over the hollow mandrel which purveys the air for blowing. The machine is dealing with a very peculiar substance and the slightest tendency to buckle up would fracture the tubing. The speed of the pulling chains may be adjusted at will.



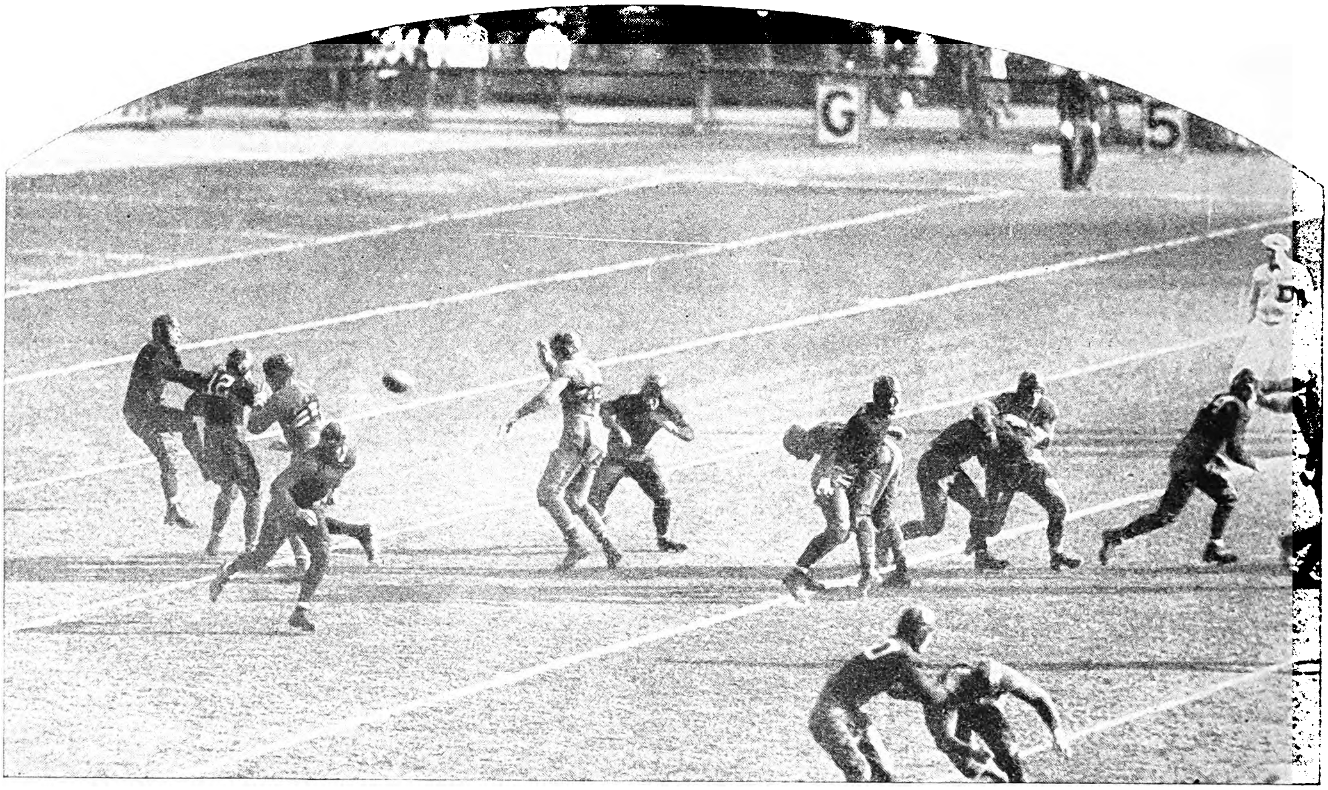


Left: Discharge end of blow pipe from which the glass is drawn. *Right:* Heater muffle and mandrel forming the continuous glass tube

The pulling machine is supplemented by a device for breaking off the tube in pre-determined lengths as it is pulled along. After the tube leaves the endless chains it encounters a second set of guide-rolls mounted on vertical spindles. Next it passes over a pressure table which yields vertically. Then it enters a part of a special wheel and is broken off to the proper length. This length is finally delivered from the machine for inspection and packing. The cutter wheel co-acts with the pressure table. That is to say, the cutter wheel moves downward and comes into contact with the work at the beginning of its own stroke. The cutter wheel cuts a surface groove on the glass. It is not designed to effect a complete severance of the glass but to make a point of weakness. A second wheel revolves intermittently and exerts a transverse pressure against the work at a point in advance of the cut, thus breaking it off at the groove. The demands for uniform glass tubing, in science and industry, are many.


After the glass tube has been drawn from the furnace with the aid of a "pulling" machine, it is cut off with this machine and the broken-off length is delivered

We are indebted to the Libbey Glass Manufacturing Company of Toledo, Ohio, for permission to inspect the interesting process.



The Army blocks a Notre Dame punt in their famous 1929 game

HOW MANY MINUTES OF PLAY IN THE AVERAGE FOOTBALL GAME?

By **HUGO L. RUSCH**
Supervisor Technical Data Section, Johns-Mansville Corp.

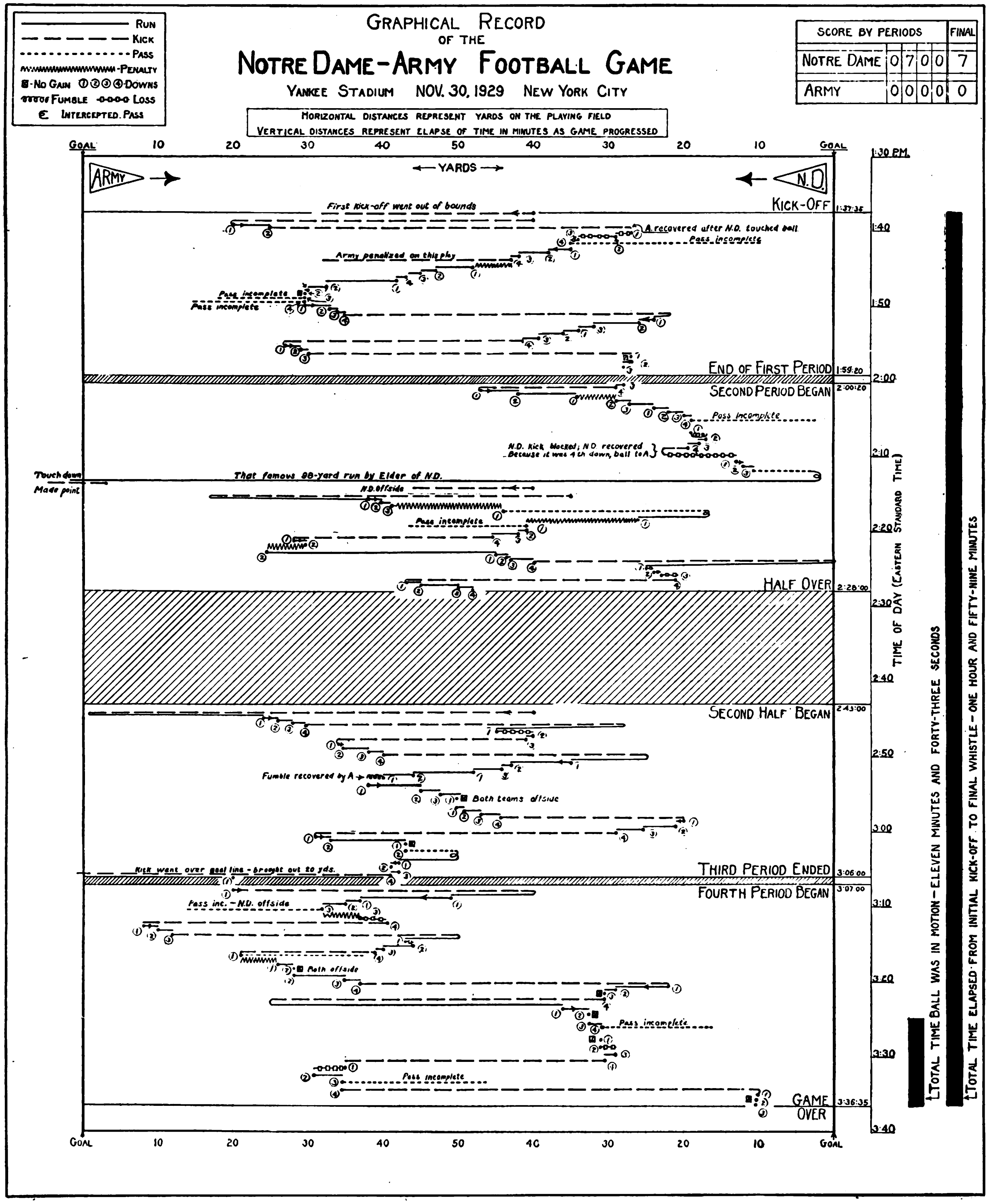
YOU pay at the rate of $24.25 per hour to watch football! It costs hundreds of thousands of spectators this amount for their amusement every autumn. The time the ball is officially in motion during an entire game—clocking each play with a stop-watch from the instant center snaps back the ball until the end of the play—totals the astoundingly short period of about 12 minutes. To be exact, the actual playing time in eight important games during the 1927, 1928, and 1929 seasons in which Notre Dame, the Army, Yale, Harvard, Princeton, Stanford, Ohio State, Columbia, Indiana, and Syracuse participated was an average of 12 minutes and 22 seconds per game. With your ticket costing you five dollars you paid at the rate of $24.25 per hour. If you were able to buy a ticket for three dollars, your hourly rate was only $14.55. If you were one of those spectators who paid sixty dollars a pair for the coveted pasteboards, figure out your own rate per hour.

The official playing time of one hour—four quarters of 15 minutes each—includes time for signals, formations, and shifts. The rest period between the first and second quarters, and the third and fourth quarters, is one minute; the time between halves is 15 minutes. Including periods for "time out," the total lapse of time from the initial kick-off to the final whistle, for the eight games mentioned, averaged 2 hours 20 minutes and 9 seconds.

TAKE the case of the Army-Notre Dame game at the Yankee Stadium on the last day of November, 1929—the game in which Elder of Notre Dame thrilled 83,000 spectators and many more thousands of radio listeners, when he intercepted one of Cagle's passes and ran 98 yards for a touchdown. For this game, many folk arrived half an hour before the kick-off and people were still leaving the stadium more than an hour after the final whistle, which blew 1 hour and 59 minutes after the kick-off. Hence some spectators spent about 3½ hours at the field to see the ball actually in motion less than 12 minutes (to be accurate, in this game it was 11 minutes and 43 seconds).

The time studies of the eight games proved that the period the ball is in motion during each play averages only 4½ seconds. This is based on a total of 1328 plays, all of which were carefully timed with a stop-watch reading to tenths of a second. As might be anticipated, some of the plays lasted four times as long as the average. And it was indeed apparent that the amount of spectator excitement was in proportion to the time the ball was actually in motion. The spontaneous cheers and yells were all concentrated in these very short intervals and all eyes were figuratively glued on the field.

On November 30, 1929, at the Yankee Stadium, in the second quarter, the Army had blocked one of Notre Dame's punts but Notre Dame recovered the ball. Since the play was on the fourth down, the ball went to the Army on Notre Dame's 13-yard line. Things looked fine for the Army. Two plunges by Cagle and Murrell netted a few yards, and then Cagle whisked a delayed pass over the left side of his line. Elder of Notre Dame rushed in boldly and, instead of playing orthodox football for a goal line defense and knocking the ball to the ground while covering receivers of the pass, he snatched



the ball from the air on his two-yard line, lost a precious split-second in regaining his balance, and then tore madly up the side line. Two Army men dove for him but missed—by a few inches. He ran unmolested until he reached the Army's eight-yard line when another West Pointer failed—by inches—to catch his elusive prey.

The fleet Elder raced over the goal line for a touchdown. But no one knew then that he carried the game with him. Carideo booted over a placement for the extra point, ending the scoring for the day. The crowd had been held spellbound. For 18½ seconds—the time of that play—they forgot the bitter cold. It was the longest play recorded in the eight games analyzed.

In the Army-Stanford game at the Yankee Stadium on December 1, 1928, there was another long play. Here also Cagle had a hand in it, but this time he did the carrying. The Army had the ball on their own 34-yard line. It was snapped back several yards to Cagle, who made a dazzling zig-zag run through the entire Stanford team, dodging tackler after tackler, to Stanford's 44-yard line for a net gain of 22 yards. It was a thriller. The play lasted 15½ seconds, the longest play of the game, and second longest in the eight games at which the time studies were made.

In the play which ranks third in point of time out of 1328, the performance of Christian Cagle of the Army is again encountered. This time it is in the Yale Bowl on October 22, 1927. With the ball on Yale's 48-yard line, Cagle received it about 12 yards back of the scrimmage line, and, by avoiding and throwing off Yale tacklers, down on his knees and back up again but never completely stopping, he carried the ball on another brilliant run of over 32 yards to Yale's 28-yard mark for a net gain of 20 yards. The total time of this play was 14½ seconds—14½ seconds bristling with thrills and gasps.

The average play in football—about 4½ seconds—hardly gives the spectators time enough to work up to a state of excitement. It remains for the long plays, such as the kind just described, to give the greatest thrills. It is these long plays that we like to see and read about. During each second of actual play the suspense is tremendous, and this is what really makes football the game it is for the spectators.

WITH the exception of the unusual plays such as those described, the punts consumed the greatest amount of time. They averaged about nine seconds, and the straight line plays three seconds. The average forward pass, counting those completed and also the incomplete, averaged about six seconds. The adoption of the pass has helped to spread the players more, and has served to increase the average time per play, thereby increasing the period of suspense and true excitement. Hence this change was a most important one from the spectator's standpoint—the standpoint that made half-million dollar gate receipts per game possible. Years ago the spectator saw little more than two struggling groups of 11 men each, pushing up and down the gridiron. The object was sufficiently apparent, but not the method of attainment. Consequently the game's power to draw paying spectators was not at its present height.

But what of the fact that the total time the ball is in motion during an entire game is only about 12 minutes? Shall we establish rules which will double or triple this period—the time during which the players are giving their every ounce of energy and the spectators are really getting the excitement they crave? No, it would not be wise to do so from either the spectators' or players' standpoint. Have you ever noticed that you are quite tired at the end of a football game, and particularly so if you are keenly interested in the outcome? As the ball moves back and forth on the field, you unconsciously push in the direction you would like to see the ball move. When the losing side cuts the air with "Hold 'em" they are unconsciously pressing their shoulders against an imaginary wall.

Students of public speaking and oratory tell us that a speaker who gets his audience extremely interested not only sways them mentally but also physically. It is said that the entire group of spectators at a football game actually moves with or against the ball, and by careful observation these waves of motion can be detected. Therefore, even though you may be paying at the rate of $24.25 per hour to see actual football, perhaps it is best for you that there is only 12 minutes of it. If you kept this tension steadily for an hour, you might have to be carried out of the stadium.

Cagle takes the ball

And now from the player's standpoint. A man running the 100-yard dash in 9-3/5 seconds is expending energy and moving at a rate which he could not maintain for 30 seconds. He would become so fatigued, if he tried it, that his pace would slacken before he traveled 300 yards. So it is on the gridiron. The men are giving every ounce they have, while a play is being executed, and it is undoubtedly good that the time per play *is* only a few seconds. Under the present rules, the players—all of them who have played hard—are usually nearly exhausted when the final whistle blows. The law of fatigue holds for everyone, regardless of his physique; the time for fatigue to take effect varies, of course, in the individual.

Consider the wear and tear upon human endurance during the game, when men line up for action 140 to 180 times. Little wonder that a rugged physique and heroic courage are required of the players. Hence it now can perhaps be better understood why, toward the end of a game, some of their performances are not quite up to standard.

Scientists tell us that when a muscle is stimulated, lactic acid is liberated in certain parts of the muscle. As this stimulation continues, an alkaline solution neutralizes the acid, which tends to relax the muscle. The process can continue until the available supply of alkali for neutralizing the acid is depleted. Then the excess acidity of the muscle stops its further activity and a state of complete exhaustion has been reached. Our whole voluntary muscular movement depends on this chemical reaction with lactic acid. There is a very definite limit to the extent any individual can use his muscles before complete exhaustion sets in.

The best way to win a mile run is to continue at a pace which will just produce exhaustion at the tape. If the pace is raised beyond this point, untimely exhaustion is certain to take place and the race is lost. Naturally, the longer the race the slower will be the average speed for each individual. Consequently, if the present rules and method of playing football results in near-exhaustion of the players at the end of the game, a change in the rules so there will be more actual playing time, without increasing the total time between the initial and final whistles, would mean a slackening of the speed and deftness with which each play is executed. Such a change would certainly not improve the game for the spectators.

A STUDY of the tabulated results of the eight games, with the number of plays and the time elapsed, provides some very interesting and instructive data. The number of plays per game averaged 166. The average number of plays per quarter varied between 40 and 43. This indicates that the proposed plan to play the game on the basis of 40 plays per quarter, in place of a definite time interval, will give us just as much football per game as at present. And, according to Mr. Harry R. Coffin of Harvard and other advocates of the new system, there are some very definite advantages. They claim the suggested period-by-play method has the following merits:

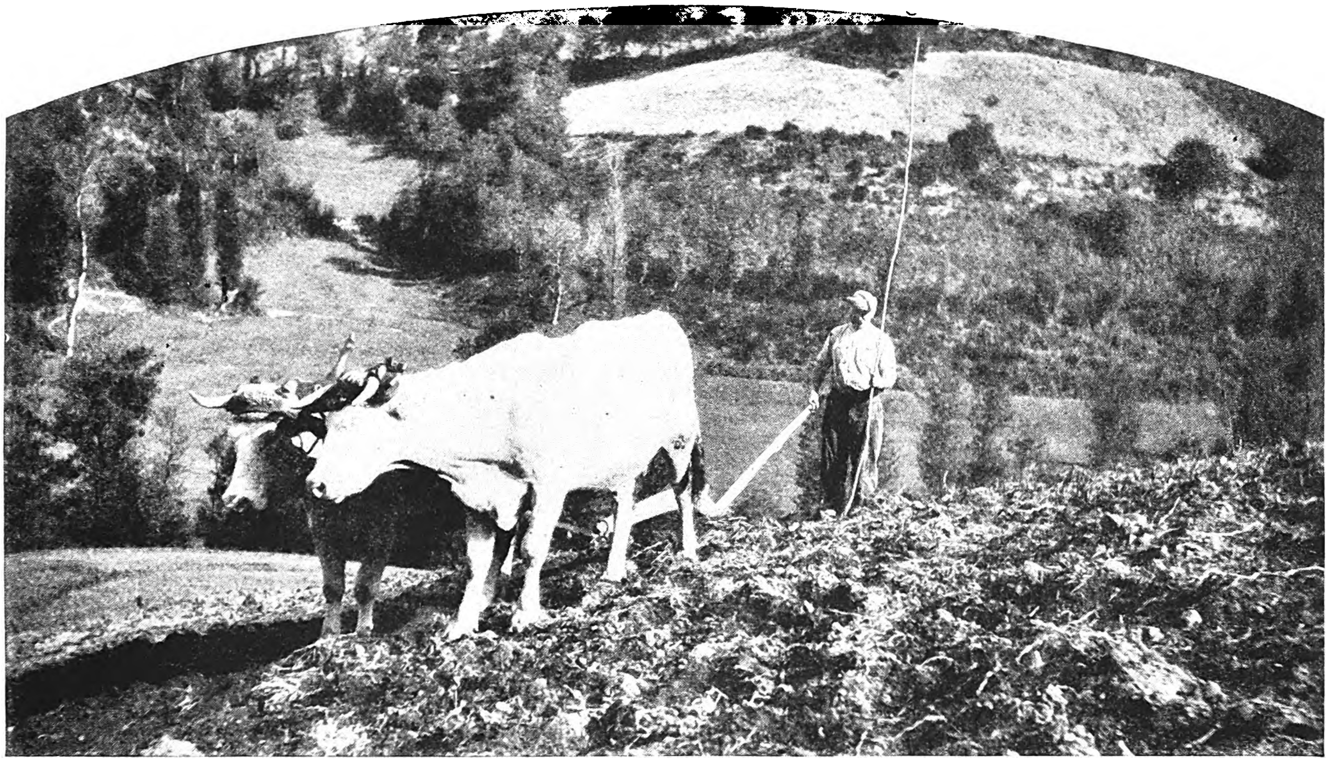
(1). It will eliminate the frantic use of the forward pass by the losing team during the final minutes of play.

(2). It will do away with any possibility of suspicious timing by officials.

(3). It will increase the interest of the spectators.

This system of playing was employed in the game between Brown University and Boston University in Providence on November 7, 1925, in which Brown won easily, 42 to 6. The consensus seemed to be that the score was too

(*Please turn to page* 411)



A member of the *Scientific American* staff also visited Glozel, as did the author of the accompanying article, and made this and other photographs. According to one account the original "discovery" at Glozel was made while the young farmer, Emile Fradin, was plowing with cows. By chance, on the day of the visit, one of the Glozelians likewise was plowing with cows and within a few feet of the famous discovery site, which was at left just out of the picture

THE STORY OF GLOZEL— A CHAPTER IN CREDULITY[1]

By DAVID RIESMAN
Professor of Clinical Medicine, University of Pennsylvania

THOSE who have read something about Glozel may wonder why I speak of it here. Is it not a dead issue? No, for as a study of human credulity and as a commentary on the hot-headedness (or should I say pig-headedness?) of many men of science it will always occupy a prominent place in the history of civilization.

Although many are probably familiar with the main facts, I want to give a brief synopsis of the involved story. I say "story" advisedly for from the very outset the mystery of Glozel has formed a fascinating tale; very much in the genre of our best thrillers, with plot and counter-plot, gum-shoe detectives, and all the pertinent paraphernalia.

Glozel is a small hamlet of four farmhouses, about 15 miles from the famous French spa of Vichy. Emile Fradin, then a youth of 18 and belonging to an old local family, was one day working in his grandfather's field when a cow suddenly slipped into an unsuspected hole. Fradin went to investigate and found that the hole led into an oval pit containing a variety of remarkable objects—bricks, tablets, vases—which he gathered and as soon as possible showed to the village school mistress, Mlle. Picandet. The latter in turn showed some of the tablets to M. Clément, a school teacher in la Guillermie.

EVENTUALLY the news of the discoveries came to the ears of Dr. Albert Morlet, a surgeon of Vichy and an amateur archeologist. Thereafter Dr. Morlet and Emile Fradin together began to excavate at Glozel and brought to light more and more buried objects which they collected in grandfather Fradin's house and which Dr. Morlet described in detail in an endless series of articles in a literary journal, the *Mercure de France*. It was through this magazine—the *Atlantic Monthly* of France in more senses than one—that I became interested in the Glozelian discoveries. My interest was especially aroused by the claim of Morlet and others that an alphabet had been discovered at Glozel which antedated every other alphabet then known. I therefore decided while spending a vacation in the Auvergne to see Glozel for myself, but before doing so I determined to interview Dr. Morlet in Vichy.

At first he suspected me of being an archeologist but when in answer to a direct question, I denied the soft impeachment and proclaimed myself merely a doctor, he became cordiality itself and showed me his collection of Gallo-Roman and Glozel antiquities. He told me that he as well as others had been inclined to consider Glozel as belonging to the Magdalenian age because of the presence of harpoons and of stones engraved with reindeer and other animals long extinct in France, but further studies had led to the conclusion that Glozel was Neolithic. Dr. Morlet kindly asked me to

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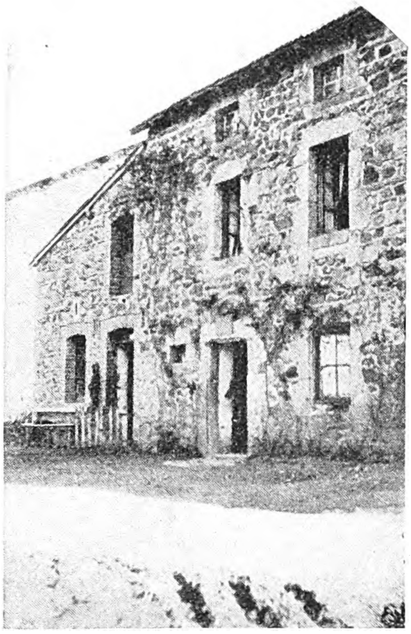
[1] Presented before the American Philosophical Society.



The little museum in the Fradin farmhouse. The crude sign mentioned by the author shows over the doorway. The picture was taken by a *Scientific American* staff member while perched on an "island" in the nearby manure-pile-quagmire, an entity which provides the cheery aspect from the typical French farmhouse. To see the exhibits he paid a few francs, as did the author of the accompanying article and, like him, was watched every instant by one of the Fradins; like a cat watching at a mouse-hole

stay over until the following day and dig with him and Professor Björn of Sweden, but I was unable to do so.

After leaving Morlet I motored, together with two American friends, to Glozel. Emile Fradin received us and at once offered to take us to the field of excavation. It was at the bottom of a deep ravine and was surrounded by a barbed wire fence. He showed us the original oval pit and the two tombs subsequently discovered. As it was raining hard and as the clayey ground was slippery, I declined his invitation to crawl into one of the tombs but asked instead to see the Museum. After paying two francs each we entered through a low door above which was a crude sign with the pretentious words, "Musée de Glozel," and found ourselves in a square low-ceilinged room with shelves on the walls and very primitive glass cases standing on the floor. The objects exhibited on shelves and in cases were astounding in number and variety—vases, tablets, engraved stones, ornaments (especially pendants), some pieces of glass, and harpoons, the last not nearly as artistic as those of Magdalenian age I had seen in Les Eyzies and at Laugerie-Basse.

Three articles attracted my special attention—vases or vase-like pottery ware having eyes, nose, and ears but no mouth, which Morlet has called death masks, explaining the absence of the mouth by assuming that the primitive makers wanted to express the silence of the grave. Secondly, a squarish object suggesting the female figure with a cylindrical projection from the forehead interpreted as the phallus—this Fradin told me was a bisexual idol; and most striking of all, clay tablets with graven signs looking in every way like alphabetical characters. I was struck by the clean red color of these tablets. When I spoke of this to Fradin, he explained it by saying that the soil in which the tablets had been found was such that it did not readily fuse with the clay and hence was easily brushed off. There were also some large casts of the human hand which differed from the imprints of the hands in the Spanish and French caves in having all the fingers present.

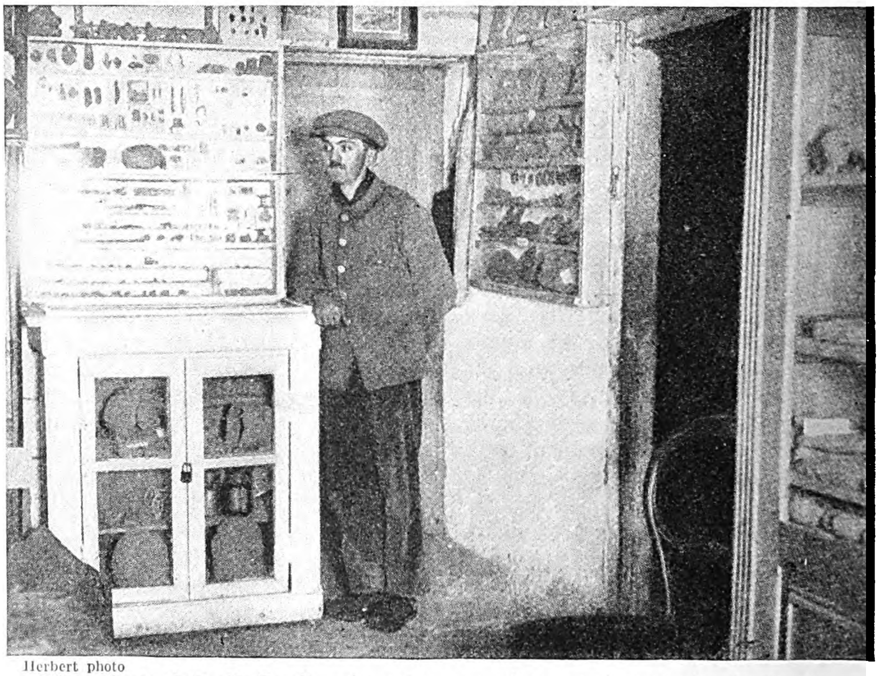
I offered to buy some of the articles, especially a tablet, but Fradin resolutely refused to sell. During the whole of our stay in the Museum, the grandfather stood silent and motionless in a doorway leading to an inner room.

The reputed discoveries of an alphabet dating back to Neolithic times, of which I had now seen the alleged evidence in abundance, created a tremendous sensation in informed circles. Altogether about 136 characters had been distinguished, representing every letter of the alphabet except the letter B.

Hitherto the credit for creating an alphabet had been given to the Phoenicians but the oldest known Phoenician record, found at Byblos a few years previous, dated back only to about 1300 B.C.; Sir Arthur Evens' baffling Cretan inscriptions to about 3000 B.C. If Morlet and those who agreed with him were right, then Glozel was truly what M. Reinach called it—one of the greatest archeological discoveries of all time.

ALMOST immediately after the first appearance of Morlet's reports, doubts began to be voiced about the authenticity of Glozel, though in the early period of the controversy there were perhaps as many scientists who accepted the discoveries in good faith as there were doubters. Soon the pro- and anti-Glozelians became personal and attacked each other with a vituperative vehemence and a destructive sarcasm for which the French language appears to be the ideal medium. Reputations were shattered, old friendships broken, and as one of the French dailies remarked—even butcher boys came to blows on the streets of Paris. In fact Mrs. O'Leary's cow did no greater damage to Chicago than Fradin's to the reputation of some French savants.

Before long the leading French pre-



Herbert photo

The principal, Emile Fradin, about 21 years of age at the time the site was investigated by the Committee. Although a humble peasant he had done better than average in school; he also was artistic and had done water color paintings. Perhaps it was a coincidence that the Glozel forgeries improved in technique from time to time as the schoolmaster Clément loaned Emile different pieces of literature on prehistory. The output of discoveries also corresponded with books given him by other interested dupes; it even accommodated itself in nature to the hopes and objections they expressed. Oddly, all periods of prehistory were represented by the objects discovered, from the Old Stone Age to historic times, and it is another coincidence that the illustrated textbook of prehistory in Fradin's possession covered the same scope. Picture taken in the museum historians with only an occasional exception began to deny the authenticity of Glozel and to declare the excavated articles to be forgeries. A number of Englishmen were likewise unconvinced. However, Dr. Foat, a London scientist, makes the categorical statement that "if the finds of Glozel are not authentic, it is equally necessary to consider as false all that I have seen in museums between London and Constantinople." Several Scandinavian, Belgian, and Portuguese scientists also supported Dr. Morlet, and a German, Dr. Wilke, in a recent article enthusiastically upholds the standard of Glozel.

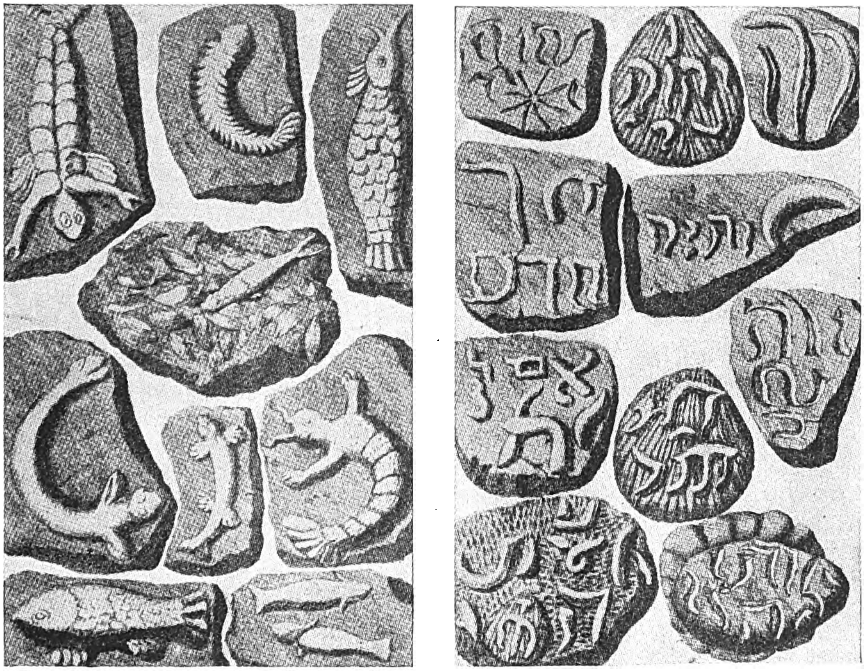
SCIENTIFIC AMERICAN staff photo

The actual site of the famous finds, at the lower end of a steep field above the valley of the Vareille stream. An attractive setting. The barbed wire fence around the site shows in the picture. It is easy for the tourist to reach Glozel; one goes to Vichy, where there are fine hotels, and hires a car to nearby Glozel

ARE Dr. Morlet's supporters right or is Glozel but one more of the long series of frauds that history recounts since Jacob imposed upon his father Isaac? Many will come to your minds—Thomas Chatterton, our own Dr. Cook, Constantine Simonides, the pretended author of the *Codex Sinaiticus*, the forger of the Mecklenburg Declaration, the Lincoln love letters in the *Atlantic Monthly*, the Tiara of Saitapharnes, and countless others.

One of the most interesting cases and the one having the greatest analogy to Glozel, if Glozel be a fake, is that of the so-called "Figured Stones of Würzburg." In the first half of the 18th Century there lived in Würzburg, in Bavaria, an ultra-pious physician named Johann Bartholomaeus Adam Beringer. He is not remembered for any great discovery or contribution to science, but for his share in a remarkable scientific hoax. At the time in which Beringer flourished an active discussion was going on as to the source and meaning of fossils. Although Leonardo da Vinci had understood their true nature—even Herodotus, 400 B.C. had a correct idea—the scientists of 200 years ago accounted for them as the result of "stone-making forces" of "formative qualities" or as growths from seeds. We may be inclined to smile, but with Dayton in Tennessee to chasten us, we can not throw stones at the Würzburg of two centuries ago nor at the Sorbonne which a hundred years later deprived the great Buffon of his chair because of his heterodox theories.

Beringer had committed himself publicly to the belief that fossils were the capricious fabrication of God, hidden by Him in the earth for some inscrutable purpose. His zealous maintenance of this fundamentalist position led some of the students, together with members of the faculty and wags of the town, to make numerous "fossils" of clay which they buried in the side of a hill where they knew the Professor was wont to search for specimens. Beringer, chancing upon these objects, was completely deceived. The jokers became bolder and buried the most extraordinary and extravagant figures their whimsical imagination could suggest. They fashioned tablets bearing inscriptions in Hebrew, Babylonian, Syriac, and Arabic, and buried them not far from the original spot. Beringer was overjoyed to find such abundant confirmation of his doctrines and forthwith in true German fashion proceeded to write an exhaustive treatise.



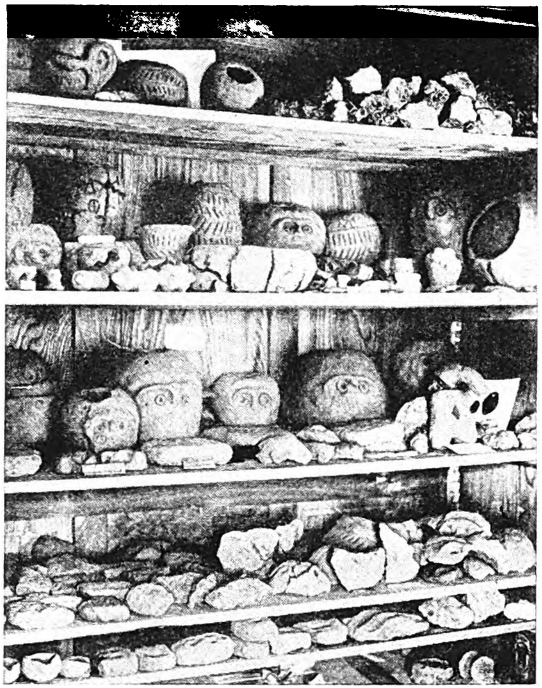
From the SCIENTIFIC AMERICAN MONTHLY, November, 1920. L. A. Hausman

Some of the famous Beringer fakes

THE wags now began to realize that they had gone too far. They expostulated with him and even told him the whole truth. Instead of believing them Beringer became more than ever convinced that the story his frightened colleagues told him was a ruse to rob him of the honor of his discoveries. No one could stop him. At great expense he published in 1728 the "Lithographiae Wirceburgenses."

Only too soon the shout of laughter with which the book was greeted brought the truth home to him. In chagrin and despair he exhausted nearly his entire fortune in a fruitless endeavor to suppress the edition and to buy up the copies already issued. He died soon afterwards, it is said, of a broken heart.

Is Dr. Morlet, like Johann Beringer, the victim of deception? Upon me personally he made the impression of an honest man. In certain quarters he was accused of fraud, for example, by the "Journal des Debats" and by the French Society of Prehistory. He promptly brought suit against them and won a



Herbert photo

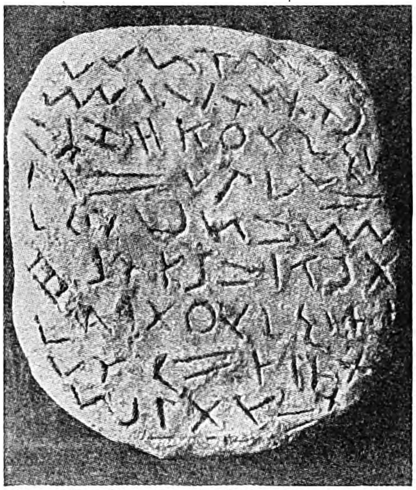
Exhibits in the museum of Glozel. Some are pots having eyes, nose, and ears but no mouth, as Dr. Riesman relates in his article. The "idol" to which he refers may be seen. Most of the objects in this picture are of pottery but the other finds have a wide variety— engravings on bone and stone, chipped flint and bone artifacts, and so on, representing a prodigious amount of industry on the part of (?)

verdict of 1000 francs damages. The defendants carried the case to the Court of Appeals at Riom, the native town of Willa Cather's lovable archbishop. In confirming the verdict, the Court gave expression to an amusing quibble. It held that Morlet, being a surgeon by profession and only by avocation a prehistorian, was not injured in the eyes of his real colleagues but only as an amateur archeologist. But as the defendants had not actually proved fraud, they were declared guilty though the fine was reduced to one franc and costs.

ANOTHER humorous episode might be mentioned. Regnault, President of the French Society of Prehistory, sued a Monsieur X because he, Regnault, had been compelled to pay the sum of four francs to see a collection of fake objects. As part of this legal action, the police of Moulins broke into Fradin's premises and took away a number of objects which were afterwards submitted to the public expert, M. Bayle. The latter reported that the tablets were of recent manufacture. Pieces of clay from a tablet crumbled readily in water; hence it was not conceivable that the tablets could have resisted the moisture in the ground had they been there for many years. Furthermore, a bit of grass picked out of a piece of earthenware showed under the microscope the vegetable cells, and some of the bone instruments still contained marrow. Bayle was soon afterward shot to death by one Philopponet against whom he had testified in court.

The Fradins themselves brought suit against M. Dussaud, member of the Institute, who in a trenchant brochure had called them fakers.

Let us now delve a little more deeply into this mystery so that we may understand better the basis of the controversy. The first serious doubt as to the authenticity of Glozel was based on the heterogeneity of the articles in Fradin's museum. How could one explain the presence of so many disimilar and unrelated objects—the 2000 or 3000 at the time of my visit have now grown into 5000 in one small field of excavation. No other archeologic site offers a parallel.



From "Glozel" by Dr. A. Morlet

One of the many inscribed tablets. After a fancied resemblance to the old Phoenician alphabet was mentioned the subsequent "discoveries" oddly came more and more to resemble Phoenician. Later, M. Bayle, the "Sherlock Holmes" of France, found minute strands of cotton colored by aniline dye in one of the clay objects. Perhaps, however, the apologists for the Glozel incident would say this proved that Neolithic man of Europe (5000 to 11,000 years ago) understood the synthetic chemistry of dyes

Morlet answered this by saying that Glozel was a *Champ des Morts,* a cemetery; and that, as among many primitive peoples of later times, everything belonging to the dead had been buried with him. C. Jullian, who considers Glozel a Gallo-Roman station, accounts for the multiplicity of objects by the assumption that Glozel was a sorcerer's sanctuary. He has added greatly to the gaiety of nations by attempting a full translation of the inscribed tablets from the published illustrations. Dr. Morlet showed me with much amusement a crack in one of the tablets which Jullian had translated as a character.

Aside from the puzzling complexity of the collection, it has been pointed out that the tablets first exhumed bore fewer and less perfect characters than the later ones. Further, as soon as some one had made a criticism, the objects next exhumed were free from the criticized defect. Quite often certain features appeared that could be traced directly to scientific articles published shortly before. These facts seem, of course, very significant. Moreover, the scratches on stones, whether representing animal figures or alphabetic characters, were without the patina covering other parts of the stones, suggesting a recent production. Much was made of the penetration of roots into vases or tablets; but upon examination these roots were not found to be properly fossilized, which would have to be the case had the objects been in the ground for long ages. The utensils—harpoons, hand axes, scrapers—are far less artistic than those in other Neolithic stations. Vayson de Pradenne and Abbé Breuil indeed contend that none of them could ever have been used.

DR. MORLET and his chief supporter Van Gennep did their best to answer all these objections. The former at the height of the verbal battle-royal made a request for a governmental commission which was speedily granted, but when he found that a bitter anti-Glozelian, the well-known archeologist Capitan was a member, he objected and the Commission was never sent. Eventually, at the International Anthropological Congress at Amsterdam an International Commission was formally appointed to investigate Glozel. The Commission consisted of Absolon, Director of the Archeological Museum of the State of Moravia; Bosch Gimpera, Professor in the University and Director of the archeological work of Barcelona; the Abbé Favret; Forrer, Director of the Prehistoric and of the Gallo-Roman Museum at Strassburg, Miss Dorothy Garrod, Member of the Royal Anthropological Institute and of the French Prehistoric Society; Hamal-Nandrin, Lecturer on Prehistory in the Museum of Liège; Peyrony, Director of the Museum of Les Eyzies; and Pittard, Professor of Anthropology in the University of Geneva. Absolon was prevented from taking part in the work of the Commission.

After spending three days at the site the Commission issued a unanimous report which was kindly sent to me by Miss Dorothy Garrod. This report states unequivocally that the articles are for the most part of recent manufacture and have undoubtedly been planted in the ground by some one whom the Commission does not name; and that Glozel is neither prehistoric nor authentic. Vayson de Pradenne in a devastating brochure in which he declared the Glozel finds fakes, also accused no one by name but put the blame upon the "Esprit de Glozel;" in other words upon a fairy.

ONE might think that with the leading French, English, and American scientists—Peyrony, Pradenne, Abbé Breuil, Sir Arthur Evans, Dussaud, and, I believe, Professor MacCurdy—arrayed against Glozel, and with the destructive judgment of the International Commission, Glozel would cease from troubling the scientific and the lay mind. Though all due obsequies have been performed, Glozel refuses to remain in its sepulchre, and the literary battle continues. Dr. Morlet constantly sends me newspapers and pamphlets[2] and a distinguished pro-Glozelian of Belgium, Professor Tricot-Royer, has just supplied me with his defense of Glozel which is particularly interesting because Professor Tricot-Royer was present during the visit of the International Commission.

What keeps Glozel alive? First we have the fact that when men take sides in print they are loathe to recant, fearing ridicule—the more untenable their position, the more stubborn their resistance.

Secondly, six months after the International Commission's visit Dr. Morlet called together a Comite d'Etudes consisting of Dr. Foat, Bayet, and Tricot-Royer of Belgium, Reinach, J. Loth, W. Loth, Van Gennep, Deperet, Ajcelin, Roman, Audollent of France, and Soderman of Sweden; all sympathetic to Glozel. At their meeting they pronounced unanimously in favor of its genuineness.

Another reason is found in the attitude of a group of French and German scientists who are opposed to the traditional belief that *ex oriente lux*—that civilization is of oriental origin. The alleged Neolithic alphabet of Glozel and similar finds at Alvao in Portugal are grist to their mill.

In addition quasi-political factors have entered into the controversy—Fradin an obscure peasant, Morlet a provincial doctor without much influence, have a definite appeal for the proletariat and for a large section of the press.

And finally, it must be remembered that the Academicians are not always right—that they ridiculed Pasteur and Boucher des Perthes; and even Koch and Lister met a similar fate in the beginning.

All these elements co-operate to keep the spark of life in Glozel. Within the past few weeks the publication of an exhaustive treatise by Dr. Morlet has been announced.[3] This, however, I fear, can throw no new light upon the subject.

Herbert photo

"The International Commission" of scientists making an official investigation

As a detective tale the story of Glozel remains unfinished and will remain so until a Sherlock Holmes discovers the person or persons who manufactured the articles and put them in the ground. What was his motive? How are we to explain the extraordinary industry that has fashioned 5000 or more articles, and how is it that he, the "Esprit de Glozel," escaped detection in a community of 29 souls where everyone knows everyone else's business. Or how, if there are witnesses to the dark deed, can we explain an unbroken neighborly silence extending over a period of six exciting years?

Herbert photo

Dr. Morlet demonstrating his claims at the site, before the members of the "International Commission" of investigation. Vayson de Pradenne, president of the Prehistoric Society of France, in *Antiquity*, characterises him thus: "Still young and endowed with wild energy, with an inflexible resolution and a naïve and immoderate self-esteem; devoid on the other hand of competence and of the critical faculty, he threw himself whole heartedly into the fray"

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[2] Similarly, the enthusiastic Dr. Morlet has sent clippings, newspapers, and pamphlets, and his publisher a book by the doctor, to a member of the *Scientific American* staff who, when passing through Vichy, attempted to see him, but who was given to understand by some one within the Morlet household that the doctor was seeing no one, and who left his card. Residents of Vichy suggested that the doctor was finding it expedient to "hide out" at the time, until the legal storm might blow over. —*The Editor*

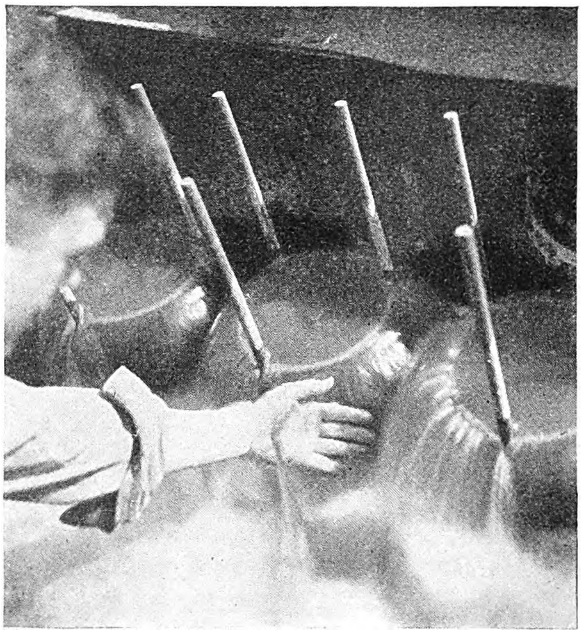
[3] "Glozel," by Dr. A. Morlet, a copiously illustrated work published by Georges Desgrandchamps, 23 rue Boissonade, Paris (XIVe). The especially interested reader will find a 20-page article entitled "The Glozel Forgeries," by A. Vayson de Pradenne, President of the Prehistoric Society of France, in the journal *Antiquity* (Gloucester, England), Volume 4, No. 14. Several *Cahiers de Glozel*, some by Dr. Morlet in his own defense, have been published by Paul Catin, 3 rue Sabot, Paris (VIe); other matter, by Octave Belin, 26 rue Pasteur. —*The Editor*

BY-PRODUCTS FROM INDUSTRIAL WASTES

By ERNEST W. STEEL

Professor, Municipal and Sanitary Engineering,
Agricultural and Mechanical College of Texas

A STATE legislator not long ago seriously advocated the abolition of the state health department, and by inference all health departments, on the ground that at best they were wasters of public funds and nuisances. Persons of the same opinion may be surprised to learn that the complaints of health officials have stimulated industries to reclaiming large amounts of valuable materials which were wasting unheeded into streams and municipal sewage.



Clear overflow from equipment that reclaims an appreciable amount of wood fiber from the discharge water in a paper plant. Where this is not in use, the discharged water pollutes streams and kills fish

The liquid wastes of many industries are of such a nature that they cause serious troubles in streams and at municipal sewage treatment plants. In the streams, fish are killed and the water is made unsuitable for water supplies and recreational uses. At the sewage treatment plants, the biological action may be upset by antiseptic substances, or the enormous volumes of organic matter from the industry may overload the plant to such an extent that it must be increased in capacity or must bypass untreated liquid into streams. Accordingly, many industries have in the past few years been notified by cities and state health departments that the burden of waste treatment must be assumed by the industry, either completely or in large part, before final discharge into sewers or streams is permitted.

SUCH notices have been received with apprehension by the industries concerned until study of the problem showed that what appeared to be a liability was capable of returning profits. An example of this is the Corn Products Refining Company of Argo, Illinois, which manufactures starch and other corn products. Final disposal of its liquid wastes is a matter of much concern to the Chicago Sanitary District. The chemists of the District found that the wastes of this plant were so large in volume and contained so much organic matter that they were equivalent to the sewage of a population of 800,000. The treatment of this waste was, of course, too great a burden to place upon the taxpayers. The alternative appeared to be the construction by the company of a special treatment plant, estimated to cost 2,900,000 dollars.

Investigation of the plant with respect to sources of the waste indicated that a considerable portion of valuable product was escaping into the waste pipes through poor control of certain processes. Improved mechanical equipment and weeding out of heedless operators remedied this. Result: a 10 percent decrease of the waste, and an increased output.

The greater portion of the waste, however, was composed of the liquor in which the corn is first steeped and softened. By installing comparatively inexpensive equipment the steep-water can now be evaporated to such a consistency that it can be used for making a stock feed. Result: an annual return of 500,000 dollars which was formerly lost through waste, and a reduction of volume and concentration of the plant waste from a population equivalent of 800,000 to about 50,000. The present wastes owe their strength to the organic matters distilled over in the vapors of the steep-water during the concentration process. It is possible that some valuable constituents can still be extracted, and further experimental work is being carried on.

Another industry which has frequently been embroiled with health departments is that of coke making. Coke is made by distilling coal, and many valuable products are in the distillate. After these are removed, there remains a liquid containing tar acids and phenol, or carbolic acid. The latter is especially troublesome, particularly if the stream or lake which receives the wastes is a source of municipal water supply within many miles of the point where the waste enters. If the water supply is chlorinated, the phenol taste is particularly bad. The disagreeable medicinal taste of the combined phenol and chlorine has been noticed when the water contained only 1/25 of an ounce of phenol to a million gallons of water. Methods of recovering phenol from the still-waters have been developed and now it is possible to extract it and obtain salable phenol in amounts sufficient to pay the cost of extraction.

THE phenol problem has also received much attention on the part of scientists of France, Denmark, and Germany to prevent pollution of the relatively small rivers of those countries. From their studies comes a new and startling solution. It has been found experimentally that if the phenol-containing liquid is applied to the soil, the injurious constituents are converted into ammoniacal compounds which can be utilized by soil bacteria and act as crop fertilizers. The conversion process takes about two weeks. Previous to the change, of course, the phenol is injurious to plant growth and accordingly the liquid must be applied a proper length of time before sowing. A very important advantage claimed is that, while the phenol is still active, it will destroy weeds and injurious insect larvae present in the soil. The combination of fertilization and weed and insect killing properties may change entirely our methods of disposing of this troublesome waste.

In the bituminous coal mining regions of the eastern states there have been many disputes between mine operators, cities, state health departments, and fish conservation commissions. The drainage water of coal mines contains little or no dissolved oxygen and hence will not support fish life. It will so lower the oxygen content of streams into which it discharges that fish cannot live in them. Mine wastes are even more troublesome because of the acid and other chemicals which they have dissolved out of the coal beds. Acid is a killer of fish and in addition makes the polluted streams black and evil smelling and unsuitable for municipal water supplies. The only remedy found so far has been to require owners of mines to seal up those abandoned workings from which drain water trickles down the hillsides. Lately, however, the Kaplan process is reported from West Virginia. It consists of adding to the mine waste a complex chemical which combines with the undesirable chemicals to form a useful blue pigment, which has a far greater value than has the chemical reagent added. Appropriately enough, the new pigment has been called Monongahela blue.

IN all of the forested states are mills engaged in turning wood into various grades of paper. The process requires much water—to break down or digest the wood into fiber, to wash it after digestion, and to convey the fiber around the plant through pipes and channels. Indiscriminate discharge of the wastes has changed streams which traverse regions of great scenic beauty into black and evil-smelling open sewers. Fish are destroyed. Regions which are ideal for camping, fishing, and vacationing are spoiled.

The paper industry, however, after exertion of much pressure by state health and game officials, is doing much to remedy the situation. Study of plants indicated that much of the conveyor water with its valuable fiber was escaping accidentally or through remediable carelessness. Some fiber unavoidably escapes from the paper machines. This waste is being reclaimed by special patented sedimentation processes which allow return to the plant of the rescued stock. At some plants the water, after removal of fiber, can be returned for further use. This is especially profitable where the water must be pumped long distances from the original supply or must be filtered or otherwise treated before it can be used.

The wastes from the digesters and washers contain much chemical matter that is especially undesirable in streams. The chemicals need not be lost, however, and most paper plants are now installing systems for evaporating this waste. After evaporation, the residue is burned and the chemical is regained in a modified form. The magnitude of this procedure is indicated by the fact that 7000 gallons of water must be evaporated for each ton of pulp manufactured.

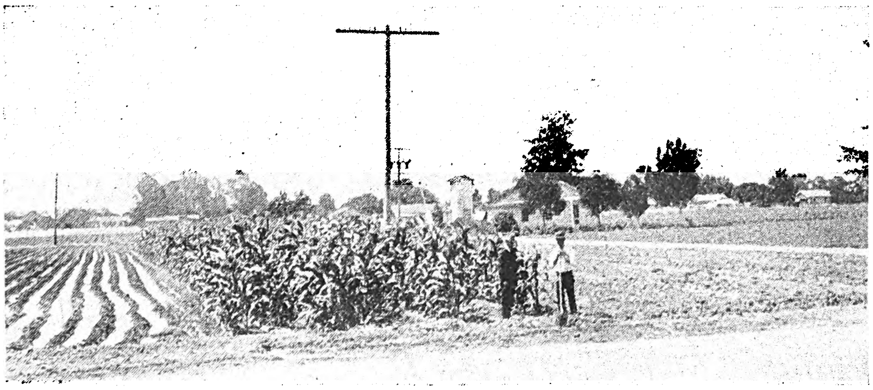
Most troublesome of all problems to the paper industry is the disposal of the highly corrosive liquid wastes from the sulfite pulping process. Some progress has been made by some plants which are converting the waste into adhesive and other by-products having commercial value. Experimentally, investigators have found that alcohol, road binders, linoleum cements, dyes, fertilizers, and many other products can be made. The difficulty is that sulfite waste is produced in such enormous quantities that if all of it were converted into by-products, the market probably could not absorb them all, although alcohol manufacturing may possibly be the final solution.

THE textile industries also produce troublesome liquid wastes. Foremost among these in difficulty of treatment is wool-scouring waste. It contains much dirt, wool fiber, and grease. Wool fibers can be caught on fine screens and returned to the plant. Grease is highly undesirable at sewage treatment plants, and wool-scouring establishments are required, or at least encouraged, to remove all grease before discharging wastes into sewers. After removing grit and heavy dirt, the waste is treated with sulfuric acid which changes the grease into a thick scum and sludge easily removable from the liquid. The scum and sludge are then pressed and the grease is squeezed out. The grease so obtained is very largely lanolin, which is much used as a base for medicinal ointments. The cake that is left behind after grease extraction has some value as a fertilizer.

The most frequently encountered waste is that from plants which handle milk or manufacture milk products. At sewage disposal plants, milk waste sours and upsets the normal bacterial action. Discharged directly into streams, the usual results of stream pollution, nauseous odors, and killing of fish follow. The whey from cheese-making plants is especially troublesome in this respect. Whey has been found to be a valuable hog food and is returned to farms for that purpose. The ordinary milk wastes contain much casein. It can be precipitated by small amounts of sulfuric acid and the resulting thick sludge fed to chickens or hogs. Since casein has many uses in the industries and can be converted into glue, or into poker chips and other artificial ivory objects, it is highly probable that the large condensed milk and cheese factories will eventually salvage this material.

IN spite of the progress which has already been made, stream pollution by industries is a rapidly growing problem. This is due not only to the increasing industrialization of the country but also to the tendency of industry toward decentralization. Formerly industries grouped in certain regions or in the large cities. Their wastes, together with the domestic sewage of the large concentrated population, were discharged into the large rivers, lakes, or harbors where centers of population naturally developed. Comparatively few bodies of water, therefore, were grossly polluted. Now, however, factories of all kinds are scattered over the country. Advantageous as this may be to the industry and to its employees it has been harmful to many streams.

Possible damages to streams should be a matter of concern to all industries contemplating relocation. Town and city officials who are tempted to bid eagerly for a new industry would do well to inquire into the nature of the wastes which it may unloose upon the countryside. Should deleterious wastes be features of the particular manufacturing process, an agreement as to their disposal may prevent unpleasantness. Finally, where wastes are already causing trouble, scientific inquiry, carried on by the industry in co-operation with the proper governmental authorities will probably bring about a solution to this problem, the growth of which is measured by the growth of industry.



Milk wastes discharged into streams cause harmful pollution. This photograph shows creamery wastes being used to irrigate a farm

THE YOUNG GIANT: NATURAL GAS FUEL*

THERE was a slight trembling as, 480 feet below the surface, the crude string of tools dropped into a pocket. The trembling became a dull rumbling, like distant thunder, and the rumbling a rapidly swelling roar until there burst from the mouth of the rough casing a mighty column of mud, oil, and water, borne on the driving fist of a tremendous pressure that rocketed tools and equipment high into the air.

The drillers cheered. At last, after two years of slow, plodding effort, they had struck oil. They were rich.

But their cheering was short-lived. The dark stream soon thinned out and then disappeared altogether, leaving only a colorless substance escaping into the air and a roaring noise that seemed to mock them. The well was a failure, it seemed, for they had struck, not oil, but a gas pocket.

For days the terrific pressure blasted millions of cubic feet of natural gas into the atmosphere in an ignorant waste that would make the gas producer of today weep, while the owners of the well stood around disconsolately and wondered if any oil would follow. Finally, after weeks of waiting, they gave up hope. Some months afterward the roaring gas jet was ignited and the towering torch lighted the countryside for miles around, symbol of a later day when natural gas would be burned for heat and power in home and industry.

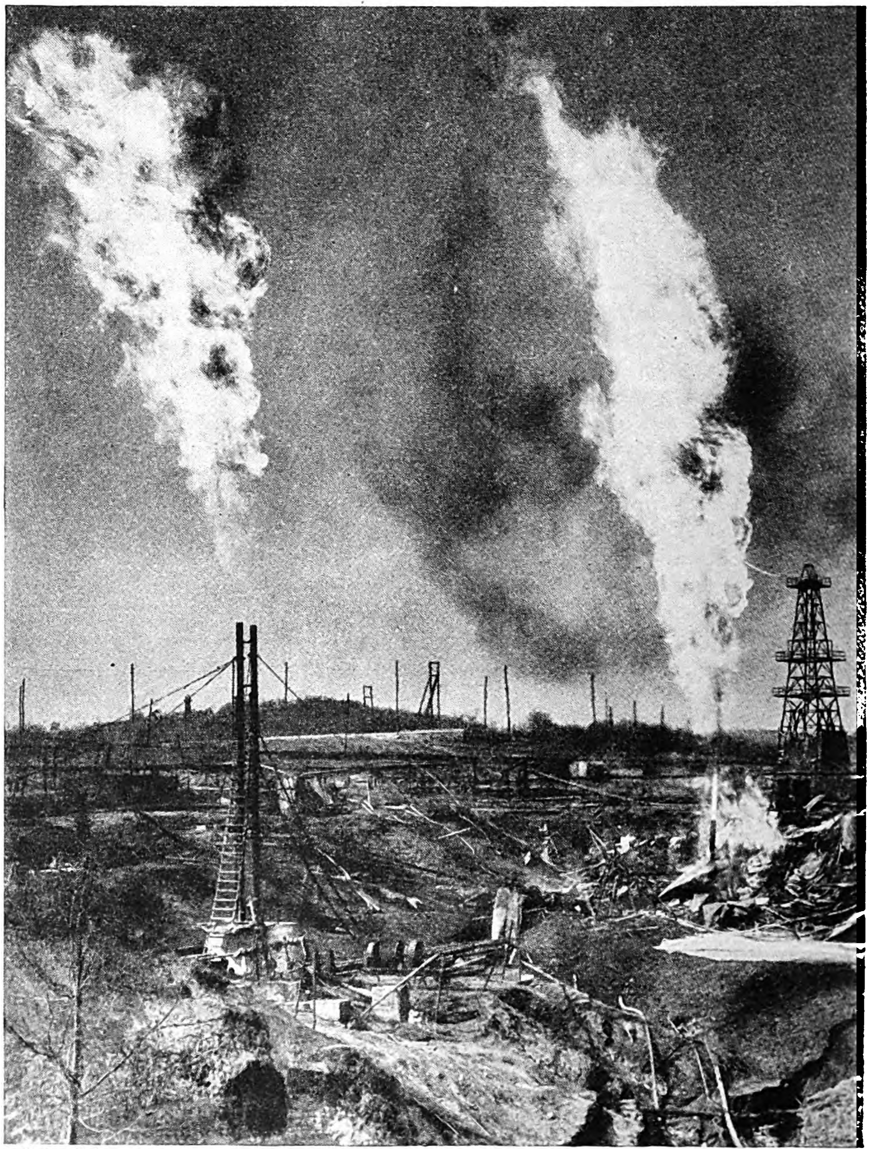
THE above incident, which is typical of hundreds, probably, in the early boom days of the petroleum industry when oil was the gold men sought, actually took place at West Bloomfield, New York, in 1865.

As a matter of fact, natural gas is as old as petroleum in the experience of men. But because it was often practically invisible, ignorance shrouded this masquerading giant of power in a veil of superstition for many centuries. The ancient oracle of Delphi is said to have been situated near natural gas fissures. According to the story, a shepherd noticed that some of his goats wandered about queerly in a certain spot. Going over to investigate, he felt a certain lightness coming over him. Villagers came at his call and immediately experienced the same dizziness, talking in disjointed sentences. So they concluded that a god must live there who had cast a supernatural spell on the place, and accordingly built a temple on the spot.

The Chinese and Japanese may have been superstitious too, but apparently they didn't let their fears blind them to the useful nature of the product. Plenty of evidence has been found to show that these people burned natural gas and even transported it in crude lines made of bamboo or animal intestines. History is full of similar instances. But it was not until 1821 that the first gas well was sunk near a spring at Fredonia, New York—a good 38 years before Colonel Drake's historical oil well at Titusville. Like petroleum, however, gas had been discovered before while boring for salt.

Between superstition, ignorance, and, later, mechanical difficulties of production and transportation, it has taken man many centuries to tame the "wild spirit" of prehistoric times and put it to work for him. A natural gas pipeline map of the United States would show a connecting maze of gas lines in many parts of the country, yet not so very many years ago natural gas was only a by-product, a waste that had to be blown off sometimes before the oil came; or, at best, something that held the pressure which carried petroleum to the surface and saved a certain amount of pumping.

Natural gas operations represent literally an "industry within an industry." Yet the business of producing, transporting, storing, and marketing this



Ewing Galloway

A scene typical of many during the early days of oil well drilling: a well comes in with a roar of gas which, accidentally becoming ignited, is wasted

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*Reprinted through the courtesy of *The Lamp.*

product differs widely from that of petroleum in many respects.

Consider production. In appearance, a gas field looks very much like an oil field to the layman. There are much the same derricks, tools, toolsheds, and pipelines. But the problem of pressure is much more vital in gas operations. The producer cannot put his well on the pump, as the oil man can, when the pressure fails. And the first well down in a new field, naturally enough, gets the full pent-up pressure of the entire area, which may be considerably reduced by the time other bits reach the gas-bearing sand. On the other hand, pressure is not always an indication of how prolific a field is likely to prove. Many an apparently promising area has come suddenly into being, yielded abundant stores for a year or more and then just as suddenly gone dead.

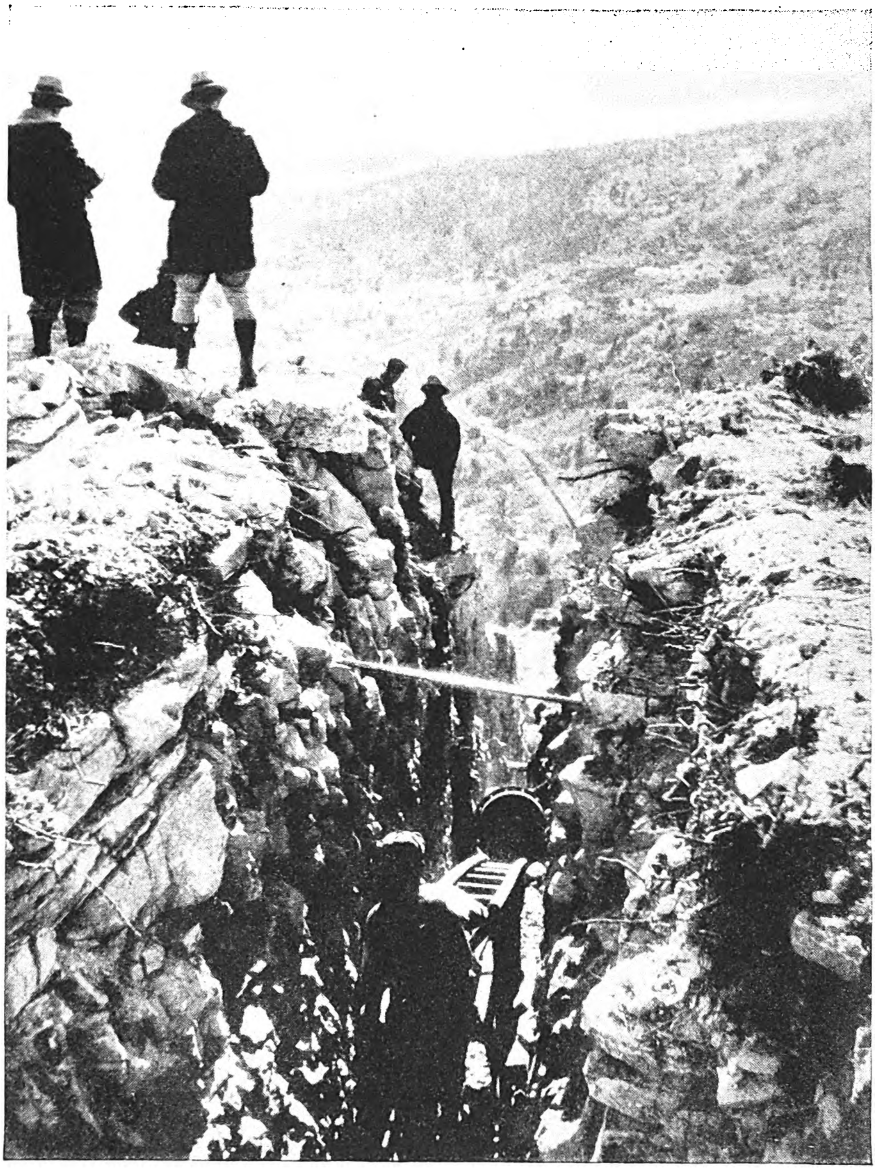
Just as difficult is the problem of transportation. Where the oil man can ship his product by pipe-line, tanker, tank car, by barge, in barrels, or in any other way that emergency may suggest, the gas producer has only one channel of transportation—pipe-lines.

ONE of the most perplexing problems, however, which the industry has had to face—one which has largely been solved by developments entirely without its sphere—has been that of marketing. As might be expected, the first use of natural gas was in the home. In areas within reasonable distance of producing fields, natural gas could be supplied cheaper, very often, than the manufactured product. But here the industry was up against the problem of seasonal demand. Inevitably, extremely cold days multiplied the drain on his pipe-line system eight to ten times. Just as surely, morning and evening drew heavily on the lines, with consumption comparatively slack during the day. Natural gas can not be manufactured as needed. If the supply is too great, the product must be kept in the ground. If it runs short, the producer has to find new fields if he expects to stay in business.

Let's see what the industry has done to get around these obstacles.

First of all, there is far less waste than in the old days. Seldom does one see gas blown wantonly into the air from wells sunk into strata containing both gas and oil. The former is far too useful for re-pressuring oil sands—to say nothing of its commercial value—to throw away. Next is the matter of storage. The producer today has found that by far the most efficient and economical method of storing his product is right in the ground from which it came.

It has been the widespread growth of industry and manufacturing, however, which in the last analysis has changed the whole outlook of natural gas markets, given the producer an incentive for seeking new and richer fields, and economically justified the huge capital expenditures for lines from producing areas to industrial centers.



A rugged ten miles of scenery on the Denver gas line. In distributing gas from the fields, pipe-lines must be laid across mountains and through rivers

The United States is the greatest manufacturing nation in the world. Nor are the factories and industrial plants of the country now crowded into the northern states, as they were in former years. Today industry thrives in the south and west where formerly cotton pickers crooned in the sun and cattle roamed the plains. The natural gas business was quick to realize that here was a chance for mutual development. Its new customer would consume gas in large quantities, and at a comparatively uniform rate throughout the year. In return, the industry could offer him the cleanest fuel known to science with a high heating value of approximately 1000 B.t.u. per cubic foot, one that burns completely with no smoke or ash.

It has been estimated that there are over four billion dollars invested in the United States today, in the various producing and marketing areas scattered over the map, with thousands of miles of trunk and feeder lines, like spider webs in a garret. The output of energy from natural gas burned in the United States during 1929 was estimated to be equivalent to 527 billion kilowatt hours—nearly six times the total production of electricity for the same period. Known fields, with improved methods of computing reserves, give the industry almost unlimited supplies of raw material to work with. Texas Panhandle and the Monroe-Richland field alone can assure the industrial markets of the south and middle west of adequate resources for many years to come. Yet all these assets of supply, scientific methods, and expanding markets which Nature, their own inventiveness, and evolving conditions have given the men engaged in natural gas operations, might well prove to be so many stones, yielding no profit, were it not for one thing. The industry has found to a remarkable extent the way to real practical co-operation.

The natural gas business is not a one-man job, so to speak. The product itself is easily susceptible of waste; and producing areas, unless scientifically drawn upon, may lose much gas that never reaches the market. The laying of lines from field to market involves the expenditure of millions of dollars. In distributing the product to numerous towns along the right of way, as well as at the destination of the main line, countless local interests have to be taken into consideration.

Here, then, is an invaluable natural resource. To bring it from its age-old prison, thousands of feet under the earth, to the burners of various industries in widely separated parts of the country, calls into play hundreds of varying interests. Producer, landowner, engineer, municipality, consumer, scores of others, all have their rights; all must be considered. The tiniest cog can wreck the whole machine.

So the tremendous projects which have been successfully swung by the natural gas industry speak volumes for the fine degree of co-operation, orderly exploitation, and scientific development within its ranks.

The eastern section of the United States was the cradle of the natural gas industry in America. From the producing fields in West Virginia, Pennsylvania, and east Ohio has crept a maze of pipe-lines carrying fuel to the scores of industrial centers throughout that territory, until the map takes on the appearance of a jig-saw puzzle. Today those eastern subsidiaries of the Standard Oil Company (N. J.) operate something like 16,000 miles of main and feeder lines, with estimated distribution for 1930 of 104 billion cubic feet of gas.

Yet, even before eastern markets for natural gas had developed to their present proportions, the wildest gambler would never have undertaken to pipe the product to Baton Rouge, St. Louis, or any of the great centers of the south or middle west. The industry would have laughed at him. And—at that stage of development—it would have been right. Production methods were not as scientific as they are today. Nor were the compressors and lines of a quarter century and more ago as efficient as they are today. Men had no way of estimating with any degree of accuracy the potential output of a field, and the industry could hardly be expected to gamble an investment which it would have to carry 10 or 20 years on the chance that the elusive material in the sands under their wells would last that long. Finally, many of the markets in the south and middle west were not yet ready for natural gas.

So fate played a fortunate trick on the industry in hiding from geologists the prolific Monroe-Richland and Panhandle fields until a time when the engineer and consumer had prepared the scene for more extended use of their treasures.

Panhandle is undoubtedly the greatest natural gas producing field in the world today, with the Monroe-Richland area not far behind. It is almost impossible to estimate how much gas lies locked in the sands of these two fields, needing now only the turn of a valve to release it. But a fair idea may be gained from the fact that the combined capacity of lines already tapping them runs up to several hundred million cubic feet daily.

Amarillo field alone, in the Panhandle district, was thought two years ago to hold some 10¼ trillion cubic feet—enough to keep a line of 100,000,000 cubic feet per day capacity operating continuously at full force for nearly 300 years. That this great natural wealth may be expected to last many years is plainly testified by the investments of many millions which have gone into the construction of 300-, 400-, and 500-mile lines.

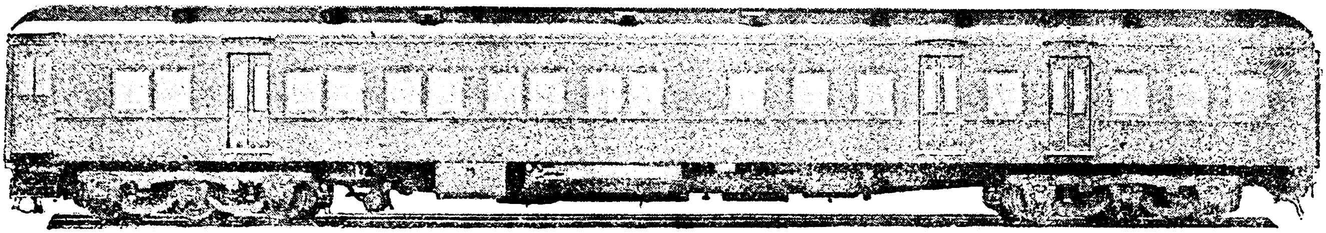
There are three main projects through the south and southwest in which Standard Oil Company (N. J.) subsidiaries have an interest, the most recent being the Mississippi River Fuel Corporation's 431-mile line from Monroe to St. Louis. In addition to the main line, branches will make the gas available to industrial plants in Crystal City, Missouri; and in East St. Louis, Granite City, and Alton, Illinois. Other industrial consumers within reach of the main line through Louisiana, Arkansas, and Missouri also will be served.

In 1927, the Interstate Natural Gas Company completed its line from Monroe to Baton Rouge. The Interstate also contracts to furnish gas from its Monroe reserves for the Southern Natural Gas Corporation's line to Birmingham, Alabama; Atlanta, Georgia; and various adjacent points, as well as to several other interests. Over in Texas the Canadian River Gas Company transports the fuel from Amarillo Field, in the Texas Panhandle district, to Clayton, New Mexico. Here it is purchased by the Colorado Interstate Gas Company (N. J.), and brought to Pueblo and Denver, Colorado, as well as to other towns along the way. In addition, the Colorado Interstate supplies gas for a line north from Denver to Fort Collins.

And so the natural gas industry has grown. Once a "wild spirit," represented by mysterious pillars of fire that issued from fissures in the earth to terrorize natives, then an incidental by-product of oil drilling, natural gas today not only has found its way into homes in many districts, but more and more is replacing its brothers, fuel oil and coal, for numerous industrial purposes. Glass, ceramic and cement plants, steel mills, brick, lead, enamel ware and vitrified clay manufacturers, oil refineries, power plants, and all other industrial users within reach of existing or projected lines are giving ample illustration of the value of the product.

To what extent new producing areas, further improvements in drilling and transporting technique, and the possibility of mixing natural with manufactured gas for maximum economic usefulness in larger centers may justify extending the web of pipe-lines to other parts of the country, plans already announced and others in formation will reveal in the next few years.

Back to the primitive. In swampy land such as this, oxen and mules have proved to be about the best motive power for transporting pipes for the pipe lines



Photographs courtesy The Pullman Company

Invalids to or from the Mayo Clinic at Rochester, Minnesota, may ride in comfort in this special car

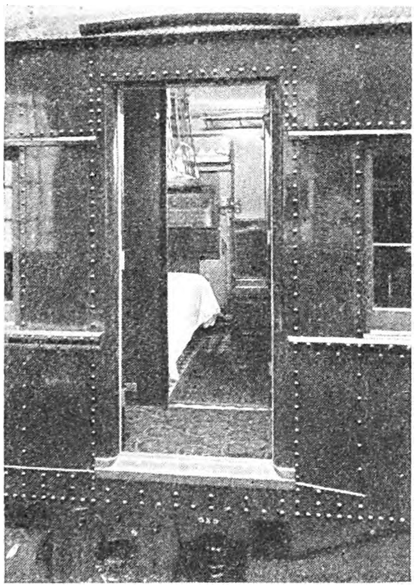
THE SICK MAY RIDE IN PULLMANS

THERE have recently been built, for operation on the Chicago and Northwestern Railway, two Pullman cars specially designed for the comfortable transportation of invalids. These cars will be operated between Chicago and Rochester, Minnesota, home of the famous Mayo Clinic.

Besides the regular platform entrances at the car ends, three doors are placed on one side of each car for the direct entrance of stretchers. These special doorways are 30 inches wide and two of them are so located that a patient on a stretcher may be carried directly into the room he is to occupy; the third provides access to the open-section division of the car. The rooms thus reached are extra wide, and provided with extra wide doors, so that the transfer from stretcher to bed can be made with the least discomfort to the patient.

Each car contains eight open sections, one drawing room, and four rooms; each room having a stationary single bed and an upper berth, as well as folding lavatory arrangements. The upper berth is available for occupancy by an attendant. At the section end of the cars is the lavatory for men, while that for women is at the opposite end.

Particular attention has been given in the construction to eliminating as much as possible the noise of travel. Diaphragms at the car ends are spring-hung from the top, the arrangement greatly reducing the amount of car-end rattle. Further, rubber insets have been placed between car trucks and bodies at points of contact, to absorb shock and further reduce noise. The cars are also equipped with roller bearings.

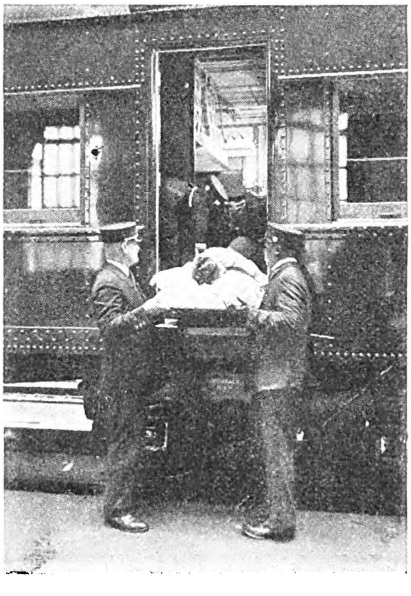


The side door, 30 inches wide, gives access to one of the private rooms

Of invalids who require to travel, the proportion who are entirely bed-ridden is small; nevertheless a considerable number are either bed-ridden or require support in getting about; for these latter a short stretcher, really a canvas seat, 30 inches long, has been devised. This stretcher can be easily handled on entering or leaving the car, because the corridors have been widened for the special purpose of accommodating them. In the ordinary car it has often been necessary to remove a window sash in order to permit a person on a stretcher to be lifted in or out.

The third side-wall door, for patients whose space is in an open section, opens into the crosswise corridor which separates the men's lavatory from the aisle between the sections. Thus only one turn has to be made in carrying the patient in or out, and the use of the platform door and vestibule is avoided.

In a number of other details these cars have been arranged to accommodate this special service; for example, electric heating pads are provided. The cars were designed under the supervision of Dr. Thos. R. Crowder, Director of the Department of Sanitation and Surgery of the Pullman Company. They are appropriately named the *Ephraim McDowell* and the *Joseph Lister*, in honor of two men whose contributions to surgical science have been particularly notable. Ephraim McDowell was not only a country doctor, but a country doctor of pioneering days; he practiced in and about Danville, Kentucky, and there, in 1809, successfully performed the first major abdominal operation ever undertaken, for the removal of an ovarian tumor. There in the backwoods, before the days of anesthesia, unassisted, and with only the crudest of facilities, his boldness and skill combined to bring success in an operation of a type which, now commonplace, has since been the means of saving uncounted lives. Dr. Joseph Lister was the English surgeon who discovered and developed the principles of antisepsis.



The loading and unloading of invalid passengers bound for the Mayo Hospital is rendered easy by the side doors which permit the direct transfer of the patient on a stretcher to the car

A typical scene taken during the filming of a talking motion picture. The microphone is the cylindrical object suspended by cords in the center of the set

THE TECHNICIAN TALKS ABOUT THE TALKIES

By RAYMOND FRANCIS YATES

SINCE the silence of the silent drama has been so effectively—or shall we say devastatingly?—broken, much has been said pro and con concerning this new magic of the movies. It must be confessed that, as measured by the box office receipts, "talkies" have, within the startling space of two years, emerged from the state of an uncertain experiment into that of a bombastic success. How deserved this success has been from a purely artistic or esthetic viewpoint, or how lasting it will be is a matter of some conjecture even at this late stage of development. This much may be said, however. The movie makers have, by sheer luck, struck upon a ready-made, ready-to-use idea that has revitalized the whole industry and captivated a public that is still applauding with enthusiasm.

As large as the success of this new idea has been there are many dissenting votes and much disillusionment on the part of movie goers who want their drama on the hoof, and who demand something more dramatically and emotionally substantial than heated bedroom scenes and voices that sound as though they might be produced when noses are clamped with clothes pins. In short, the talkies have not been universally successful and the possibilities of reaching this point will become more and more remote unless our movie manufacturers see more quickly their folly in attempting to produce pictures to meet the fickle demand rather than a standard of artistic perfection. We have seen and heard the talkies in their unpolished nakedness, and now we want stark realism with a ring of real sincerity back of it.

THE movie manufacturers have still much to learn of technical control of sound recording. To put a bald record of voice or music on the sound track of a film or the wax of a record is one thing. To give that record the expansive breath and verve of life is quite another thing. Even a superficial observer of talkie technique cannot help but lament the obvious absence of realism that is so noticeable in the average production. Contrary to what appears to be the established opinion of the critics, the fault does not lie wholly in the technical limitations of the electrical equipment but partly in its manipulation. To draw an analogy: the movie makers are playing a Stradivarius with the technique of a fiddler at a barn dance. In their frantic effort to please a fickle public and to take advantage of a demand that has swept down upon them with unprecedented fury, they have failed to tap the resources of their equipment.

Situated between the microphone in the set and the recording apparatus there is what is known as a mixing panel. Here the monitor listens-in on all sounds passing over the circuit on their way to the wax and photographic film records. This vigil of the monitor is of vast importance for it is he who regulates the degree and intensity of the sound-laden currents passing over the circuit on their way to the "canning factory." The monitor is lord over all that he hears; he may by a twist of his wrist make a whisper out of a call for help, or he may on the other hand make a cough sound like an eruption of Mt. Vesuvius. It is all in the knobs!

At present it is the monitor who is the weak link in the chain. He is all technician when he should be part technician and part artist. He is interested largely in microamperes and the response curves of audio-frequency transformers when esthetic effects and realism should be uppermost in his mind.

SOME months ago the writer was seated in the studio theater of one of our largest producers, reviewing bits of a musical comedy that had recently been filmed. The novices present talked with a learned air about the "highs" and "lows" of the recording, at the same time being serenely insensible to the appallingly bad job of monitoring that had been done in recording the sound. There was a close-up of a young lady engaged in a normal conversation with a friend. While talking, this young lady turned her back to the audience, but there was no change whatsoever in the intensity of her voice. Here the simple turn of a knob might have added a valuable touch of realism for it is obvious that orientation has a pronounced effect upon the voice. During conversation, turning the head affects the volume of the sound reaching the ear of the listener. A small effect, to be sure, but not small enough to lose every vestige of importance. It is going to be through the painstaking attention to these small effects that the movies will eventually emerge into a state of polished and formal art. The paramount question is,

THE motion picture, and now the motion picture in its talkie form, has become such an integral part of the average person's daily life, that any suggestions for improvement take on a personal interest. In the accompanying article Mr. Yates points out some of the failings of the talkies, and how they may be overcome. His technical background in sound work gives the voice of authority to his statements.—*The Editor.*

"When will the talkies learn to talk?" The answer lies with the technicians whose esthetic sense is usually no keener or more susceptible than that of a coal-wagon driver or an ice-man. It is a far cry from the grid bias of a vacuum tube to the artistic niceties that will eventually put more interest in faithful reproduction.

Some of the efforts of our movie makers to produce realistic effects are painfully amusing to one who has any knowledge of the technical considerations involved. There is a scene on the screen showing a canoe being paddled down a stream in an enormous canyon. The canoe is almost an insignificant speck, a dot in the void of a great spectacle of nature. Strange as it may seem, one hears the dip of the paddle. One who knows the making of the talkies can visualize a stage-hand standing beside a tank of water placed under the microphone and dipping a paddle so that the great American movie audience will be treated to a bit of realism. The whole scene was incongruous enough to make a school boy laugh.

Realism in talkies will not come as an over-night development. It is something that must be fathered, something that must be nursed, something that must grow out of a multitude of unpardonable mistakes. It is something that must be first felt and then learned. However, when one considers that we have had nearly three years of unrestrained talkie making, one is inclined to believe that the perfection of realism has not been as rapid as it should have been. Let us take another example of bad talkie making.

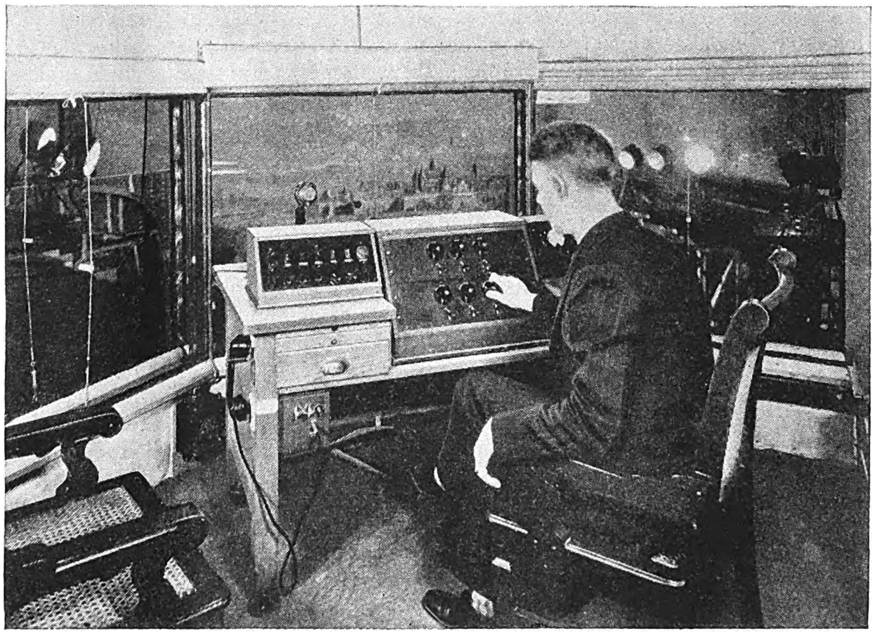
THE scene is a living-room. There is a normal conversation taking place between the occupants. The recording is, on the whole, fairly good. There is a quick flash to the platform of a railroad station. A locomotive with a string of Pullmans rushes into the scene and stops. The effect is terrible. What has happened? The sound produced by the approaching locomotive, a locomotive that one would think almost knocked the tripod from under the camera so closely did it approach, had a volume that was not much greater by comparison than the voices that immediately preceded it in the living-room set. The effect was strikingly incongruous. There was no dramatization at all. The locomotive should have thundered into the scene with a rattle of monstrous iron wheels, with the screaming of brakes and with the glamour and noise that always attends the approach of such gigantic pieces of mechanism. This particular locomotive really almost whispered its way into the scene.

It might be confessed here that the technical equipment in present use is not designed to handle the recording of an approaching locomotive the way the recording of an approaching "he" locomotive should be handled. There is some question as to whether or not this terrific high level of sound intensity could be passed through the amplifying tubes. The question arises: "Why would it not be possible to arrange an automatic switching in of additional amplifying equipment and additional horns so that the whole theater would resound with the thunder of the great iron horse?" It is true that sound amplification, when the sound takes the form of noise, can be amplified to a tremendous extent without the audience becoming at all aware of any distortion. When the sound of an orchestra is recorded the engineer must take care to keep the mould of distortion cut away but when he is recording noise such as the eruption of Mt. Vesuvius or a battle scene, the "sky is the limit." Perhaps we may look forward to the day when locomotives will be locomotives and battle scenes will sound more realistic than Boy Scout Troop No. 125 having their annual outing.

At the present time it is the general practice to place the ear of the "talkies," the microphone, in the center of the set. The technical reasons for this practice have never been made quite clear to the writer. Would it be unreasonable to assume that the microphone, representing as it does the ear of the audience, should be placed at the front of the set in a position bearing the same relation to the performers that the audience bears to the screen? With the microphone assuming this position it would appear that a portion of intelligent monitoring might, to a certain extent at least, be automatically solved.

A still more glowing example of bad manipulation of equipment was recently made obvious when a performer entering an extremely deep set from the back, walked into a close-up as he talked. The monitor had made no effort to fade him in. The sound effects were distinctly displeasing and somewhat incongruous when one realized that a sixty thousand dollar oriental rug adorned the floor and the room was furnished with a carload of expensive trappings fit for kings. There is no expense to which a well-managed studio will not go when it comes to supplying the necessary furniture and equipment and scenery for a major production. It makes one wonder why the smaller details of sound recording are permitted to pass by practically unnoticed.

IT would seem that sound recording is now in the same state of perfection that photography was in 15 years ago. This sorry state of affairs has been brought about by giving the technicians, the sound engineers if you will, too much of a free hand at the studios. Their judgment is in no case tempered with artistic sensitiveness; they cannot see the woods for the technical trees. They are interested in curves and technical precision and they have quite forgotten that technical precision is a far cry from artistic realism. It matters not to the man in the audience whether a tube is biased correctly or whether a resistance deviates one watt or 50 watts, he has come to the theatre to see life lived on the screen, to see an illusion that will be so perfect as to cause him to forget about his daily troubles, his trials and vicissitudes, and the sooner the talkies can deliver this message to him in the true, unvarnished voice of life, the sooner the talkies will be here to stay.



The monitor operator sees all and hears all. He should be part technician and part artist, for by a twist of the wrist he can improve or mar a sound record

A herring gull in full flight showing the slots of its wings opened

Courtesy *Nature Magazine*

A sailing kingbird flying slowly. Primary feathers are outstretched but the false wings forming slots are barely visible

BIRDS HAVE NATURAL SLOTTED WINGS

By RAY P. HOLLAND, Jr.

SLOTTED wings seem to be one of the most recent of the greater aerodynamic developments. It has been in comparatively recent years only that they have been used to any extent at all. As they are used on the airplane, they seem to be one of the man-made devices which have no parallel in nature. There are many such things that appear to have been developed entirely in a scientific laboratory or as the result of continual development of complicated theories. When the result is finally reached and the product is finished, the general opinion is that something entirely new has been made. Then, suddenly, it becomes known that the identical thing that man has worked so hard to attain has existed all the time in a rather simple and surprisingly perfect application in nature.

Slotted wings are an excellent example of this. In nature they are almost as old as flight itself. The earliest flying creatures had no feathers. They flew with a skin web as the supporting surface, as does the bat. With the development of feathers, the primitive slotted wing appeared. That which corresponds to the fingers of our hand became the long, stiff feathers that form the wing-tip of the bird. The thumb developed, on the bat, into a projection to aid it in clinging to walls. On the bird, it became what has been known as the "false wing" or "bastard wing."

The false wing consists of a small group of long, stiff feathers above the leading edge slightly less than half the distance to the wing-tip on most birds. In its normal position, it fits into the conformation of the wing so well that it is not easily seen. When open, it is plainly visible. Being directly in front of the more flexible portion of the wing, it is in a perfect position to direct the airflow over the lateral control surfaces. Thus, in its function it is like the airplane slot.

The manner of operation is slightly different. Naturally, because of mechanical reasons, the bird can not open its slot directly to the front as on the airplane. The means it uses is to move the tips of the slot feathers forward and downward with the joint where the group connects with the wing proper as the pivot. The portion of the wing left exposed by this motion is very well shaped to produce high lift. The feathers of the false wing are disposed so that the cross-sectional shape of the airfoil they form is easily altered. When the slot closes again, the feathers shape perfectly into the wing. It is the ability to change shapes and areas at will that gives the bird such a remarkable control of its flight.

The primary feathers that form the wing-tip of a bird have an aerodynamic action somewhat similar to that performed by the bastard wing. The quill of these feathers is close to the front edge. Each feather is an airfoil in itself. They are arranged so that in overlapping, the leading edge of one feather is above the trailing edge of the feather in front of it. The nearer the end of the wing they extend, the more they diverge, until before the tip is reached, there is space between the individual feathers. The effect is that near the wing-tip there are several airfoils at high angles of attack, one behind the other, the whole group forming one large airfoil. Although not exactly like a multi-slot wing, this arrangement probably has some similar characteristics.

IT is likely that the tips of the primary feathers, which are free to twist over certain limits, place themselves in positions with negative angles of attack when the bird is in certain attitudes. This would form a true multi-slot wing. Mechanical difficulties prevent man from using such a wing, although he understands its action perfectly. This type of wing using numerous slots has been tested in a wind tunnel up to over 40 degrees angle of attack without reaching its "burble" point. The bird probably makes use of the principle in landing and in slow flying. At that time, the tip feathers are spread wide. In rapid climbing, maximum lift is obtained in the same manner.

When high-speed level flight or a dive is desired, the bird's wing-tip moves to the rear in relation to the rest of the wing; folding closes the openings between feathers. In addition to closing the slots, this action furnishes a desirable sweepback. Moving a supporting surface to the rear will move the center of pressure in the same direction and steepen the dive. In extremely rapid dives, birds fold their wings until they are scarcely stubs on the sides of the body. In this means of airfoil modification, natural flight has one of its greatest advantages over artificial flight.

The very shape of the wing-tip feathers is strong evidence that they act as individual airfoils. They are flat and of practically uniform chord out to the point where they are spread wide enough to cause a space between them when the wing is spread. At that point there is a sudden tapering of the plan form. The part of the feather in front of the quill narrows down almost to nothing. The feather becomes an efficient airfoil instead of only a component in a arrangement that makes up one larg surface. The cross-sectional shape f these feathers is usually similar to hat used on our racing planes, but eve thinner. It is so thin, in fact, that it ould not be practicable to construct a airplane wing using the same proport ns.

As an example of a bird ich uses its slotted wings to great adv tage, let us consider the wild duck. C tain species of them migrate from as ar north as Alaska in the summer and uthward to the Gulf of Mexico in t winter. When not disturbed, they pr r not to fly, unless they have a certa destination. In their flight to that tination, they travel in a straight line a high speed. When disturbed, the must be able to climb almost vertical for their protection. Also, they posses marked ability to change direction d speed suddenly when they see som ing that arouses their suspicion.

Suppose that an order should be received in an aircraft factory for a ship of very high wing-loading, the nearest thing possible to a racing plane, that would have a low landing speed, an ability to stunt, extremely good climb, and also be capable of long-range non-stop flights. It would be absurd to try to fill all the specifications in a single ship. Any one of the requirements could be fulfilled in a specialized job for that purpose, but no individual plane could possess all the qualities necessary. Nevertheless, a duck can do all those things.

After flying all night at a high altitude, the duck reduces its wing area to almost nothing, shifts its center of pressure to the rear, and begins a long bullet-like dive to just above the surface of the water. At that point, it increases its wing area and resistance at the same time. As its speed diminishes, the false wing moves forward from its position to form the slot. It maintains perfect lateral control up to the point when it becomes practically motionless in the air only a few inches over the water. Then, with a few flaps of the wings, it lets itself down easily. If it is disturbed, it springs from the water with amazing alacrity. A rapid and steep climb is maintained until the bird is out of danger. During this climb, the slots are continually open. They are, more than any other one thing, responsible for this performance. They increase the lift and prevent "burbling" in the attitude necessary for the climb.

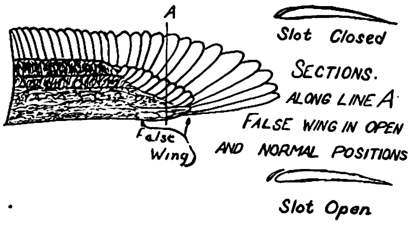
DIFFERENT birds, depending on the degree to which they use them, have slotted wings developed to different degrees. Generally, the false wing is comparatively small on gliding birds. They are slow fliers that employ extremely efficient airfoils. Birds such as the albatross derive their efficiency from a supporting surface of very high aspect ratio. Their light wing-loading provides a sufficiently slow landing speed for them. Great climbing speed is unnecessary because they fly over level stretches of water with only slight changes in elevation. Their continuous gliding is made possible by the rising currents of air caused by the swells of the sea. Birds utilize these slopes of water in exactly the same manner that a sailplane uses a long gradual hillside.

Those birds which have a high-speed flapping flight have the slots developed to the greatest extent. They are birds of very high wing-loading. High-speed wing action is necessary in order to maintain flight. Nevertheless, a remarkable rate of climb and a reasonably slow landing speed can be produced. Quail, grouse, and pheasants are birds of this type. Examination shows that these birds have abnormally large bastard wings.

I have noticed that the position of the slot varies on birds of different sizes. To illustrate this, I will compare the Hutchin's goose, which weighs about eight pounds, to a representative small bird. The center of the group of feathers, on the goose, that constitutes the bastard wing, is approximately 58 percent of the distance from the body to the tip of the wing. On the smaller bird, it is only 37 percent of the distance out. The smaller bird's false wing occupies slightly over 20 percent of the leading edge, while that on the goose occupies only 17 percent of its leading edge.

HOWEVER, this latter comparison creates the wrong impression because the goose is a bird of high aspect ratio while the other is not. The slotted wing area of the goose is much larger in comparison to the entire wing area than is the case on the other bird. Its wing-loading is considerably greater also. The manner of flight, in the same way that it affects the size, is likely to have a direct bearing on the position of the false wing.

On the ruffed grouse, a bird of heavy wing-loading that flies with an extremely rapid wing action, the slot feathers are very close to 50 percent of the distance to the tip. On birds of light wing-loading it is usually less than half way out. These observations indicate that the bastard wing, viewed from a standpoint of size and position only, has a direct relation to the size and flying characteristics of the bird, and must be a part of its control system, and not merely a useless appendage.



Goose wing showing similarity to airplane slotted wing arrangement

If you would like to see a practical example of the actual means the bird uses to open his slotted wings, it is only necessary to obtain a bird's wing to experiment with. This should be easy, for there are many species of detrimental birds, such as the hawk or crow, that may be killed at any season. The wing of the bird, cut from the body, is all that is needed. There is a tendon just in front of the wing bone. As this is pulled the wing starts to unfold. Everything goes on normally with the false wing in its original position until the maximum wing area is reached. In landing, the bird would employ this position of its wing in order to have the lightest wing-loading, and consequently the slowest landing speed. It is also in landing that it makes the greatest use of the slotted wing. It is, therefore, logical that the action of the false wing should be governed by the tendon that holds the wing outstretched.

By pulling with slightly more force on the same tendon, the false wing will move forward and downward into its correct position to act as a slotted wing. When actually seen operating in this manner the function of the so-called bastard wing is very evident.

ACTUAL photographs showing the slots open on flying birds form the only more convincing evidence I know of. It is difficult actually to watch birds and see the system in operation, even with binoculars. The opening is slight and there is only a short period of time during which to observe it. It may be seen after much effort but not distinctly enough to be a proof. However, to take a wing in your hand and actually make the slot open, will make even the most stubborn doubter stand convinced.

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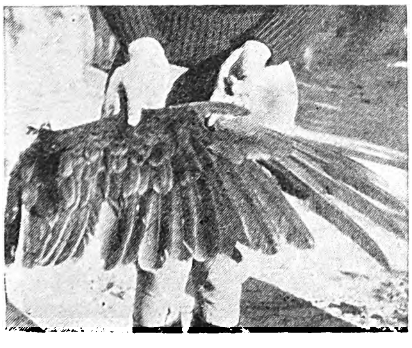
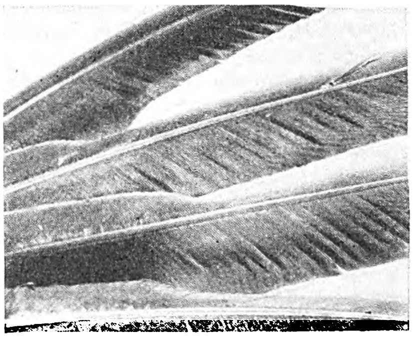
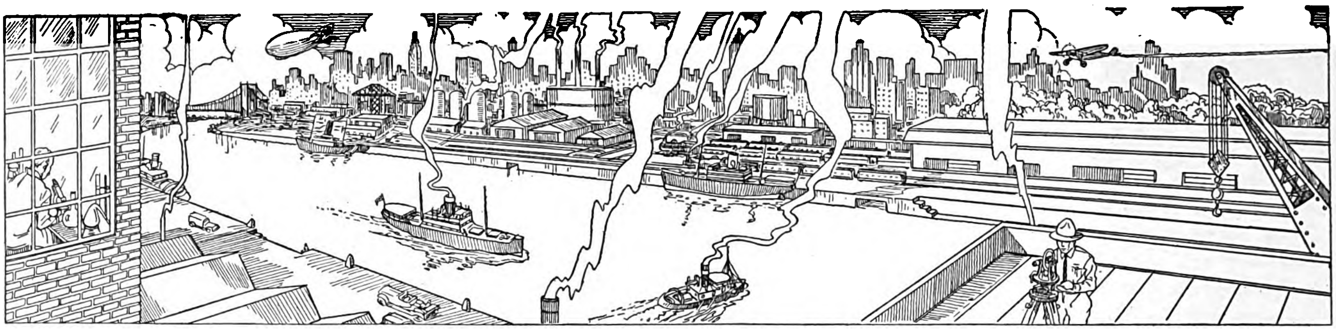
¶ *Instruction in "blind" flying is becoming increasingly important to the aerial transport industry. An article telling how it is carried out is scheduled for early release.*



Left: **Comparatively small false wing on slow-flying, soaring bird**



Right: **The sudden tapering at the point where the primary feathers begin to act as individual airfoils**



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

NOW YOU CAN BUY INSECTS FOR 10 DOLLARS A MILLION

TEN dollars a million for insects! Who'll buy? The average stung, bitten, and be-itched picnicker or camper may ask wearily why anybody should want to buy a million insects at that price when you get more than a million for nothing every time you show your nose out of doors.

Recently developed safe, fireless lamp for flashlight photography

But the insects that are worth 10 dollars a million are cheap at the price, for they prey on the eggs of other insects, thereby preventing the pests from ever seeing the light. They are the almost microscopic wasps known as *Trichogramma*, which are reared in captivity by Stanley E. Flanders, entomologist of the Citrus Experiment Station at Riverside, California. Mr. Flanders has been at this work for some time now, and has improved his rearing methods to a point where the tiny parasites can be produced at a thousand for a cent. They are shipped out in great numbers to orchardists, who release them to assist in their endless warfare on fruit-spoiling insect pests.—*Science Service.*

NEW PHOTO FLASH LAMP

A FIRELESS, smokeless, odorless, and noiseless photographic flash lamp has been developed by the incandescent lamp department of the General Electric Company, Cleveland. The flash is confined entirely within a bulb, with resulting advantages that are expected to revolutionize flashlight photography. Requiring only one-hundredth of a second to act, and being without hazard, it will make possible the taking of flashlight photographs in places heretofore practically impossible to "shoot," such as in trains, airships, and theaters, under water, and by insurance companies requiring night photographs under all weather conditions.

Contributing Editors
ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University
A. E. BUCHANAN, Jr.
Lehigh University
MORRIS FISHBEIN, M.D.
Editor *Journal of the American Medical Association,* and of *Hygeia*

The lamp consists of a clear bulb of standard design, with the flashlight filament coated with a special preparation, and with a quantity of very thin aluminum foil in crumpled sheet form within the bulb. The bulb is oxygen-filled.

When the circuit is closed the filament is lighted and this, in turn, lights the foil. The lamp operates on any 115-volt house supply, or with dry, storage, or flashlight batteries. A new lamp is needed for each flash. The lamp is most efficient when used with suitable reflector equipment.

NEW PROCESS FOR CARBON BLACK MANUFACTURE YIELDS HYDROGEN

THE production of carbon black from natural gas has been, heretofore, a wasteful process, but experiments carried out by the United States Bureau of Mines give promise of an increased yield of more than 400 percent.

The old method, and the one in widest use, consisted of burning natural gases incompletely and collecting the unburned carbon on cold metal surfaces when the gases passed off. Sometimes the carbon black was collected by filtering the gases through cloth.

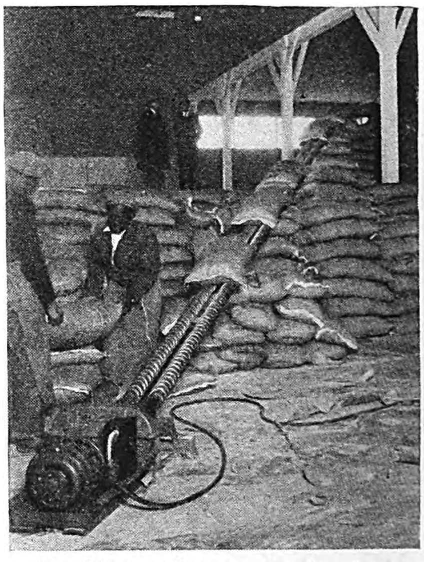
The new method calls for the passing of the gases through ignited coke. The coke is fanned to great heat by subjecting it to a forced air draft, after which the natural gas is passed through it and cracked.

An advantage to be gained by the new process is that, in addition to the carbon black, hydrogen may be recovered and used in some localities for the synthesis of motor fuel and the manufacture of ammonia and other products.—*A. E. B.*

DOUBLE-SPIRAL CONVEYOR

A NEW portable, flexible, power-driven, elevating and tiering conveyor has just been introduced and has already found many useful applications in a wide range of industries.

The TwinVeyor, as this new apparatus is called, uses a new principle: two external spiral tubes are turned toward each other by a power head. Anything placed on the conveyor travels forward rapidly, perfectly balanced. It is used for handling raw materials and finished products in bags, bales, and bundles. The equipment finds other applications handling crates and boxes, and experiments are being made handling the finished product itself, without packaging, where its shape and size permit the spirals to get hold of it. It carries bagged sugar up a 30 percent grade at the rate of 90 feet per minute, handling 1800 bags per hour.



Double spiral conveyor for bags and bales. It is motor operated

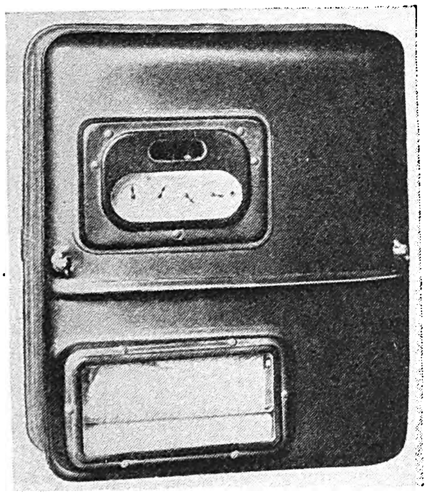
A standard unit consists of six eight-foot dual sections and a power head which draws current from any power line. Each section joins to the assembly with an automatic lock. It is easily shifted about by one man and the entire 50-foot line can be assembled or disassembled in six minutes. Flexibility is secured by the ability of any joint to take a 15 degree angle horizontally, 15 degrees up or 10 degrees down.

A hurdle section permits any number of TwinVeyor 50-foot units to be hooked together, forming a continuous line of any desired length. The traveling load hurdles each power head in the line. Right and left spiral chutes are provided for shunting the load from one TwinVeyor line to another without manual handling, thus making right-angle turns simple.

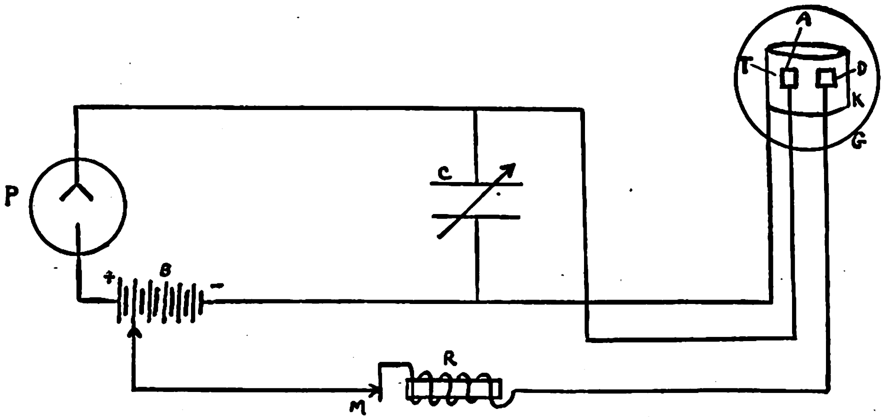
MEASURING ULTRA-VIOLET RAYS

THE element of danger in the indiscriminate use of the ultra-violet ray has had to do with the dosage, the amount of exposure, the proper measuring of ultra-violet radiation for the purpose at hand. It has heretofore been a difficult task to measure this amount exactly, but now there is an ingenious device for the purpose, an ultra-violet ray meter that records the amount of ultra-violet rays coming one's way as accurately as an electric house meter gives the amount of electricity one is consuming in the home.

This indicator operates from dry cells within it. Its essential element, the "eye" of the instrument, is a photo-electric cell which was developed by Dr. H. C. Rentschler of the Westinghouse Lamp Company. The cell in this case is sensitive only to those light rays supposed to have therapeutic value or other effect on vitality—rays .0029 to .0031 millimeters in wavelength. The cell itself is the result of research findings that: (1) By a proper selection of the active material, a cell may be obtained that will not respond to light of longer wavelength than that desired; and: (2) By use of proper light filters it will not respond to light of shorter wavelength than that suitable for the purpose. (A cell of uranium metal and Corex D glass, for example, responds only to that band of light used in prevention and cure of rickets.)



Graphic meter for recording the quantity of ultra-violet on a chart



The circuit of the instruments used in the ultra-violet ray meter

When the rays strike the cell of the meter, a certain amount of current passes through it, proportional to the intensity of the rays, and charges a condenser which, when fully charged, trips a counter. The operation is then repeated, each impulse measuring a definite quantity, irrespective of the light intensity. Since the unit of measurement has at present no name, the value taken is arbitrary. Over a given period of time the number of impulses per minute, each accompanied by a "click," thus indicates intensity, while the total number of impulses indicates quantity.

The principle on which the meter operates is as follows, referring to the diagram: A battery B charges condenser C at a rate determined by photo-electric cell P when light falls upon the cathode. Glow tube G has metal cylinder K for cathode and a primary anode A and main anode D. A small gap exists between A and cathode at T. When C is charged to a potential such that a discharge takes place between A and K, the cathode resistance of the glow tube is broken down and current flows between D and K. This operates the relay R, registers the count, and opens the main circuit M. The condenser is discharged simultaneously. The operation is then repeated. The total quantity of light falling on P is proportional to the total number of discharges registered.

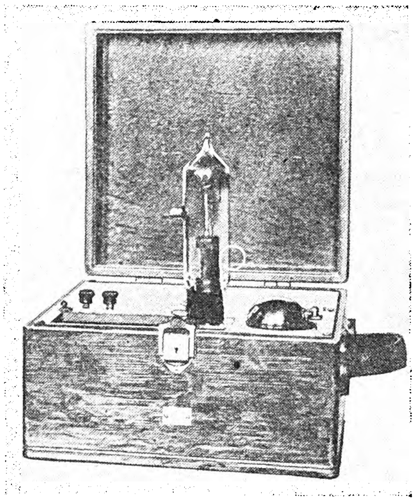
WOOD ALCOHOL

WITHIN recent years it has become possible to produce synthetically the wood alcohol that was formerly prepared only by destructive distillation of wood. The substance is now manufactured from water-gas and hydrogen at a cost which makes it possible to produce large quantities at a low price. Modern industry is, therefore, attempting to introduce the substance for a large variety of purposes, including its use as an anti-freeze mixture in automobile radiators. It is also used in the manufacture of quick-drying shellacs and varnishes. It has long been known that wood alcohol is a dangerous poison with cumulative effects. When taken frequently in small doses, it produces blindness; in large doses, it causes death. The added danger from this product is in the fact that the repeated inhalation as well as the drinking of very small doses of the poison may produce the most serious results.

If this substance is to be used as an anti-freeze mixture in the coming winter, employees of garages who will inhale large amounts of it from overheated radiators are likely to suffer serious injury as a result.

Cases have already been reported in which women and children who have used quick-drying shellacs or varnishes, made with methanol, in closed rooms have suffered harm as a result. In the great spray process used in automobile factories, the spraying is done under hoods and employees wear masks, so that they are protected against the hazard.

As is usual in modern industry, the name of the product has been concealed by the bestowing of fanciful names and the average person does not recognize under the name *methanol* or some other fanciful title the old, old hazardous wood alcohol.—*M. F.*



Ultra-violet indicating meter which uses a special photo-electric cell

FEATS OF SHORT WAVES

RADIO waves which will do the family cooking, provide wireless illumination for homes, alleviate pain, and cure disease are the goal of new investigations into the possibilities of the short-wave high-power vacuum tube, according to Dr. Willis R. Whitney, director of the General Electric Research Laboratories, in a research narrative issued by the Engineering Foundation.

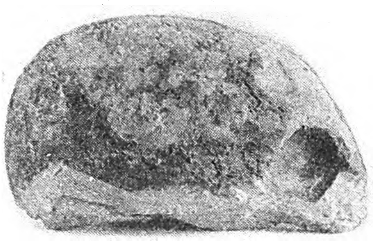
Control of this power for practical uses will immediately open up lines of advance in industry and therapeutics hitherto closed to science, it is stated. Simplified mechanisms and a reduction in the cost of producing large volumes of radio energy are the problems now facing solution.

Radio cooking has already been demonstrated in tests with the new tube.

"A wire was suspended over a table,"

Dr. Whitney states, "at a distance of a few feet from the radiating aerial, which was a copper bar about 10 feet long. A sausage in a glass container suspended from the end of the wire was soon cooked. Likewise an egg was 'fried' in this container, and an apple spitted on the end of the wire was thoroughly baked in a short time. .

"With suitable changes of utensils, cookies were baked and water boiled. There were no flames or other visible evidences of heat accompanying the cooking. The vacuum tube from which this weird power emanated was only two feet long and five inches in diameter.



Robert P. Robinson of the Skelly Oil Company, found this stone at San Angelo, Texas. Its resemblance to a human skull is striking, but since it came from rocks of the early cretaceous period, thus making it something like 115,000,000 years old, scientists are not inclined to take its human origin at all seriously

"As yet the high-power short-wave vacuum tubes are being used for experimental purposes only. To bring them into practical usefulness at reasonable cost and discover their many possibilities for service to mankind is now our task."

BLOOD PRESSURE

THE blood pressure of human beings is measured by putting an elastic cuff around the arm, inflating it with air, and then listening to determine the points at which the sound of the blood in the vessels is extinguished and the point at which it again appears when the pressure of the cuff is released. This simple test has been of tremendous importance, particularly in examinations for life insurance. A normal blood pressure is recognized as being approximately 120 millimeters of mercury. Insurance companies insure persons with pressures ranging from 100 to 140.

In order to make some more exact determinations regarding blood pressure of a considerable group under controlled conditions, Drs. W. C. Alvarez and L. L. Stanley took the blood pressure of all of the prisoners in the San Quentin prison in California. They are inclined to believe that there is a normal blood pressure for each person; that if a person has a high blood pressure at 20 years of age, he is likely to have a high pressure at 40. The lower limit of normal pressure they found to be 90 millimeters of mercury and the upper limit 140. They found the normal pressure about 115, which is lower than the figure usually found for men out in the world. The reason for this they consider to be the fact that the prisoners are not fatigued and worried by the struggle to make a living. They did not find that alcohol affected the blood pressure, but tobacco appears to raise it about 4 millimeters.

Men who have been convicted of murder in the first degree showed a blood pressure slightly higher than that of other prisoners of the same age. They found that the prison guards had a pressure considerably higher than those of prisoners, which they consider to be due particularly to overweight, and also to the fact that the guards were applying for positions at the time when the pressures were taken and that many of them were anxious for fear they might be rejected.—*M. F.*

POTATO RUBBER

THE Firestone Tire and Rubber Company is experimenting on the commercial value of a new variety of rubber with potato starch as the base. The synthetic product contains no latex or plantation rubber. It is made by mixing the starch with chemicals which coagulate it into a gum-like substance differing from rubber only in that it is less elastic.—*Barron's.*

REFRIGERANTS FROM THE TROPICS

"YOUNG as we are," says Dr. H. E. Howe, editor of *Industrial and Engineering Chemistry*, "we can remember the days when sailing vessels carried cargoes of natural ice from Maine to Cuba, and we believe even as far as Calcutta. How times have changed!

"There is now en route to New York from Mexico one of three vessels, each of which has been equipped with a compartment insulated against heat exchange by 12 inches of cork board to bring solid carbon dioxide to the metropolis for refrigerating purposes. One of the petroleum companies in drilling for oil struck a supply of carbon dioxide which rushed to the surface at a pressure of 1000 pounds.

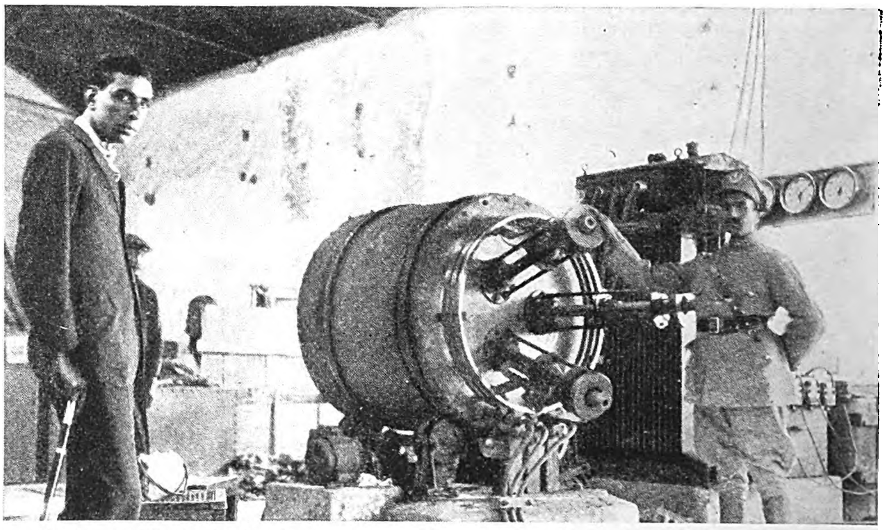
"It is much too early to discuss the economics of this venture. Inasmuch as the solidified gas must be cleaned of its impurities before it can be re-made into commercially pure solid carbon dioxide, it is doubtful whether the natural high pressure will be of much advantage, and undoubtedly there have been some nice technical difficulties in the purification of this particular supply of gas. We have yet to learn, too, with what efficiency and what percentage of loss the solid gas has been stowed in the hold, transported, unloaded, and distributed. These are technical details concerning which no information has so far been made available. However, the whole venture is intriguing. The mere thought of preparing a refrigerant in the tropics for shipment into the temperate zone is so complete a reversal of the old established practice as to afford another example of how chemistry is helping to remake the world."—*A. E. B.*

NEW INSECTICIDE PRODUCED BY "CUBE ROOTS"

IT used to be a favorite wheeze at college to suggest to the room-mate who had prematurely squandered his allowance that he write home for funds with which to buy a cosine for use in mathematics class. We used to assume that Dad either had never been exposed to trigonometry or had forgotten that a cosine was merely a mathematical function of an angle and that he would "enclose check" rather than admit ignorance. We were forcibly reminded of that ancient practice by a recent statement in a publication of the staid United States Bureau of Agriculture, when we noticed the sentence "cube roots are not yet available commercially."

We still think Dr. R. C. Roark, of that department, had his tongue in his cheek as he wrote that sentence, but further investigation revealed the fact that "cube" is a South American plant and like most other plants, it has roots. (The plant's name, incidentally, is pronounced koo-bay.)

In the course of this reading, we learned further that the cube plant has been found to contain a substance called rotenone which has been found to be an excellent insecticide. The Department is therefore urging the Malay States to grow rotenone-bearing plants on a commercial scale for



Even turbulent Afghanistan, where kings are made and unmade overnight, must have coins. Here is shown the electrical smelting machine, imported from America, which has just been installed in the mint at Kabul, the capital. Beside it stand an army officer and a modern young Afghan "intellectual"

American trade. This new insecticide is found in quantities up to 7 percent in the root of the South American cube plant, up to 5.5 percent in derris roots, and to a lesser extent in three other plants. The cube plant now grows in a part of South America where the climate is similar to that of the Malay States and surrounding countries.

Tests by the Department of Agriculture indicate that rotenone is highly poisonous to both sucking and chewing insects. In tests conducted privately, rotenone was fed to dogs, cats, sheep, and chickens in quantities up to 1 grain per pound of body weight and no injury was noticeable.—*A. E. B.*

KETOGENIC DIET IN EPILEPSY

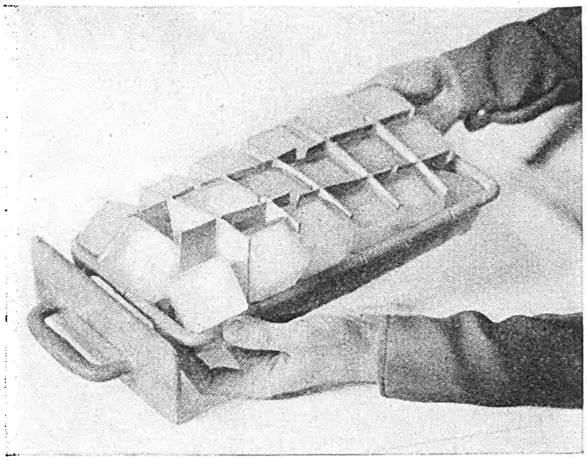
IN 1921 it was suggested that children with epilepsy might have the number of their attacks greatly reduced by providing them with a diet low in protein and containing large amounts of fat as compared with the amount of sugar taken into the body. This is called a ketogenic diet, because it tends to produce an excessive amount of ketones and their derivatives in the blood and in the excretions. The diet must be carefully watched, since an excessive amount of this substance produces serious symptoms.

Recently, Drs. Henry F. Helmholz and H. M. Keith have recorded the results of this diet on 272 children who had suffered with epileptic attacks. Two hundred forty-three children with epilepsy of unknown origin, in that the attacks could not be related to any disease or surgical disturbance, were treated by this diet. One hundred seventy-one of these children cooperated fully. One hundred forty-one children had been on the diet more than a year and 30 had been treated less than a year. Of the 141 patients treated for more than one year, 43 patients had remained free from epileptic attacks from one to seven years, and 32 others had shown definite improvement, as evidenced by the decided improvement in the number and severity of the attacks and by improvement in their general demeanor.

It has been argued by some observers that dehydration of the body is an important factor in the lessening of the convulsions. The investigators admit that this plays a part, but do not believe that it is the only factor.

Apparently 30 percent of the patients with epilepsy of unknown origin are freed from convulsive seizures by the use of this diet and, under completely controlled conditions, as many as 37 percent may be relieved of their disturbance. It is, of course, impossible to keep such children in hospitals over many years, and it becomes necessary for parents in the home to learn how to handle the diet and to take care of the child properly.—*M. F.*

Ordinary ice cube trays of automatic refrigerators are unsatisfactory because it is difficult to remove one or two cubes without emptying the tray entirely. A flip of the finger, however, is all that is necessary to remove just the number wanted from this new tray developed by the Frigidaire Corporation. It is made of strong rubber on a rigid steel rod frame



CHEMICAL PARADOX LEADS TO BETTER INSULATED WIRE

RUBBER is a non-conductor of electricity. Carbon black is a conductor. Therefore, it would appear natural that the admixture of carbon black in rubber would increase the latter's conductivity. In fact, this has been generally assumed to be the case until W. B. Wiegand and C. R. Boggs, in a recent issue of *Industrial and Engineering Chemistry* disclosed experimental evidence to the contrary. As a matter of fact, up to about 10 percent, by weight, of properly made and dried carbon black may be added to each 100 parts of rubber hydrocarbon present in rubber insulating compounds with marked improvement in dielectric strength, resistivity, and power factor, and without serious increase in dielectric constant of the rubber insulation.

The exact amount of carbon black required depends somewhat on which electrical property is to be brought to its maximum value.

This discovery is of importance to the makers of insulated wire who use a rubber covering next to the metal. In fact, these results would seem to render advisable the rewriting of many specifications dealing with rubber insulating compounds, and thus make it possible to apply the well-known beneficial effects of carbon black compounding—improved toughness, density, wearing resistance, imperviousness to light, tear resistance, and so forth—to the electrical insulation field, from which it has hitherto been barred.—*A. E. B.*

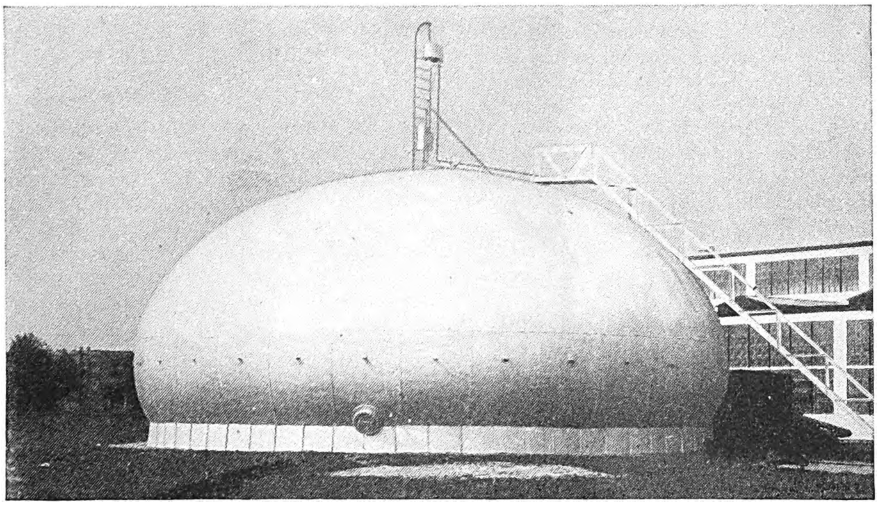
NEW OIL TANK HAS UNIQUE SHAPE

IF you were to visit certain oil company properties in Texas you would see unusual steel structures which have the appearance of giant mushrooms breaking through the ground. They are a new type of storage tank designed by the Chicago Bridge and Iron Works.

The Hortonspheroid, as this unusual shaped tank is called, is used to store high-test gasoline and other volatile oils. Such liquids are placed in the tank and the tank closed tight to prevent evaporation loss taking place.

It is possible to close the Hortonspheroid tight because it is designed to withstand a certain pressure, usually 10 or 15 pounds per square inch. As the temperature rises, the pressure increases but no vapor escapes. Each installation is, of course, equipped with a safety valve.

But why the unusual shape? It is simply the shape which a flexible container would take if filled with liquid and subjected to a few pounds pressure. It is the most natural shape for such conditions and, by the way, the most economical one, as all of the metal used in its construction is used effectively.



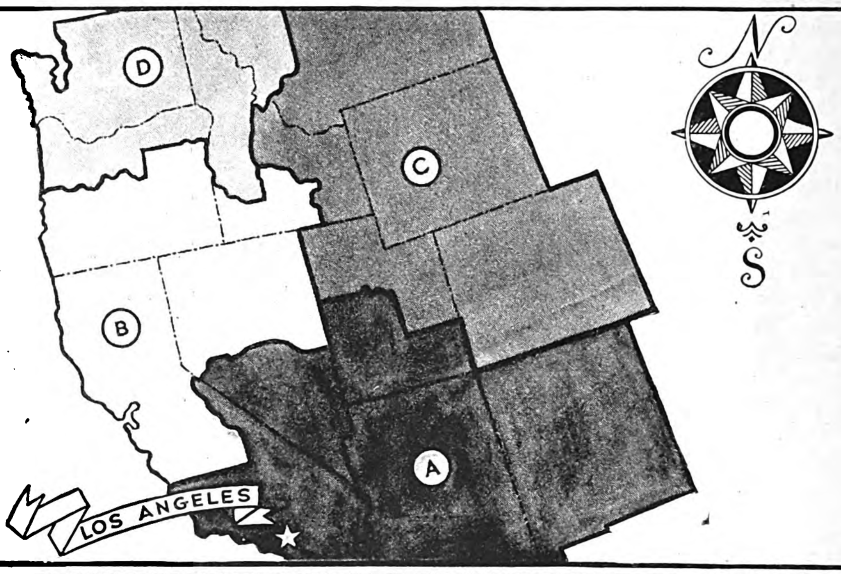
Looking like a huge drop of water on some oily surface, this Hortonspheroid holding 10,000 barrels of oil, was built for experimental purposes at Chicago

SWORD SWALLOWERS

THE sword swallower is able to pass a long knife down his throat by developing a special agility in the movement and by developing also the ability to breathe by movements of the ribs without moving the diaphragm. That fact was recently determined by three French physicians who subjected two sword swallowers to a

Western Market

12 Million People



— served most economically from Los Angeles County

There is a distinct freight advantage in serving the Western Market of 12,000,000 population from Los Angeles County... its largest metropolitan center.

Zone A —Population 3,982,582... Local market immediately tributary to and including Los Angeles County.

Zone B —Population 3,002,753... Local market.

Zone C —Population 2,239,483... Parity in freight rates enjoyed by Los Angeles County.

Zone D —Population 2,598,129... Served from Los Angeles Harbor by regular steamship transportation, at low freight rates.

Truck haul delivery is made direct by manufacturers in Los Angeles County to three-fourths of the 4,000,000 people in Zone A... at a freight rate advantage so large as to more than offset slight rate differentials via water route to Zone D.

It will be obvious to the manufacturer who wishes to serve the entire Western Market that he can do so at a great saving by locating his plant in Los Angeles County.

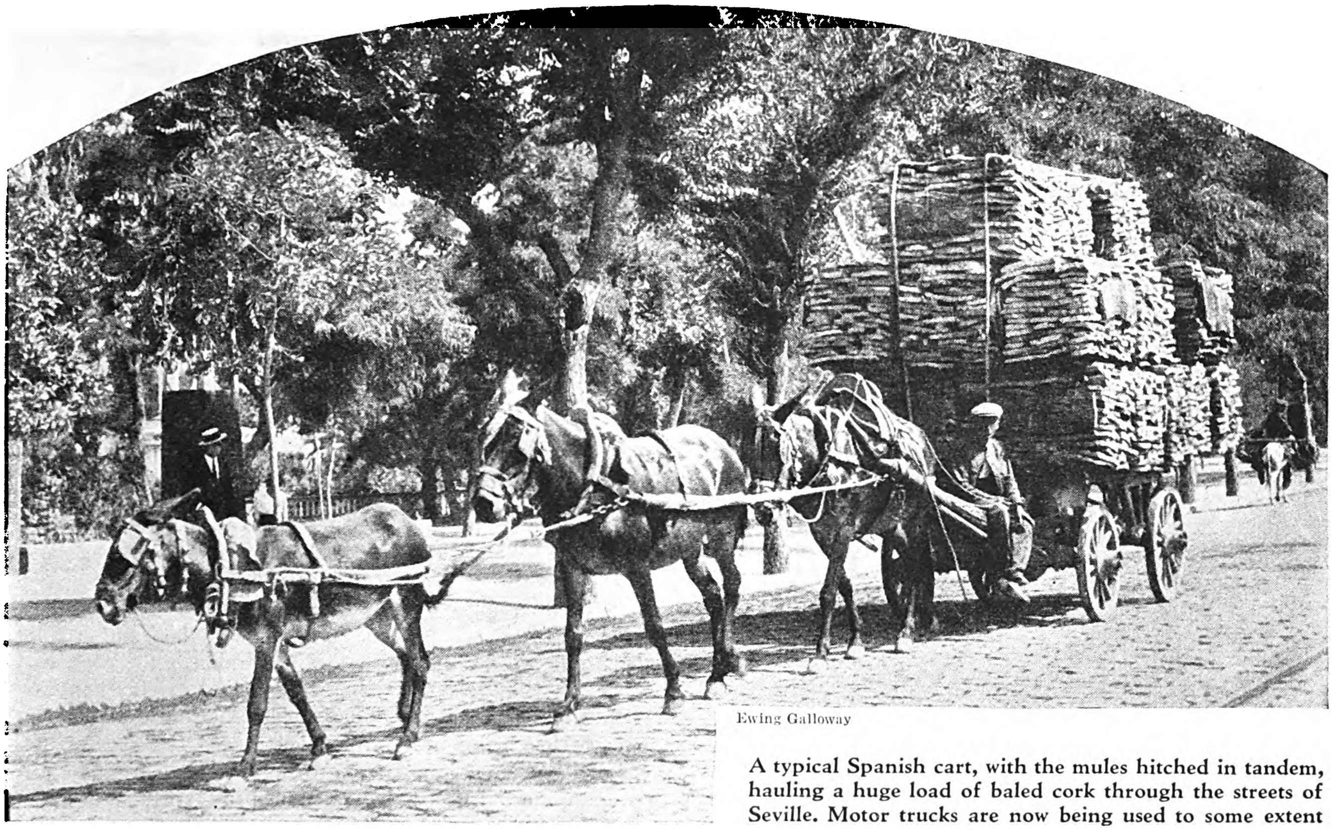
Industrial LOS ANGELES COUNTY

POPULATION 2,199,657

Manufacturing Executives Are Invited to Write to the Industrial Department, Los Angeles Chamber of Commerce, for Detailed Information Regarding this Great Western Market

ANDREW WELLS ROBERTSON

A HIGH SCHOOL principal whose vision saw beyond the confines of school walls and whose understanding of men, fairness, and canny Scot's industriousness have carried him to the high position of Chairman of the Board of the Westinghouse Electric and Manufacturing Company—that, in brief, is the biography of Mr. Robertson. Like many other leaders in American industry, Mr. Robertson's family background is modest. His father, a native of Scotland residing in Panama, New York, was a stonemason by trade. He died when young Andrew was but three years of age but this did not prevent Andrew from getting an education. He was graduated from Allegheny College in 1906 and was principal of a high school for a time. He studied law while conducting a private school for boys and was graduated from the University of Pittsburgh in 1910 with the degree of LL.B. Admitted to the bar, he joined a Pittsburgh law firm, practiced privately for a time, and later became trust officer for a large Pittsburgh firm and attorney for another. By 1918, he had become general attorney for the Philadelphia Company, was made vice-president in 1923, and president in 1926. In 1929, he attained his present position with the Westinghouse company. He is a trustee of his two alma maters, a director of many large corporations and associations, and a member of New York and Pittsburgh clubs. Being an able speaker, he is much in demand on public occasions but has never been attracted to politics—he has been too busy for that.



Ewing Galloway

A typical Spanish cart, with the mules hitched in tandem, hauling a huge load of baled cork through the streets of Seville. Motor trucks are now being used to some extent

THE TREE BARK OF A HUNDRED USES

By BURTON DAVIS

WHEN the dry sirocco sweeps up off the Mediterranean and blows its hot breath on the Latin lands that border it to the north, there is one tree that remains gayly green. When the simoons twist north from the parched sands of the Sahara and whirl across Algeria, Tunis, and Morocco, one evergreen oak flourishes. That tree is protected by nature with a thick layer of the finest natural insulation in the world: you know it as cork.

All woody plants have a coating of cork, but this one sort of oak has more than any other. Certain elms and birches elsewhere in the world have outer bark that resembles it, but theirs is comparatively useless to man. The outer bark of *Quercus suber* and its almost identical cousin, *Quercus occidentalis*, known as the cork oaks, is in many ways unique in nature and invaluable in human industry. Nothing natural nor artificial has yet been produced to compare with it, for the *Quercus* bark has seven properties: resistance to the passage of moisture and liquids, buoyancy and light weight, resilience and compressibility, ability to absorb sound and vibration, strong resistance to progressive deterioration, low conductivity of heat, and an uncommonly high coefficient of friction.

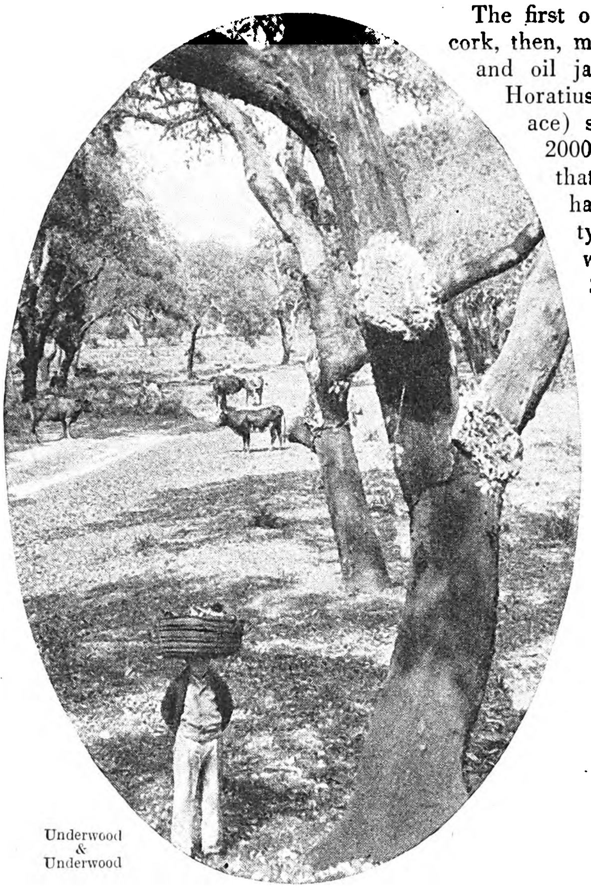
Through at least 2300 years, these properties have successively been discovered and utilized by man. Yet, although cork now has more than 150 distinct uses in the complicated apparatus of civilization, little is known about the physiological, physical, and chemical properties of the odd material.

ALL the literature on the subject of cork, including reports of previous research, could be carried in a small brief case. The men who have handled cork throughout the ages never bothered to find out much about it. A dozen chemists and botanists had worked on the problem of explaining how it grew and of what it was made up, but from 1787 to about 1927, had chiefly developed theories that were later discarded.

There was no accurate information on the number of cork trees in the world and how much cork bark they could supply. Man was using a natural resource and might reach the limit of its supply. Reforestation of cork oak had been largely left to nature and rare private enterprise. Culture of the cork oak was not fully understood. All this had to be studied so that provisions could be made against the future.

And that was what the American cork manufacturers set out to do less than a year ago. Since then another factor has loomed up. Apparently we are about to enter another ice age, this time in food distribution, for huge plants are being built for the quick freezing of meats, fish, vegetables, and fruits to be retailed in packaged form, hard frozen, and kept at sub-zero temperatures. Such low temperatures in freezing plants, refrigerator cars and trucks, storage cases, and household iceboxes will demand cork-board in huge quantities.

Cork, therefore, has rather suddenly become an object of keen industrial interest. The factories called in the research doctors and set them to work to find out how cork is put together, of what substances, and, in exhaustive detail, what its physical and chemical properties and peculiarities are beyond the known and obvious ones. Cork was such a mystery that there was no predicting what they might uncover. To develop a satisfactory substitute for cork is one of the things the scientists hope to do, although at present that



Underwood & Underwood

Cork oaks partially stripped of their valuable bark in a scattered grove at Almorasma, Spain

seems to be a hopeless, impossible task.

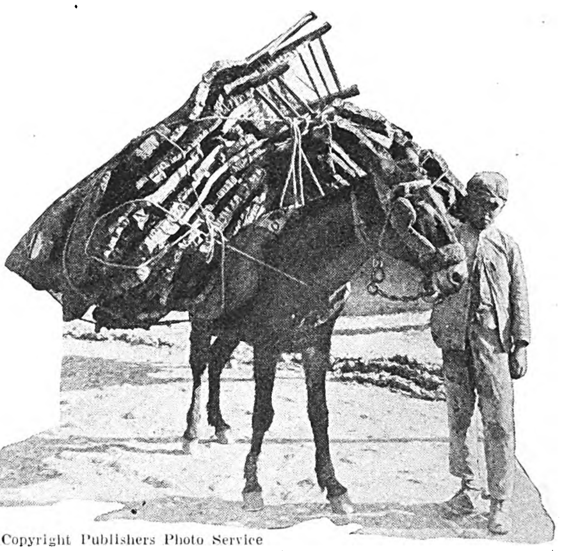
In the research and testing laboratories of a large cork company at Lancaster, Pennsylvania, only lately a photomicrographer took the first picture of the individual cork cell. The research, by scientists attached to the company, that led up to the taking of this picture—as well as the picture itself which is reproduced on page 347—showed that the cell has the geometric form known as tetrakaidecahedral.

This difficult word is from the Greek and means "having 14 faces." Lord Kelvin, years ago, found that units of 14 faces solved the problem of dividing all space, without interstices, into uniform bodies of minimal surface. In 1928, Dr. Frederic T. Lewis, of the Harvard Medical School, conducting independent research into cell structure, demonstrated that cork cells are tetrakaidecahedrons, each making contact with an average of 14 others.

EVEN though there are minute interstices between cork cells, these are filled with resin that is impervious to water and most liquids. Obviously a substance, the cells of which fit so snugly, is going to baffle the passage of any fluid which is unable to eat its way through. Thus the word for cork is the word for stopper, also, in most languages—a "stopper" is a "cork."

The first of the seven properties of cork, then, made the stopping of wine and oil jars one of its first uses. Horatius Quintus Flaccus (Horace) spoke of that in Ode III, 2000 years ago. Earlier than that, doubtless, the ancients had used the second property: buoyancy and light weight. Pausanias (not the Spartan admiral, but the traveler and geographer of the 2nd Century, A.D.) recorded that cork bark was used for anchor boards and on fish nets. Since each cork cell is more than half filled with air, the mass is buoyant. Its specific gravity is between .15 and .20, making it one of the lightest of solid substances.

The cell walls of cork are of tough, highly elastic material—much more so even than rubber—hence its resilience and compressibility. At Lancaster a one-inch cube of natural cork was recently put under pressure of 14,000 pounds to the square inch. The sidewise spread under that load was only a quarter of an inch. Released, the cork in a few hours regained between 90 and 95 percent of its original height, while the horizontal edges of the cube returned to exactly one inch. The secret of cork's unique behavior appears to be that only the air in the cells is compressed, hence the lack of side spread and the unequalled regain. Corks jammed in champagne bottles for 10 years will regain three-quarters of their original volume shortly after being withdrawn from the bottle.



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Sure-footed burros, top-heavy with huge loads, transport cork in the mountainous sections

Since dead air, in finely divided spaces, is, next to a vacuum, the best insulator known and the poorest conductor of sound and vibration, the fourth and sixth properties of cork are easily explained.

What will keep out heat will, in the popular phrase, "keep out cold"—which means it will keep heat *in*. Hence the use of cork-board insulation, which threatens to outstrip every other use of the cork in a few years, not only to insulate refrigeration units but also to insulate buildings against the winter's cold and the summer's heat. That last-mentioned use may have been the first to which cork bark was put, for the peasants all over the cork oak country still roof and wall their huts with slabs of the crude cork.

THE known chemical inertness—except to a few acids and strong alkalies—of the walls of the cork cell and the intervening resin explains cork's uncommon resistance to deterioration.

The fourth and seventh properties in the list have been the last to be utilized. Cork has only lately come into general use to absorb sound and act as a corrector of acoustics in echo-haunted halls and rooms. The first use in this respect was of cork tile as flooring for libraries and hospital halls. Now whole auditoriums are lined with a fine-grained cork-board. Radio broadcasting and sound film studios are using cork to exclude exterior noises, reduce interior sound and vibration, and break up echoes. Lastly, cork, long applied to reduce vibration and clatter in machinery of a hundred kinds, is now being used in slab form to insulate machines, from light fans to enormous engines and dynamos, against the transmission of vibration and noise.

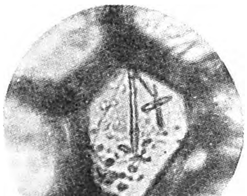
The seventh property of cork—its high coefficient of friction—has been put to use only since the machine age came in. When cork bark is sliced cleanly, a surface is created exposing tens of thousands of hexagonal open cells to the square inch, each acting as a tiny vacuum cup. This, and the unusual resistance of the cell wall to frictional wear, gives cork the gripping and polishing properties now widely utilized. Plate glass mirrors and windows, fine glass and crystal, and optical lenses are polished on cork wheels. Leather and rubber both wear slick in short order, for their cell material has little of the toughness of cork's mysterious material, called "suber," which is neither cellulose nor wood fiber.

In the Lancaster testing rooms, one-inch squares of cork, belting leather, and rubber, all designed for the same use, were equally weighted and placed on an inclined plane. When the plane was inclined 18 degrees from the horizontal the leather slid down. At 28 degrees the rubber went coasting. Not until the plane was slanting 42 degrees did the cork creep down.

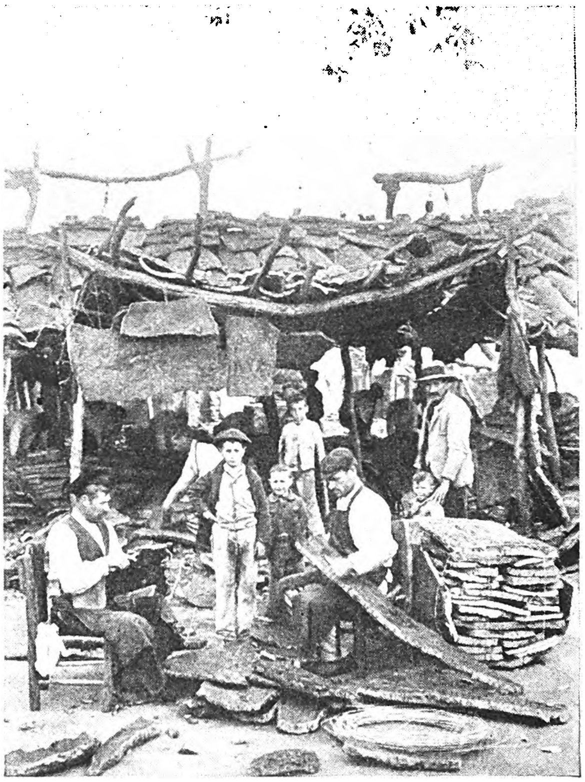
THE temptation in discussing the seven properties of cork is to wander off into fascinating bypaths to tell of the applications of cork that derive from these seven traits. They range from the tiny pieces in the pincers of pince-nez eyeglasses to the acres of cork-board, up to 12 inches in built-up thickness, in the walls of the quick-freezing meat packing plant of 1930; from the cork-lined cap of the tooth-paste tube to the newest and most uncommon use of cork in a planetarium. The first of these in America, recently completed in Grant Park, Chicago, has 9450 square feet of cork-board insulation on the dome.

The story of how and where cork grows, how it is gathered, prepared, transported, manufactured, and used, can only be sketched, for a full description of these fascinating phases would overflow this issue.

With a cork oak acreage of 550,000, Portugal leads the world with a production of 80,000 metric tons of cork; Spain is second with a production of 75,000 metric tons from 637,500 acres; Algeria is third with a production of 27,000 metric tons; while France, Tunisia, Italy, and Morocco come next in order; and even Japan produces about 400 tons of inferior cork yearly.



***Right:* Photomicrograph of the cork cell. Six cells are shown touching the central one at the point of cleavage**



Underwood & Underwood

After the cork has been cured and dried flat, it is trimmed and packed in bales for shipment

When part of a grove of cork trees has attained an age of about 20 years—for the first cutting—the expert cutters, each helped by apprentices, start to work. The expert makes a careful cut, with a tomahawk-shaped hatchet, around the trunk just above the exposed roots—in Algeria he may use a circular saw—and another just under the lowermost branches. These he connects with two vertical cuts, following the biggest natural cracks. The assistants help him pry off the bark. All this is done with the finesse of a surgeon, for any injury to the inner bark, or *phellogen,* which builds up the cork, results in a scar area over which no new cork will ever grow. This first cutting of bark, called "virgin" in Spain and "male cork" in France, will sell for a low price, to be used in the rough for florists' baskets, arbors, ferneries, and to be ground into low-grade granulated cork.

Nine or ten years later, the cutters will be back in that same grove, removing the new growth of cork, of finer grain and in every way more valuable. In some places they will also strip the bigger parts of the chief branches; in others, restrained by law or local regulation, they will wait for about five years, strip the large branches, and four years later denude the trunk again. In the French government forests—about half of those in Algeria and Tunisia—stripping the branches is prohibited. In some private forests of Spain the cutters may go back after eight years. In Portugal the law demands a wait of nine years, and the first crop cannot be removed until the tree is 15½ inches around, three feet above ground. Each crop after the first is progressively better until the tree is about 40 years old. Thereafter it may be expected to continue to produce fine cork until it dies, at from 100 to 150 years.

Copyright Underwood & Underwood

Great stacks of the cork as it comes from the trees. In foreground, a bale ready to be shipped

Virgin cork is bought with no particular care, on a weight basis. But from the second stripping on, the value of the cork makes buying a careful balance between buyer's and seller's ideas of its worth. The cork buyer is an important personage, for on his judgment profits are made or lost. He migrates with the cork cutting season, penetrates all manner of country and deals with all manner of cork grove owners, cutting contractors, and government officials.

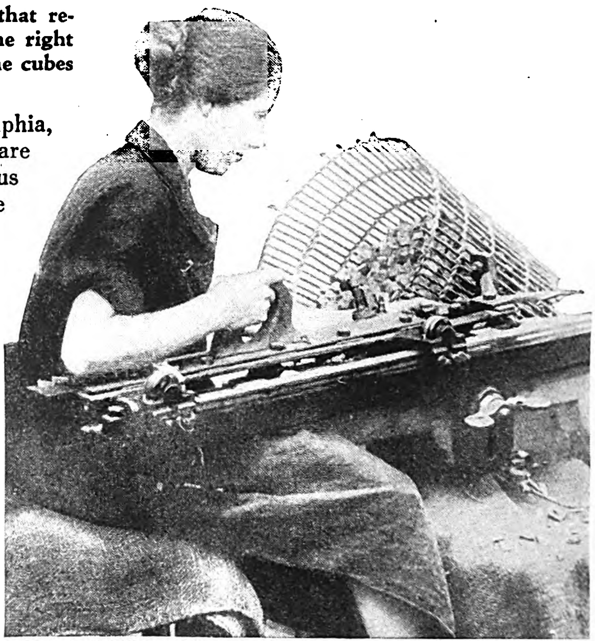
Arrived at a certain stand of cork, in advance of the cutting season—April to June in North Africa, July and August in Europe—the buyer sends his sampler through the grove on a beeline. With a cylindrical punch, the sampler cuts out a disk of cork from every 5th, 10th, or 20th tree and jumbles these in the huge sack on his back. At the buyer's office these are scrutinized with care, for on the average of them the buyer will base his bidding for so many tons of cork, perhaps for the stripping from a whole mountainside. In the French government forests of north Africa, however, the cork is gathered at stations to be sold at auctions.

To return to the typical scene, say in Spain or Portugal: The stripped cork bark is piled up in the grove and left a few days to dry. Then it is weighed on a "romana," a type of yard scale introduced by the Romans 2000 years ago. (Cork harvesting methods have changed little in 20 centuries.) The bark is carried on burro back or in carts to the boiling station at the edge of the forest nearest the market or the railroad line.

Boiling the curved slabs in large vats fired with dead corkwood softens the bark so that the rough, creviced, outer layer can be scraped off by hand with a flat tool. This process removes about 15 percent of the weight of the slab, removes the tannic acid from the cork, increases the volume and elasticity, and makes it possible to dry the slab flat. After being roughly sorted for quality and thickness, the dried bark is loaded on sturdy burros, which pick their way carefully down the mountain trails to the railway station, topheavy with a huge pile of the light bark aboard, bigger than the animal himself. As roads in Spain and Portugal are improved, motor trucks are replacing the picturesque burro.

Ewing Galloway

The cork industry in southern France is the same as it is across the border in Spain. Above is shown a girl operating a cork cutting machine that reduces strips into cubes which are later cut into bottle stoppers. At the right a girl is operating by hand a machine that cuts the stoppers from the cubes



Underwood & Underwood

ARRIVED at the warehouse and manufacturing center the crude bundles are opened and the rough edges trimmed off the slabs. Another grading for quality takes place, dividing the cork into about 25 classes. The bark for export is baled in a hand or a hydraulic press, bound tightly with iron straps, and stenciled. The bale is then ready to be loaded into the hold or on the deck of a steamer. Philadelphia, New York, or Baltimore will be the destination of nearly all of the exported crop; the rest will have gone to the stopper cutting shops nearby, the trimmings and "waste" from which will also be baled for export to the cork composition or linoleum factories overseas.

One manufacturing company has its own receiving plant at Gloucester, New Jersey, just below Philadelphia, where the various grades are separated and sent to various plants. At Pittsburgh, where the finer grades are made into bottle stoppers and other natural cork products, the final sorting puts the bark into as many as 80 bins, the grades differing so little that only the expert can detect the difference.

At this point the story of cork divides into four stems: the business of making bottle stoppers and natural cork products; the distinct processes used to make cork composition products out of scrap and grinding grades; the process carried on elsewhere which turns out cork-board for insulation, machinery isolation, and corkoustic; and the complex business of making linoleum, linotile, and other flooring material.

The key to this maze is the utilization of waste. Automatic machines punch bottle stoppers out of the best of the bark. The punched-out strips are ground into flour for linoleum or granulated for making cork composition. The coarser cork is ground into larger granules to be pressed, at high temperature, into cork-board slabs, the natural resin forming the only binder used.

Natural cork is used for pistons for plunger fountain pens and for wind musical instruments; seine and gill corks for fishing nets, and bung corks and artillery practice wads. From natural cork are also made disks for bottle crowns and patent caps, bulletin boards, penholder grips, cork balls for games, plasterers' floats, and many other products.

CORK composition is used for box toes, counters, insoles, heel lifts and pads, and bottom filler in shoes; also, in all manner of gaskets to stop leakage of gasoline, oil, or water; in churn strips, bobbers or floats for fishing lines, and so on.

In the automobile, cork and cork composition may be used in as many as 50 places, most of them unsuspected by the owner.

Linoleum is made from cork flour, as described in the October issue of SCIENTIFIC AMERICAN. Linotile, a tile of linoleum composition, is laid in special patterns by hand and produces marble and tile effects. Cork brick, non-skid, almost impervious and resistant to acids, is used in dairy barns and modern pigsties for better sanitation.

Cork carpet, made of coarser cork, is used particularly in public buildings where sound deadening is important.

Granulated and regranulated cork is used for packing fine china and glass, grapes, and other fruits. Despite modern industrial advances, cork holds its own as one of the most useful of natural substances, although it is still one of the most mysterious after 2300 years of use; in fact, it is playing an increasingly larger rôle in the drama of industrial progress.

OUR POINT OF VIEW

ACROSS THE ATLANTIC

NO transatlantic flight or attempt to make an airplane crossing of this stormy ocean since the unsurpassed flight of Colonel Lindbergh, in May, 1927, has so fired the imagination of the world as the three successful westward flights this summer. A Briton and a German made the first two flights, each with one or more stops, and the climax came when a Frenchman, already famous and a hero among his people, made a non-stop flight from Paris to New York in a plane that was also already famous for its share in his exploits.

In June, Wing-Commander Charles Kingsford-Smith, with E. Van Dyk, Captain J. Patrick Saul, and J. W. Stannage, flew from Ireland to Roosevelt Field, Long Island, in the *Southern Cross*, making one stop in Newfoundland. His flight marked the completion of a spectacular 'round-the-world air trip which had started over a year previously. In August, Captain Wolfgang von Gronau, with Edward Zimmer, Franz Hack, and Fritz Albrecht, made an unheralded flight from Germany to New York Harbor, with stops at the Faroe Islands, Iceland, Greenland, and Nova Scotia. His flight was praiseworthy for two reasons: first, because in this day of blatant exploitation of air feats, his was a surprise trip, few knew anything of it until it was over, and, so far as we know, he has not commercialized it; and secondly, because his route may prove the most feasible when transatlantic airplane services are inaugurated.

When Dieudonné Coste and his copilot, Maurice Bellonte, landed the red *Question Mark* at Curtiss Field on September 2, the final chapter in the long and tragic story of the conquering of the stormy north Atlantic by airplane was written. They had taken off from Paris 37 hours 18½ minutes previously. To these two daring fliers go, therefore, the laurels for the first non-stop crossing of the north Atlantic by airplane from the continent of Europe to the United States. They have accomplished what many others before them had tried and what they had unsuccessfully attempted in 1929.

Aviation owes much to these pioneers of 1930. When and if airplane service is started across the Atlantic to and from the United States, the lessons learned by their flights will have much influence in the choice of routes, modes of operation, and so forth. But we consider that the pioneering has now been completed except in cases where totally different types of planes—such as the Dornier *DO-X*—may be involved, and will frown upon any further individual attempts to conquer the Atlantic. Such transatlantic flights will seem to us to have the taint of commercialism or to be inspired by individual desire to exalt an already inflated ego.

GAS FROM THE EARTH

ON page 380 of this issue we publish the story of the amazing growth of an industry about which little is known: that which has been and is being built up around natural gas. Possessing about twice the heating value of artificial, or manufactured gas, this natural mixture from the earth's reservoirs has been used commercially for over 60 years but has only recently become an industry of huge proportions because of recent technical developments that have shown the way to discovery of large natural gas reserves and have made possible long distance pipe-lines.

During the current year, the natural gas industry has expanded at a greater rate than perhaps any other industry of importance—and that despite world-wide business depression. Its increase in pipe-line mileage from 80,000 to 90,000—including pipe-lines put into operation and also those on which construction has been started—represents an increased capacity of more than 12½ percent. *The Lamport Review* estimates that this 10,000-mile increase adds "at least 250 million dollars to capital investment" in the industry.

Truly this is the bright spot on the business horizon. It puts to shame many other industries that have not progressed this year—yes, despite the depression—and teaches a lesson of research and development, far-sighted belief in the future and rapid expansion. The confidence of the men behind it is worthy of the highest praise.

FUTURE AIRSHIPS

SHORTLY after the successful flight of the *R-100* from Cardington, England, to Montreal, Sir Dennistoun Burney, its designer, outlined a new proposal to establish a transatlantic airship service in which he attempted to prove that a company possessing four or six new ships twice the size of the *R-100* could operate with profit.

Such proposals are not new, but the fact that this one takes such definite form indicates that the time when a transatlantic airship service of some kind will be a commonplace thing draws rapidly nearer. In the face of this fact, American vision apparently does not see as far ahead as does Sir Dennistoun. We have under construction two airships that will be far larger than any heretofore built but beyond construction of these two we have no plans for the future—unless they be deep, dark secrets. And even for each of these two dirigibles, we are importing eight Maybach engines from Germany. This may have no very great significance but to us it is indicative of the passive interest of American engine manufacturers in the development of American airship engines.

One of the many criticisms of the dirigible is that it is bulky. True, but *The Engineer* (London) points out that its weight per passenger is only 1.56 tons as contrasted to nearly 24 tons per passenger of the liner *Mauretania*. Fuel consumption is not considered excessive; and transatlantic passenger and mail rates little in excess of steamer rates are to be expected.

But aside from all such arguments, the airship is with us and we believe it will stay, although no one can predict its ultimate status. Why, then, American apathy toward developing it to the fullest extent? Much experimental work is yet to be done but we should like, particularly, to see some intensive research done toward developing an American airship engine.

INTERNATIONAL AFFAIRS

Navy Day

OCTOBER 27TH, Theodore Roosevelt's birthday, is Navy Day, and at every Navy Yard and on every man-of-war the Navy personnel will be at home to the American people. All who can should take the opportunity to visit the nearest ship or station, to show their interest in the officers and men who are our first line of defense.

In time of war we lavish praise on our Navy; in time of peace we are too likely to forget it. We take the efficiency

(*Please turn to page* 409)

RADIO CHARTS THE UPPER AIR*

By JEROME D. VAN BRAKLE

SIGNAL CORPS engineers of the United States Army have devised a means by which radio can be used to determine air conditions several miles above the surface of the earth, and after more than seven years of experimentation they have perfected, at the Signal School laboratories at Fort Monmouth, New Jersey, equipment by which the direction and velocity of the winds at high altitudes may be computed with a high degree of accuracy regardless of visibility.

Visual observations of upper-wind conditions are impossible at night and when visibility is reduced by low-lying clouds or fog. Since many war operations are carried on behind smoke screens or after dark, it became necessary to devise a method of obtaining the desired upper-air information under these conditions for Army use. The radio method was the answer to the problem.

THE radio device, perfected at Fort Monmouth, consists of a miniature continuous-wave transmitter which is sent aloft by means of three hydrogen-filled balloons. Its flight is followed with a loop direction finder, a process known as "tracking" or making a "balloon sounding." Long research was necessary before an efficient direction finder was perfected, as it was found that the commercial instruments used in radio compass work were not sufficiently accurate for meteorological use.

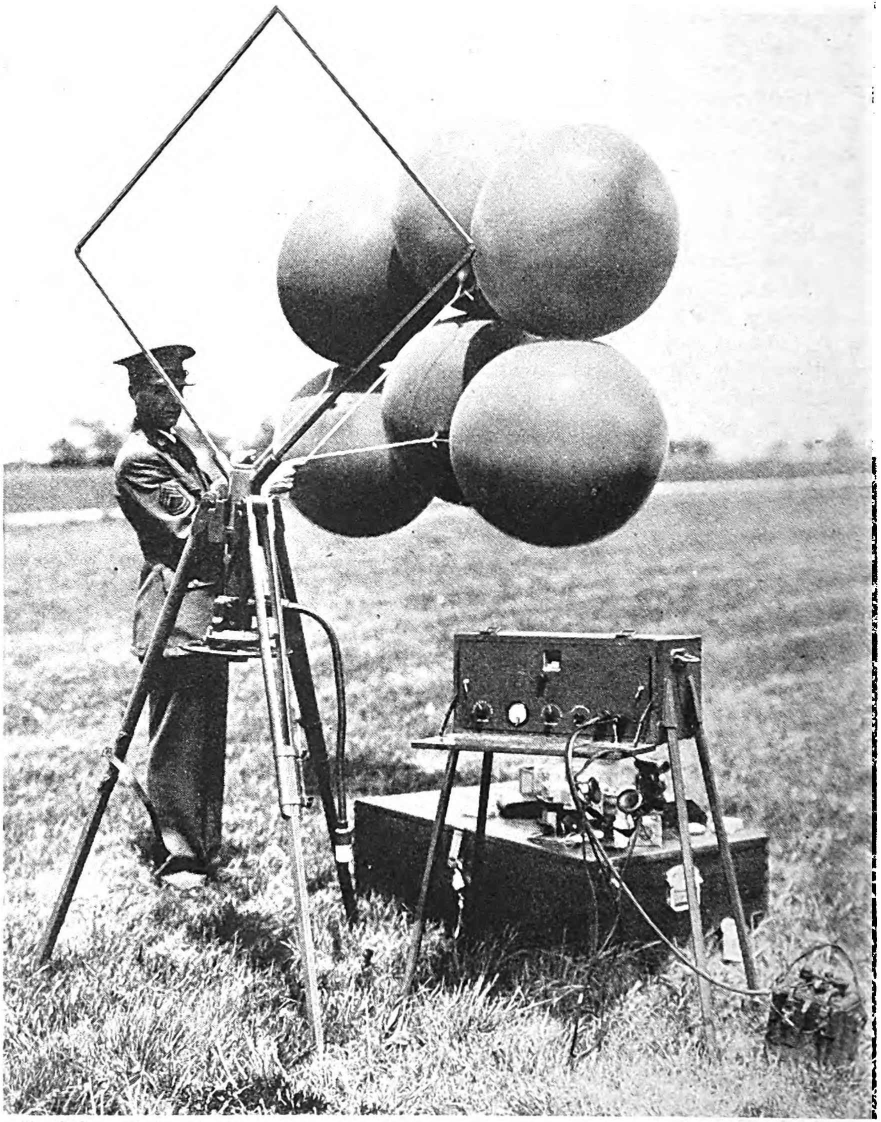
The loop direction finder consists of a specially-built radio receiver of rugged construction connected to a loop antenna composed of a single tube of copper, mounted on a tripod base. To the shaft of the loop is connected a calibrated dial, graduated in degrees and fractions. This dial is used to measure the angles through which the loop turns. Except for the fact that the receiver is of the regenerative type, Signal Corps authorities refuse to divulge the details of its construction.

The transmitter which goes aloft with the balloons is compact and sturdy and weighs less than a pound. It consists of a small vacuum tube, an inductance coil of enameled wire, a small transformer, and a small flashlight battery, the whole outfit costing about five dollars. When the battery is snapped into place at the bottom of the device, continuous-wave oscillations are started which will continue for more than two hours. This wave has been picked up from a distance of 15 miles.

The length of wire which connects the transmitter to the balloon cluster acts as an antenna. Signals are sent at a constant frequency of 2300 kilocycles or 130.5 meters.

When the balloon cluster, carrying the transmitter, is liberated it ascends vertically, because of the hydrogen gas, but at the same time it is blown about by the winds it encounters. This lateral motion is recorded by observers and from the data obtained, the speed and direction of these winds may be accurately determined.

It has been found that the cluster will rise at the rate of approximately two hundred yards a minute and that this rate of ascension will continue until the internal pressure of the hydrogen gas exceeds the outer pressure of the rarefied atmosphere and one or more of the balloons burst. Usually only one bursts and then the others act as a



Signal Corps photographs

The direction finder receiving set and the balloons for carrying the radio transmitter, used in the newly developed method of determining upper air currents

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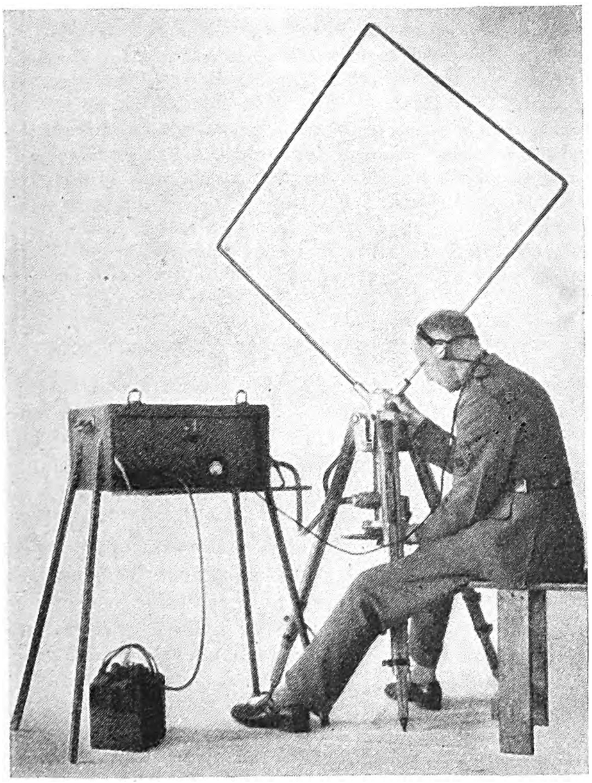
*Published by permission of Major General George S. Gibbs, Chief Signal Officer, United States Army.

parachute and gently lower the apparatus to earth with little damage.

While the balloons are in flight, observations are taken by two direction finders set up on a base line of known length. Experiments have shown that this length should be three miles for the best results, although shorter distances have been used with a high degree of accuracy. Sometimes three instruments are used; then they are set up in the form of an equilateral triangle of known sides. The third instrument, however, is used principally as a check on the others.

AFTER the release of the balloons, operators obtain bearings on them every minute. Accurate time is given by a clockwork device which emits a howl at the end of each minute and a warning buzz ten seconds before the minute. The bearings are telephoned to an observer at a plotting board where they are entered on a scale map. The point of intersection of each set of two bearings shows the exact position of the transmitter at any minute. From these data it is simple to determine the horizontal flight of the apparatus and by means of a special protractor and a wind scale, the required velocity and direction of the wind at each level of altitude is computed. Balloons may thus be tracked for several miles.

The observers at the loops base their calculations upon the zero point, where the signals from the transmitter are not heard. The loop is revolved until the signals disappear and the angle is read from the scale on the shaft of the loop.

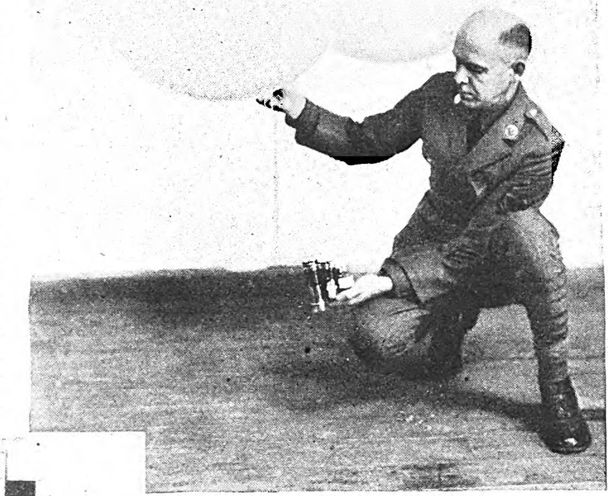


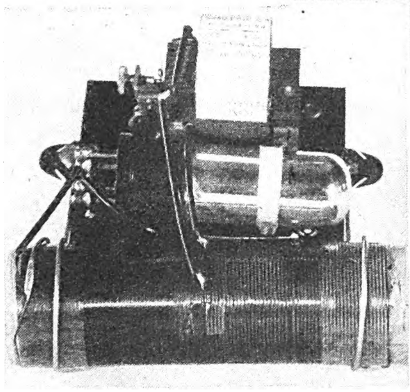
The direction-finder loop in use. The operator swings the frame, listens to the signals, and reads the angle

At the zero point, the plane of the antenna is at right angles to the direction of the transmitter. One of the points of high efficiency of the Army receiver is that the zero point does not vary until the transmitter is more than three miles from the receiver, then the variation is so small that accurate results may be obtained for seven miles and usable results for several miles further. Experiments have shown that the zero point in commercial sets splits before the transmitter is a mile away, greatly lowering the efficiency.

While the new system was undergoing preliminary tests at Fort Monmouth, simultaneous readings were made by radio and visual methods. These experiments showed that the radio method gives more accurate results as the continuous signal can be more easily traced. The visual method is more commonly used, however, because of the greater distance possible and because of the economic phase.

In the Atlantic seaboard states, where the prevailing winds are easterly, most of the instruments sent aloft are lost in the ocean, but in the Middle West, 95 percent of the transmitters are recovered. To insure the return of as many of the transmitters as possible, a notice is attached to the set offering a small reward to the finder if the instrument is sent back to the base station.





Above: **The one-pound short-wave transmitter attached to balloons.** *Left:* **A close-up of the transmitter. The battery is behind the instruments**

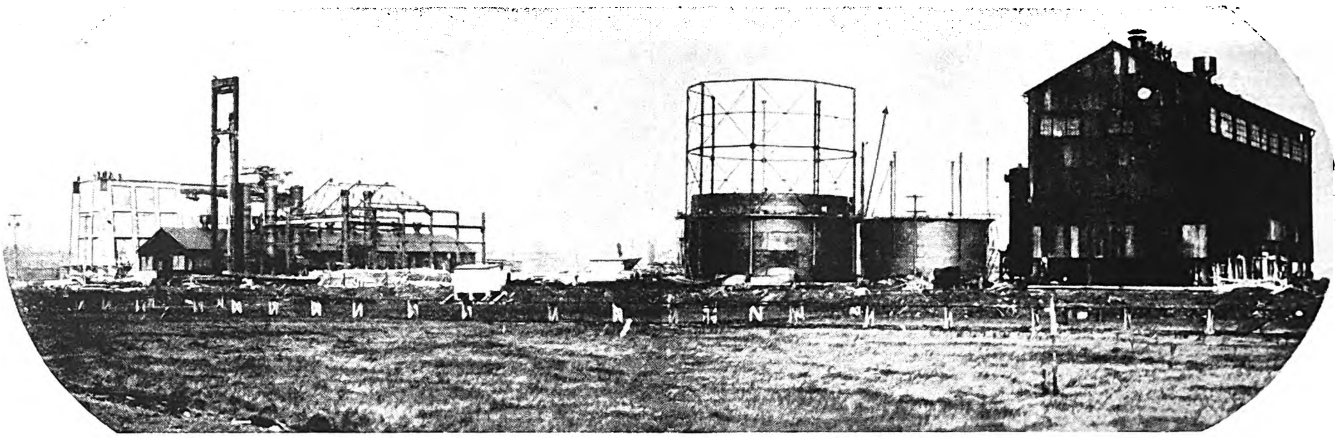
At Fort Monmouth, one day recently, a farmer drove up to the reservation in a dilapidated farm wagon. He walked up to the meteorological officer and handed him one of the transmitters which had fallen on his farm.

"You came mighty near not getting this contraption back," he declared. "When it came fluttering down in my cornfield I thought it was some new kind of bird and I almost wrecked it with my shotgun."

Although many of the instruments are returned in peace times, few recoveries would be expected in time of war. The cost of the apparatus in comparison with its utility and the value of the information it gives is so small that little thought would be given to the loss.

AT the present time, radio officers at Fort Monmouth Signal School are experimenting to find a method of determining upper-air temperatures by radio. A bi-metallic plate of variable capacity at different temperatures has been inserted in the circuit of the transmitter just described. It is designed so that the wavelength will vary as the air temperature increases or diminishes and these wavelength changes will be noted on the ground by means of suitable instruments.

Now that the common wind vane has been lifted high into the air by means of radio, it is the ultimate aim of these agents of Uncle Sam to use the radio device, with variations, to unfold many other secrets of the upper air currents.



Hydrogenation plant of the Standard Oil Company of New Jersey under construction at Bayway

A GALLON OF 'GAS' FROM A GALLON OF OIL

By HENRY W. HOUGH

"OIL DIPLOMACY" is the title of a long chapter in Ludwell Denny's arresting new book "America Conquers Britain" (Knopf), a remarkable record of economic war which is taking place today on a worldwide front in the form of bitter struggle between America and Britain for world markets in major commodities. The struggle takes its most violent form in oil. The most powerful world participants in the great contest are the vast Deterding interests (Shell) of Great Britain pitted against the Standard interests of America. The oil reserves of the smaller nations—Persia, Mexico, Colombia, Venezuela, and so on—are the rich fruits of battle. The accounts of some of the dealings between the rival giants make fascinating if somewhat grim reading; the international oil war is not a game of tiddleywinks. Ostensibly the oil war between America and Britain is conducted by private interests but Mr. Denny reveals that both governments have taken a hand. And why not? Oil is a national asset; without it no nation today can remain a first class power. Britain is not losing the oil war; we are. She has largely outwitted us, gaining control of the best resources. We are left holding the bag. "The public has been in no mood to champion the cause of any oil company at home or abroad," Mr. Denny writes, "but this sentiment is changing. The danger point will be reached when a near-shortage drives prices upward and American automobile owners are told the British have cornered most of the world supply." Britain is keeping much of her own oil supply intact and cleverly finding ways to exhaust ours. The Bergius processes, described in Mr. Hough's article, are German in origin and Standard has obtained them, but the cheapest oil at present comes from the ground. When the American people finally wake up about the oil situation will it be too late?—*The Editor.*

LAST season, or perhaps it was the preceding season, a thrilling drama was witnessed by theatergoers. It involved a young genius who had made a scientific discovery of startling significance. He proved that he possessed the power to blow the world to smithereens. His secret was known only to himself. Anxiety and apprehension resulted—until the closing scene of the play.

Another drama almost equally exciting although somewhat less sinister now is being enacted before a much larger audience. The opening scene was in a laboratory in Germany, and centered about the research of the noted investigator, Dr. Friedrich Bergius. The scientific world was amazed by the news concerning his hydrogenation process for converting wood into coal, coal into oil and gasoline, and so on.

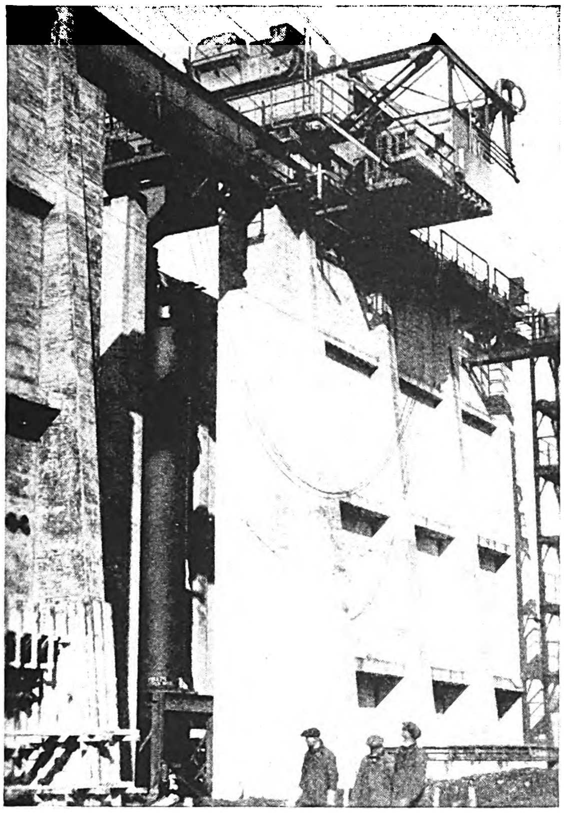
NOW the scene has shifted to America. About a year ago the rights to Dr. Bergius' process were acquired by the Standard Oil Company of New Jersey, in affiliation with the I. G. Farbenindustrie or "Dye Trust" of Germany. With the news of this merger, which followed three years of co-operative examination of the technical and commercial possibilities of the process, there came another startling announcement: "It now is commercially practicable to produce 100 gallons of gasoline from the running of 100 gallons of crude oil, by the addition of gaseous hydrogen under high pressure and high temperature in the presence of certain catalytic agents."

These developments have aroused rather than allayed the fears of those who anxiously await the outcome. Will the next scene show chaos in the petroleum industry? With over-production of oil constantly worrying the producers, must they now face a flood of cheaper "artificial" gasoline?

The petroleum industry has waited rather impatiently for further progress reports. The general public has exhibited similar interest, for today "the man in the street" is not only a consumer of gasoline and oil, but also is on the lookout for investments which seem to have great potentialities.

With the opening, a few months ago, of the first of three 5000-barrel-a-day hydrogenation plants, it seems that the Bergius process at last is ready to become an important factor in the petroleum industry. The first commercial plant is located at Bayway, New Jersey. Two others are to be built soon, one in Louisiana at Baton Rouge and another in Texas at Baytown. These plants are more than experiments, for each is a large-scale commercial unit based on the results of several years of intensive research and development. No effort has been spared to perfect the conversion apparatus and the methods of operation best suited for commercial production of gasoline and light oils.

To the layman, who may have grown weary of hearing about over-production in the oil industry, it may seem that hydrogenation has been born too soon. Even in the face of solemn warnings that the world's supply of petroleum



The retorts (inside the concrete structure) in which the hydrogenation takes place at Bayway

can last only a few more generations, there are many who feel that at present there is no place for any revolutionary method of producing motor fuels. However, the situation takes on a different aspect when one is familiar with the other great developments which have led up to the present state of affairs.

When the oil industry was very young, there was a well-distributed demand for all of the important products of petroleum. Then the market for illuminating oil stepped ahead of the others. While meeting the demand for kerosene, the refiners found that something had to be done about disposing of the rest of the products.

The solution was found in a new process, by "cracking" the heavier fractions of the crude oils in such a way that a larger proportion of kerosene was obtained. Crude oils which normally yielded 20 to 30 percent of kerosene were made to yield from 50 to 70 percent by this revolutionary step.

SOME time later, the situation took a new turn. Gasoline became the most valuable fraction, and the demand for kerosene declined. Again something had to be done about utilizing the less valuable products, and again the solution was found in improving the process. It proved to be considerably more difficult to increase the gasoline yield, but the result was nearly as good as when effecting the decomposition into kerosene fractions. At the present time about one third of the world's total demand for gasoline is met by "cracking" or conversion, rather than by refining.

With this background, it is easy to see where hydrogenation fits into the picture. With the ever-growing demand for gasoline and light oils, there has been constant over-production of the less valuable products, the heavy oils. The market has shown that it does little good to lower the price of this class of fuel. There simply is little demand for it.

Careful examination of the cracking process does not give any grounds for presuming that the problem can be met by an improvement in technique with the present production methods. Attempts are being made to perfect the Diesel engine to so great an extent that it will operate satisfactorily on the inferior grades of fuel oil, as it now does on the better grades. Research in both of these fields is yielding some very commendable progress, but there seems to be no justification for high hopes. Meanwhile, the world has an enormous over-supply of heavy fuel, and the market for the more valuable motor fuels has not yet neared the limit of its elasticity.

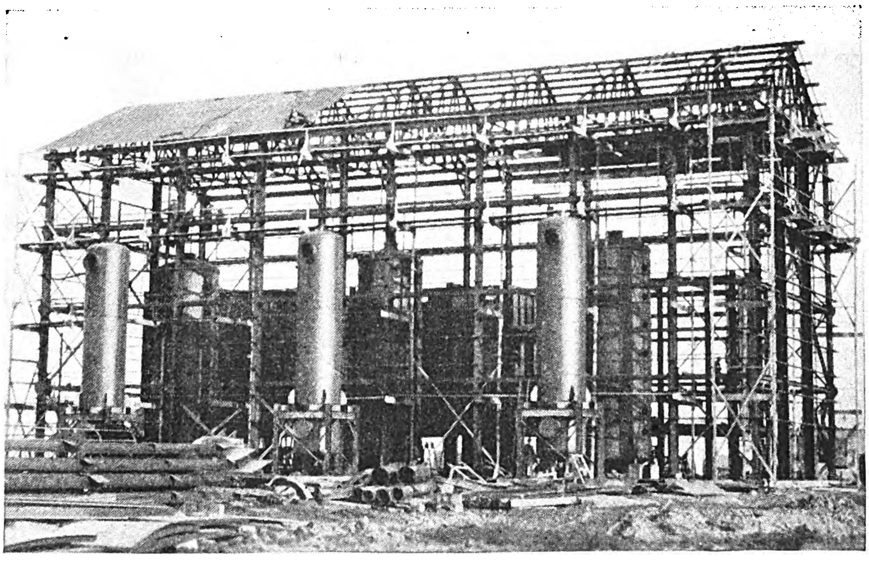
From this it is clear that there is need for a new manufacturing process which can make profitable use of the petroleum products which now are a drug on the market. The hydrogenation process, in its present state of development, is more than capable of meeting this need. This process has shown its ability to do greater things than convert heavy oils into gasoline.

Dr. Bergius took several steps at once when he worked out a method for converting wood into gasoline. First he duplicated nature's "incoaling" process, by which he quickly transformed wood or other vegetable matter into coal. Then he went on with the same process, converting the artificial coal into oil. It was found that the same thing could be done with natural bituminous coal. The hydrogenation of heavy oils into gasoline and light oils is but a page in the story of Dr. Bergius' achievements.

After enumerating that remarkable series of advances, the writer scarcely dares mention Dr. Bergius' one great purpose, an unfinished performance which may yet make these others seem like mere side-shows. Underlying all of his research is the greatest objective of all—to perfect a practical process which will enable man to make his own food, and food for his animals, by utilizing apparently worthless materials which now are burned as rubbish.

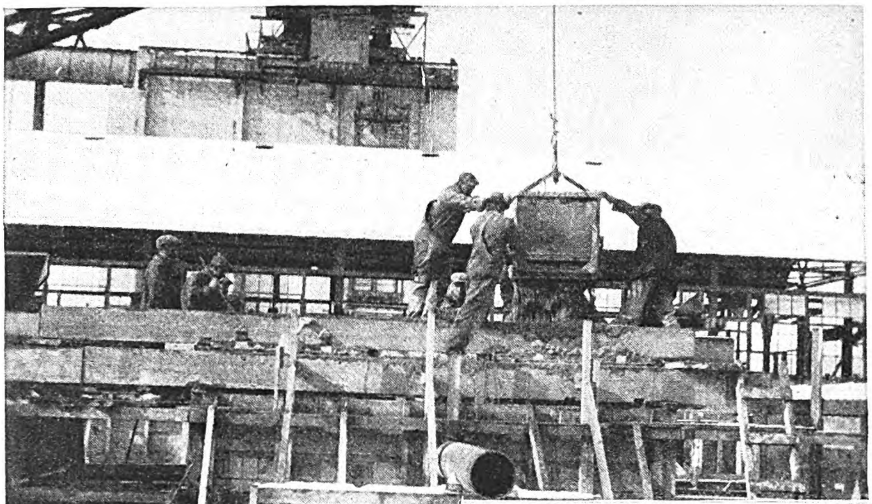
RETURNING to today, after this glimpse of the day-after-tomorrow, we can look more deeply into the process which now is being used to produce gasoline from almost worthless heavy oils. Of paramount importance in this conversion process are the toxin-proof catalysts. These make it possible for the gaseous hydrogen, which is introduced into the high-temperature conversion apparatus under exceedingly high pressures, to transform the molecules of the heavy oils into molecules of gasoline and other light fractions.

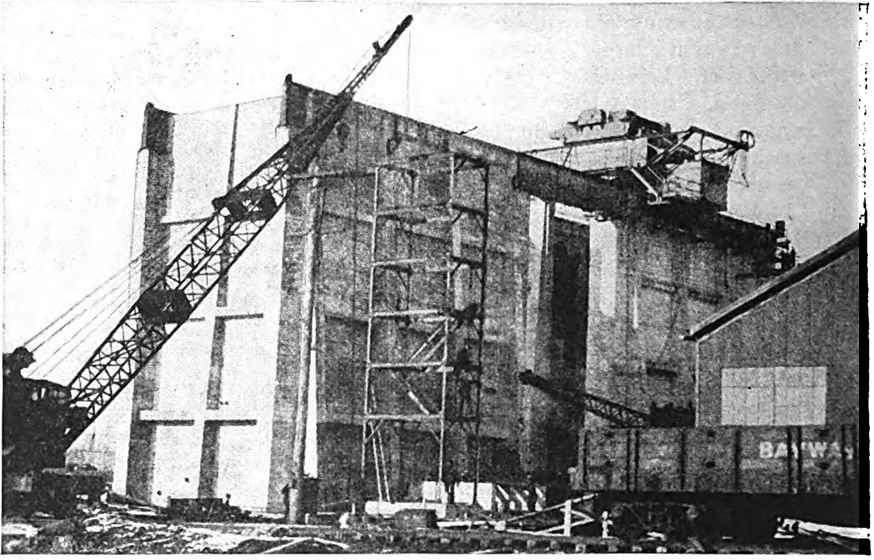
It might be well to add a word of explanation about catalysts, for the benefit of those who find the term an unfamiliar one. In chemistry, a substance which serves the useful purpose of stimulating or facilitating a reaction, without adding to or detracting from the



Where the hydrogen will be manufactured—the gas plant building under construction. The new process consists essentially in adding hydrogen to the oil materials involved, is known as a catalyst. In matrimony, a person who plays a similar rôle is known as a matchmaker. In both instances, they may be very helpful.

Years ago, Dr. Bergius effected the conversion of wood into coal, at a temperature of about 340 degrees, in the presence of water in liquid form. A pressure of about 200 atmospheres was provided as a means of keeping the water from vaporizing at such high temperatures. The water served to prevent super-heating of the newly-made coal, and made it possible to control the physical conditions during all phases of the incoaling reaction.





Upper: **Pouring some of the 4700 cubic yards of concrete that went into the Bayway hydro plant.** *Lower:* **Huge concrete slabs enclosing the reaction towers in which hydrogenation actually takes place. Overhead is a traveling crane**

In his coal liquefaction process, Dr. Bergius used ferric oxide with the hydrogen, in apparatus designed to withstand pressures up to 2000 pounds per square inch. At a temperature of 400 to 500 degrees, Centigrade, under a pressure of about 150 atmospheres, the conversion into oil and gasoline took place. The catalysts now used with the Bergius process, as it has been improved for the commercial production of gasoline and light oils, are considered a secret. There also is great secrecy about the exact temperatures and pressures used, and other features such as the design of the high-pressure conversion apparatus.

OTHER investigators, Satatier and Senderens, had found that a nickel catalyst aids in the production of methane gas from coal. The Fischer process of hydrogenation produces benzine by using iron and cobalt as the catalytic agents, and high pressure is not required. In this instance, the catalysts tend to inhibit the formation of methane, and when caustic alkalis are added the conversion continues on down to solid paraffins.

The Bergius process now is being adapted for the conversion of gasoline from heavy crude oils, such as that produced in Venezuela. By present methods of refining and cracking, only a small proportion of gasoline can be extracted from these heavy crudes. Most of the residue is heavy fuel oil, for which there is practically no demand at present.

In the hands of almost any other industrial organization, it might reasonably be feared that the exploitation of the hydrogenation process would bring about chaos in the petroleum industry. However, because of the Standard Oil Company's enormous investment in the oil industry, it is felt that the owners of the hydrogenation process will move with extreme care in order to avoid changing the *status quo* to any great extent.

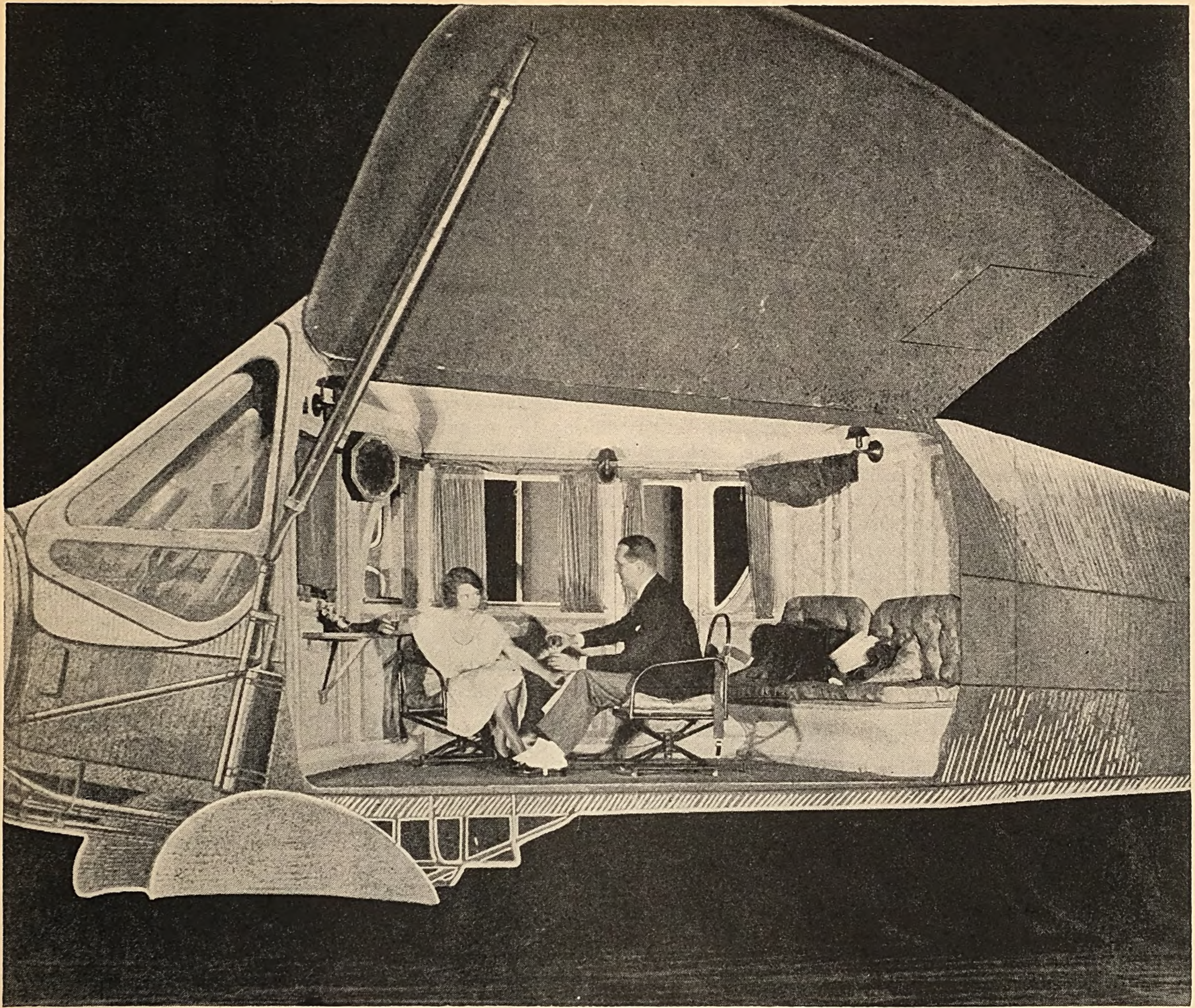
The rights to use the new process in the United States will be leased to other oil companies. Licensing companies will purchase stock in the Hydro Patents Company, a subsidiary of the Standard-I. G. Company, at the rate of one share of stock for each barrel of daily hydrogenation capacity. For example, a firm desiring to establish a plant to produce gasoline at the rate of 20,000 barrels a day will buy 20,000 shares of stock in the Hydro Patents Company.

These outside firms also will be required to align themselves with another subsidiary corporation, the Hydro Engineering and Chemical Company. This organization will furnish the technical information and will supply the catalytic agents. It also will act as engineer in designing, constructing, and supervising the plants of licensees.

ACCORDING to Mr. W. C. Teagle, president of the Standard Oil Company of New Jersey, the future of the oil industry will be determined by the extent to which both producers and refiners recognize that it is not a question of the volume of the products which governs their destiny. It must be realized that the real test is in the industry's ability to measure production to fit the requirements of the consuming markets. The probable effect of hydrogenation upon the petroleum industry is best expressed in Mr. Teagle's own words:

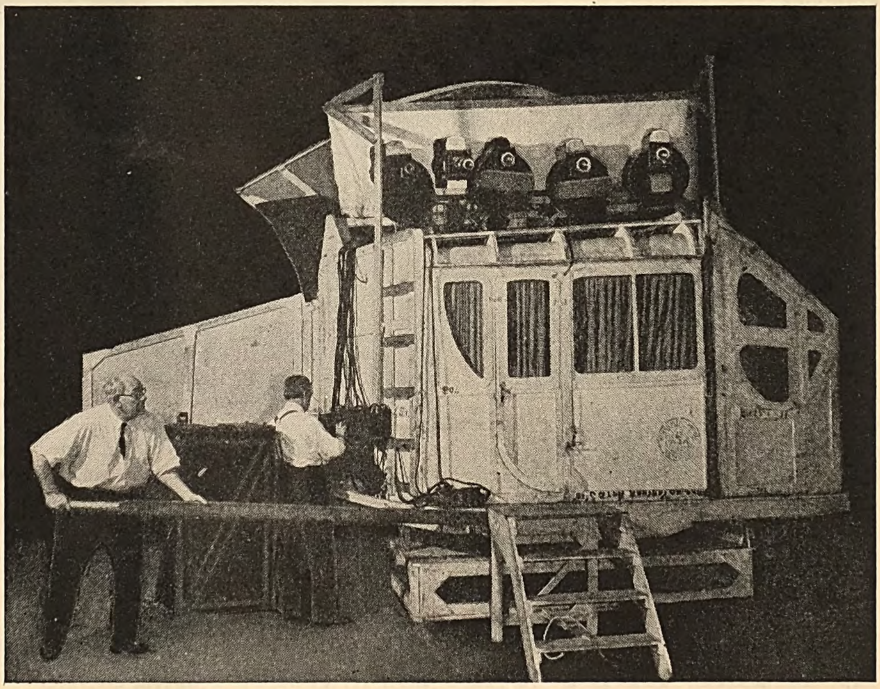
"Through hydrogenation it now is shown to be practicable to convert coal into liquid hydrocarbons at a cost which, although above prevailing oil prices, is not prohibitive. Thus, the coal reserves of the world become supplemental to the crude oil reserves.

"Because of the innumerable new technical problems, solutions of which are required for the practical and profitable use of the hydrogenation method in the oil industry, and because of the relatively large investments required, progress toward its general application will probably be slower than was the case with the cracking development. The ultimate effect, however, should be even more important."



THE STAGE GOES "AIR-MINDED"

ANY play which goes through the hands of David Belasco is sure to be elaborately staged with a fine feeling for detail by this rare artist. His latest production, called "Dancing Partner," has a scene where the lovers are taken aloft in an airplane which cavorts around while fleeting terra firma, clouds, and the starry heavens are viewed through the cabin windows. These illusions are produced by means of projectors carried on the top of the airplane, hidden from the audience by a wing and projecting directly on to the back drop. The electrician controls these effects from the side of the airplane. The huge loudspeaker for the engine effects is located at the left behind the operator who is giving motion to the plane. Another speaker in the dummy cockpit simulates the noise of the propeller and, together with the motions of the landscape and clouds and the sliding passenger seats, serves to give realism to the scene.



EARTHQUAKES

By G. AUSTIN SCHROTER

MANY bizarre theories are prevalent in the popular mind as to the origin of earthquakes and many other unrelated phenomena have been attributed to them, yet they are quite ordinary and commonplace natural processes originating within the outer crust of the earth.

The great Japanese earthquake of 1925 was probably the greatest catastrophe of modern times, and since its advent, Japanese scientists have been among the leaders in seismic studies as well as pioneers in the science of earthquake precautionary measures. Aside from the purely geologic phase of their studies, the Japanese have inaugurated a hitherto undreamed of architectural era in which beauty and safety from crustal movements have been combined.

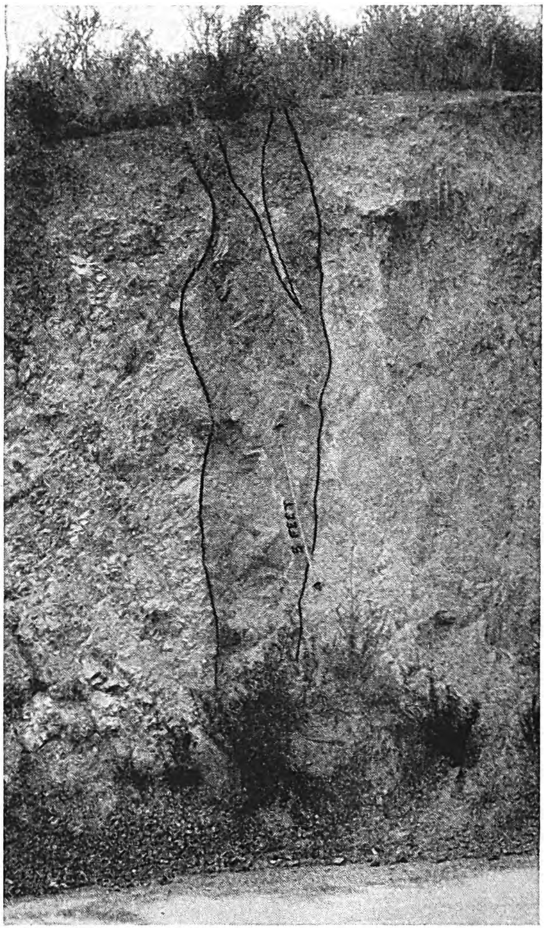
FOR innumerable years scientist and layman alike believed the source of all seismic activity to be in volcanic activity. Although it is quite true that many sharp local shocks owe their inception to volcanic action, in the aggregate volcanism is rather a subordinate cause of major earthquakes.

There are several types of volcanoes whose classification is dependent upon the types of their eruptions.

The quiescent type, of which Mauna Loa and Kilauea in Hawaii are typical examples, completely lack the catastrophic phenomena of the volcanoes mentioned below. The quiet types give rise to outflows of intensely hot lava, without violent projection of gases or solid material; much as a pot of mush will quietly overflow its container and run down upon the stove top. Quite frequently the pent-up lava content will break through the sides of the vent and peacefully roll down the sides of the volcano until it comes to rest on the slopes below. This type of volcano is of relatively slight importance from the seismic standpoint.

The intermediate (Vesuvius) type of volcano stands midway between the quiet and explosive varieties, and quiet outpourings of lava may be preceded by or alternate with periods of violent explosive activity. This is by far the most common type of volcano, and although local tremors may have their birth in this type of eruption, they usually are of unimportant magnitude.

The explosive type of volcano is, as the name implies, marked by violent explosive activity during the eruptive stage, and sudden ejection of gases, dust, and rock fragments is typical. The most outstanding example is Krakatoa, located in the Straits of Sunda near Java. In the eruption of 1883, Schuchert says that "after premonitory outrushes of gas for some time, the great explosion occurred which blew away over a cubic mile of material from the volcano! The vast cloud of ejected material arose over 17 miles into the atmosphere, completely hiding the sun . . . over a vast area. The noise of the detonation could be heard for over 150 miles, and the atmospheric disturbance affected barometers all over the world!"



All photos by R. C. Bowes

A fault showing at a road cut. The black lines were drawn in, as the materials were poorly distinguishable in the photograph. They delimit the zone of crushed, ground-up granite. Note the uncrushed pendant within the crushed zone

Small wonder then, that some violent volcanic outbursts give rise to sharp, disastrous, local shocks. These may be due to the effect of the actual detonation on the surrounding rocks, or they may be due to collapse of the crust due to extravasation of underlying lava, just as a building will be weakened and finally collapse if the foundations are gradually removed. Still another explanation of earth tremors in connection with volcanic activity is the sudden violent shattering of hot rock in contact with steam or cold water. This process is similar to the old trick of shattering rocks by heating them in a fire and suddenly quenching them in water. There is little or no proof for this theory of rock-bursts.

IN the year 1811, the lower Mississippi valley was visited by a series of shocks, many of them catastrophic in magnitude. New Madrid in southern Missouri was demolished, and this earthquake was named after the town. Much of this region is an area of limestone rocks which are relatively soluble in circulating ground waters, as indicated by the many limestone caves which abound in the region. It has been suggested that one of the contributory causes to the New Madrid earthquake may have been the sudden collapse of the roofs of certain of these caverns due to the weight of overlying rock masses. It is, however, obvious that other factors must have entered into the case as the shocks were too heavy and too widespread to have originated in this manner alone.

This leads us to a consideration of the most outstanding and common cause for earthquakes, especially of the more sudden, heavy, and frequently disastrous shocks.

That the outer crust of our old earth is constantly undergoing alteration and modification is a fact patent to the most unskilled of observers. The mighty forces of nature seem to be forever in a state of unrest, and they are constantly at work in their task of altering, shifting, and disintegrating the strongest of rocks and the mightiest of mountain ranges.

The sea reaches eager fingers to the land, and the sea waves with their burden of sand and littoral material wear away the land, under-cutting the strongest of cliffs, and piling the waste material in spits and bars. Tiny drops of rain fall upon the earth and, as each follows the path to the sea, does its finite bit in wearing and transporting the small products of rock decay. Rills, rivulets, and rivers scour their channels and sweep away portions of the banks, ultimately to deposit their load of silt and sand in the ocean or on some lower flood plain. Winds loaded with dust and sand abrade the toughest of rocks and carry the products of the disintegration many hundreds of miles before they are dropped. Glaciers pluck away whole mountains and move them away. Thus, even the mighty continents themselves are in motion! Throughout the vistas of geologic time mountain chains are worn away and new ones are thrown up to take their places. All of nature is at work in the age-old processes of tearing down and building up.

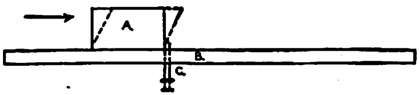
AN attempt to discuss the details of the stupendous forces of mountain making or of the uplift and subsidence of land masses, would require much space, but it becomes increasingly obvious that, when millions of tons or hundreds of thousands of cubic miles of rock are moved from one portion of the earth's crust and deposited upon another portion, adjustment of the crust must ensue to support the gigantic loads thrust upon it.

Every beam, bulwark, or foundation must have an ultimate breaking point when the loads upon it exceed its strength. And so we find that the crust of the earth must give way in places when the load placed upon it exceeds its strength. In short, a rupture or break is bound to occur, and the broken segments in turn will adjust themselves to the stresses which are acting upon them. Such ruptures or fractures in the outer crust along which appreciable movement has occurred are "faults," and it is to them that we must turn in looking for the most common cause of earthquakes.

Proof that the great crustal blocks do readjust themselves to the loads thrust upon them is apparent on every hand. Sea shells and the remains of marine organisms are found on the highest mountains, thousands of feet above sea level, old marine strand lines and beaches are elevated far above the reach of the nearest sea waves. Man-made monuments and temples that were constructed within historical times on perfectly dry land are now found to have sunk beneath the sea and been resurrected, not once, but many times. It does not seem so strange, then, that proofs of this constant crustal unrest frequently manifest themselves as shocks, tremors, and ghostly sounds, apparently arising from the very bowels of the earth.

Movements along faults are constantly in progress. No one region is free from them, and if they happen to occur suddenly or with much friction, they are manifested to our senses, but if the slip be slight or gradual, only the most sensitive of seismographs can detect it.

No hour in the day, no day in the year, and no region on earth is free from earthquakes. They are as common as life itself, but by far the largest number are not apparent to the senses. The idea that any given region is free from earthquake danger is fallacious. In New England, for example, in the 230 years following its settlement, Schuchert says that over 230 earthquakes have occurred.



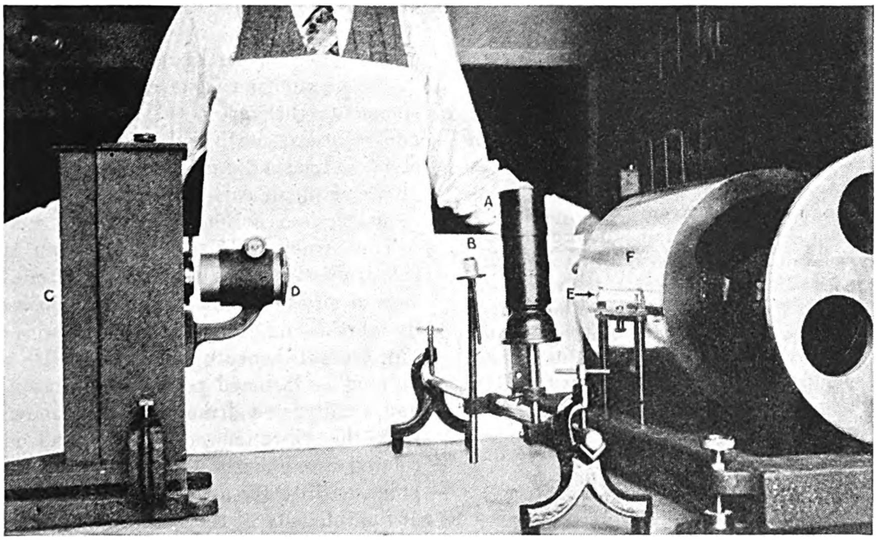
A model to illustrate the principle of elastic rebound. An India rubber block (A) sliding over a table top (B) is impeded by an upward projecting nail (C) until it tends to undergo elastic distortion. If the nail is quickly removed while the force is in operation, the elastic properties of the cube will cause it to snap into its original undistorted shape, causing an "earthquake"

Displacement along faults may be horizontal, vertical, or both vertical and horizontal, the latter being the most common type of movement. One of the most recent theories to be held regarding the origin of earthquakes is known as "Reid's theory of elastic rebound," and it may be explained somewhat as follows.

SUPPOSE that a block of India rubber is moved over a table top, as shown in the figure, until the bottom of the block is intercepted in its movement by a nail or peg driven up through the table. If the moving force continues to act, the top of the block will continue to move forward, but the bottom of the block, by virtue of the obstruction will cease to move. As a result, the elasticity of the rubber block will tend to snap it back to its original undistorted position when the obstruction is removed, and the block will assume its former shape and gliding motion with a sudden snap due to the molecular forces within it.

This process is exactly what may occur in two contiguous blocks of the earth's crust. If they are slowly moving past each other due to the stresses of readjustment, and the movement is impeded by a force tending to stop it, stresses will immediately be set up in the two blocks. The stresses will continue to grow until the moving force or the elastic tendency of the blocks overcomes them, or the rock shatters.

When either of these two phenomena occurs, it will manifest itself by a sudden sharp jar or shock, the intensity of which will depend upon the amount of deformation overcome, and upon the in-



Torsion seismograph perfected by Dr. J. A. Anderson of the Mount Wilson Observatory staff, and Dr. H. O. Wood, Research Associate of the Carnegie Seismological Laboratory at Pasadena, California. A beam of light is sent from the lamp (A) to the prism (B) from whence it is refracted to the mirror of the seismometer within the case (C). The rotating mirror of the seismometer reflects it through the telescopic attachment (D), thence through the cylindrical lens (E) to a strip of light-sensitive paper mounted on the revolving drum (F). The entire apparatus is mounted on a concrete pier within a light-proof cabinet. The optical recording system does away with many difficulties encountered in a mechanical one

tensity of the moving force. The jar will be transmitted instantly to the surrounding crust and waves will be sent out from the point of origin. These are the earthquake waves, and their physical characteristics will determine the amount of damage which they are able to do.

Some faults, quite naturally, are undergoing no movement at present, and are known as "dead-faults." Those which are at present undergoing readjustment are "live-faults." Likewise, some faults are undergoing more rapid readjustment, or are subject to greater stresses, and hence are more pregnant sources of violent shocks.

The great San Andreas rift of California has been studied more in detail, probably, than any other earthquake fault in the world. It has been traced for over 600 miles and forms the boundary between two great crustal blocks, one moving south and the other north relative to each other. It was the San Andreas rift which was the source of the California quake of 1906. In connection with this temblor, it underwent displacement for over 290 miles. Fences and roads crossing it were observed to have been broken and moved apart as much as 20 feet.

MANY earthquakes are due to vertical movement along the source-fault. For example, the great Mino-Owari earthquake in Japan showed a vertical displacement of 20 feet in one place, while the Owens Valley earthquake showed a maximum uplift of 23 feet.

Awe inspiring stories without number have been related by the survivors of great earthquakes, of the fearful sounds accompanying the shock, which were scarcely less terrifying than the quake itself. Tales of unbelievable groaning and grinding noises, of whole forests obliterated, of new streams and waterfalls formed where none before existed, of gaping fissures and dried-up wells, are commonplace and, stranger still, in the aggregate they are true.

For purposes of study, most of the sounds accompanying an earthquake are referred to the Davison sound scale, which is given below:

(1) Sounds resembling wagons, carriages, engines, or trains passing, generally very rapidly, on hard ground, over a bridge, or through a tunnel; the dragging of heavy boxes over the floor.

(2) Thunder; a loud clap or heavy peal, but most often distant thunder.

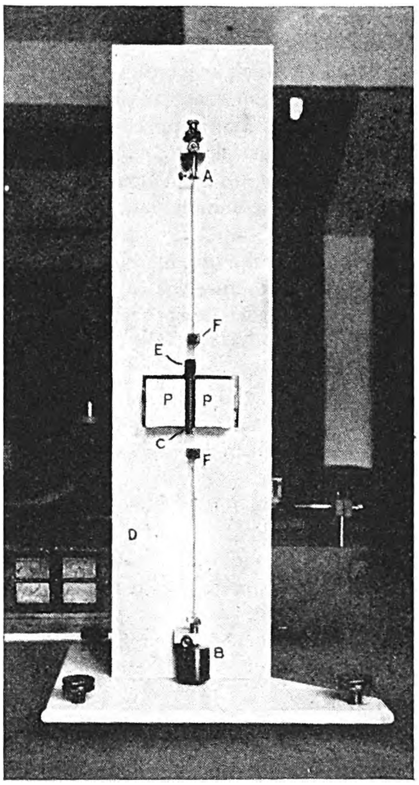
(3) Sounds resembling a moaning, roaring, rough, strong wind, a rising wind, or a heavy wind pressure against the house, a chimney on fire, and so on.

(4) Sounds of great loads of brick, coal, or rock being dumped.

(5) The fall of heavy bodies, banging of a door, pounding of the surf on the shore.

(6) Distant blasting, explosives, firing of artillery.

(7) Miscellaneous sounds such as the roaring of a waterfall, rending or tearing sounds, or the sounds of an immense covey of partridges on the wing.



Enlarged model of the torsion seismometer. A fine tungsten wire is suspended from the screw clamp (A) to the tension attachment (B). A copper cylinder (C) is mounted eccentrically on the wire. When the standard (D) vibrates, the cylinder, due to its inertia, tends to remain at rest. Torsion is set up in the wire causing rotation of the tiny mirror (E) about the suspension. A beam of light can be reflected from the mirror to a sensitized paper on a revolving drum, thus obtaining a photographic record of the shock. A magnetic field from the poles (P) damps the vibrations of the torsion pendulum. The vibration of the wire as a whole is damped by the reservoirs (F) filled with castor oil. This instrument is for use with the horizontal components of the waves. The vertical components are measured in the Carnegie Seismological Laboratory at present, on a seismometer perfected by Mr. Hugo Benioff, Research Associate

The different sounds of the Davison sound scale vary, of course, with the distance of the observer from the source of the earthquake. They may resemble the roar of a train through a tunnel in one place and the low moaning of wind in another. They may be audible to one person and entirely inaudible to another, depending upon the individual's sense of hearing. The author has many times detected the sound of thunder or heavy explosive blasts in connection with seismic activity.

The most outstanding characteristic of these seismic sounds is their extreme lowness or depth of tone, which helps to explain why they may be difficult for some persons to hear. The accompanying sounds owe their origin, of course, to the vibrations set up in the rock by the quake, just as an organ reed vibrates and causes different sounds by different intensities of vibration.

So-called "tidal waves" are another phenomenon accompanying earthquakes, especially in those of submarine origin. These waves have no relation to the tides, but are caused by the elastic rebound of submarine rock masses. In strong submarine earthquakes, the effect on ships is much as though they have struck on a rock or grated over a reef. Seismologists call these vast sea-waves *tsunamis*, from the Japanese, or when they are observed in bays or inlets, as *seiches*, especially when they are stationary waves. They may be as much as 100 or 200 miles from crest to crest, 40 feet high at the point of origin, and they may sweep across the seas with a speed of from 300 to 500 miles per hour. Such *tsunamis* may be unperceived in the open ocean, but upon reaching the land they may pile up as great waves and sweep far inland with great loss of life. Such were the waves that played havoc with Lisbon in 1755, Japan in 1854, and Peru in 1868.

EARTHQUAKES may dislodge loose masses of earth or rock, cause landslides or avalanches, and thus completely denude forest slopes, or dam streams and rivers giving rise to new lakes and "sag-ponds."

The study of earthquakes and earthquake phenomena is seismology, the instruments that are used for detecting and recording earthquakes are seismometers and seismographs, and the record obtained of an earthquake with a seismograph is a seismogram.

The principle of the seismograph is relatively simple. The instrument consists of a heavy mass of metal which by its inertia tends to remain at rest while the ground beneath it vibrates. If a pointer is fastened to the inert mass, and a calibrated drum which will move with the vibrations of the ground is rotated in contact with the pointer, the pointer will leave a record on the drum of the intensity of the shock, and of the frequency, amplitude, and period of the accompanying waves.

The classic example of the seismograph, and at the same time, one which is easily constructed, is a heavy steel ball or bearing placed on a smoked glass plate. If a shock occurs, the ball will tend to remain at rest while the glass plate under it will vibrate to and fro, and a record of the "quake-tracks" will be left on the soot.

The ideal seismograph should be able to record the wave motions in three dimensions; that is, north-south, east-west, and up and down. So far, no such ideal instrument has been devised and in practice it is necessary, if accurate results are required, to use two types of instruments, one for vertical, the other for horizontal components.

The movements of the ground during an earthquake shock may be of two kinds: (1) in large earthquakes, there may be a sudden, large displacement, or a violent lurch of the crust, either horizontal or vertical, or in both planes, or (2) as in all earthquakes, there is a vibratory motion of the ground. The measurement of the former, the great lurches or sudden displacements, can not be accomplished by seismographs. When they take place the ordinary seismographs are thrown out of action or damaged. For recording the vibratory movements, the latter, it is necessary to have two sets of seismographs, one for near, and the other for distant, shocks.

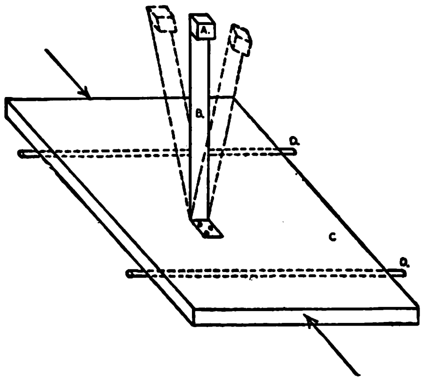
A STUDY of seismograms has indicated that the main shock is preceded by smaller, so-called "fore-shocks," and followed by slighter "after-shocks." The fore-shocks are due to the waves which have taken the shortest path from the source of the temblor to the instrument *through* the earth. The waves of the main shock are those which have traveled *around* the periphery of the earth. After-shocks are usually the result of final readjustment to stresses along the fault. In the Italian earthquake of July 23, 1930, the after-shocks continued for several days after the main, destructive shocks, and did much damage to buildings already weakened.

If three or more stations accurately record the shock, it is a fairly easy matter to calculate the origin of the earthquake. The greatest difficulty is to record the exact time of arrival of the quake at any one station so that the relative time may be determined.

The Seismological Laboratory of the Carnegie Institution of Washington, which is situated at Pasadena, California, is connected with a network of seven recording sub-stations located at Tinemaha, Haiwee, Santa Barbara, Riverside, Pasadena, Mount Wilson, and La Jolla, California. The time of arrival of a wave at any station is co-ordinated with the other stations by means of a dot-dash radiogram from a powerful, long wave, radio station. Thus, if a wave arrives at Pasadena at the beginning of a dash, and at Santa Barbara at the end of a dash, the relative time of arrival between the two stations can be calculated, and the ultimate source of the quake located.

Although, as has been mentioned, no locality is free of earthquakes, certain regions are more liable to dangerous tremors than others. These large well-defined tracts are known as seismic belts. One of them borders the Pacific Ocean, and follows the west coast of South and North America, Alaska, the Aleutian Islands, and the islands off the coast of eastern Asia. The other seismic belt borders the Mediterranean, the Alps, the Caucasus, Himalayas, and so into the East Indies.

The seismic belts follow in general the great zones of weakness in the crust of the earth. For example, off the west coast of the Americas the land is rising with respect to the ocean floor. In regions of active mountain making, great river deltas, rising or subsiding land tracts, and so on, the danger of heavy shock is more imminent.



A model to illustrate the motion in tall buildings or high stacks. The heavy metal bob (A) is mounted on the flexible brass pendulum (B) which in turn is screwed to the base (C). The base is free to roll over the rollers (D). A slight back-and-forth motion of the base will cause the pendulum to swing through a constantly growing arc

In accordance with what has been said regarding the origins of earthquakes, it would seem that in a region where many recurrent slight shocks are prevalent or common the danger of heavy damaging shocks is less. Conversely, in regions of seismic activity, periods of long quiescence may be the forerunners of a violent earthquake.

To the American people, perhaps the most horrific example of an earthquake in the rôle of a destroyer was the great California earthquake of 1906, which resulted in untold suffering, property loss, and a casualty list of close to 1000 lives. The city of San Francisco suffered the greatest loss, due in large part to the destructive fire which swept unchecked over the city following the quake, owing to destruction of pipelines by the tremors.

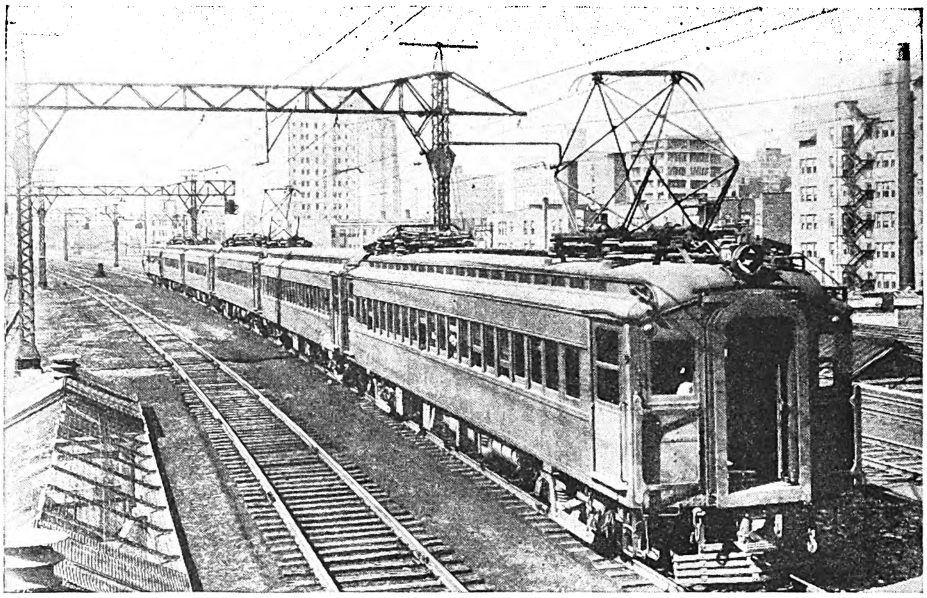
On the 28th of December, 1908, the two cities of Reggio and Messina in southern Italy, were completely destroyed with a loss of life of approximately 200,000 souls. The more recent Italian earthquake of July 23, 1930, probably had its inception in the same region, which is an active seismic one, and had the proper precautionary measures been observed, the loss of life in both of these disasters would have been very greatly reduced. In general, the least risky part of the earthquake cycle is the period after a quake; while the stresses once more accumulate after several years. Yet, such is human nature, much attention is given to precautionary measures at the former part of the cycle, but the least at the later time of increasing risk.

THE greatest danger to the populace during an earthquake arises out of poorly constructed buildings and the tendency to become panicky. By referring to the accompanying figure, the danger to be expected from very high buildings becomes obvious. A high building during a shock may act as an inverted pendulum, so that a very slight oscillation of the ground will be greatly amplified in the upper portions of the structure. Notice a clock pendulum at the point of support. The arc through which it swings is slight. At the bob, however, the arc of swing is greatly amplified, and it is in this principle that the danger from high buildings lies.

In an active seismic region the heights of buildings should be, and frequently are, limited. The danger from falling cornices, high smoke stacks, and perched water tanks can not be stressed too much. In a metropolitan district, it is far safer to run into a Class A building than into the street during a tremor, as the greatest danger lies in falling objects rather than in collapse of walls. Buildings on filled or made ground, likewise are in more danger of collapse than similar buildings built on bed rock.

Movements are now under way, in many of the larger cities, to pass ordinances requiring that buildings be designed to withstand horizontal stresses as great as the stresses upon their foundations. Large buildings, dams, and similar structures should never be built over or close to a live fault, as the danger is imminent. Brick buildings, unless highly reinforced, should be avoided in active seismic regions.

The science of seismology is still in its infancy, so that it is difficult to predict just what strides in earthquake prognostication will be made within the next few years. It is certain, however, that at present, no person can predict the time of occurrence of an earthquake in advance. The old superstitions that earthquakes are more apt to occur during the summer in preference to other seasons, or that they are preceded by "earthquake-weather," is so much rubbish. No good can ever come of such fallacies. They should be relegated to oblivion with the old superstitions of witchcraft and astrology.



Multiple unit cars in service on the Illinois Central in Chicago. Passenger cars of this type are widely used in suburban and urban service

RAILROAD ELECTRIFICATION

By FRANCIS H. SHEPARD

Director of Heavy Traction, Westinghouse Electric and Manufacturing Company

WIDESPREAD opinion has it that automobiles, buses, and airplanes are taking the business of the railroads and that, therefore, they are being electrified for economy's sake. Neither the postulate nor the conclusion is correct. While railroads admittedly are not now operating on a high-profit basis, there is a steady increase in freight shipments and even an increase in long-distance rail travel and far-sighted authorities are very optimistic for the future. Economy has no place in the American scheme of electrification, for the operating economy on electrified American roads is practically nil. Mr. Shepard has, in the accompanying article, given us the truth, as an expert sees it, about rail transportation, its relation to the electrification problem, and the full significance of the latter—what it means to railroads, to the investor in railroad securities (who will read between the lines), and to the country at large.—*The Editor.*

RAILROAD electrification in the United States is entering into an era of increased activity. Several of our railroads are now beginning to electrify their main lines and others are actively considering plans to the same end. The cost of projects at present actually under way exceeds a hundred million dollars, and the total for those contemplated is many times that amount.

Much the same tendency is noticeable throughout the world. All of the nations listed in the accompanying table are either extending or planning to extend their electric service, and, in addition, electrification work is under way in seven or eight other countries.

No single cause is responsible for all this interest. Electricity as a tool for moving traffic has a number of advantages, some of which may be the determining factors in one case while totally different ones may govern in another.

IN many instances, especially outside the United States and Great Britain, the fuel situation provides the underlying motive for electrification. When a nation lacks abundant supplies of first-class coal but is favored with ample waterpower or some form of low-grade fuel, the use of electricity for railroad operation not only may effect a large saving in operating expenses but means independence of coal-producing countries in times of emergency. Switzerland, which has already electrified almost half of her route mileage, furnishes a typical example of this condition, and in the same category are Austria, Brazil, Chile, Italy, Norway, Sweden, and, to a lesser degree, France and Germany.

In this country, on the other hand, where the cost of coal and oil is comparatively low, little or no operating economy would result by saving fuel through electrification; the fixed charges of the electric installation would, in general, be greater than the cost of fuel saved. In the decision to carry out one American electrification—that of the Chicago, Milwaukee & St. Paul—the use of waterpower played an influential part, but all the other installations in the United States were due to other considerations, which can be summarized as follows:

Tunnels. The original application of

IMPORTANT ELECTRIFIED RAILROADS OF THE WORLD

	Electrified Route Mileage	*Total Route Mileage*
United States	2500	251,000
Argentina	68	23,000
Australia	230	22,300
Austria	450	4370
Brazil	251	18,700
Canada	40	40,000
Chile	210	5400
Cuba	155	3800
Czechoslovakia	30	8800
France	875	33,000
Germany	975	36,000
India	150	38,000
Italy	1070	12,000
Japan	200	13,000
Morocco	150	900
Norway	115	2000
Spain	370	9700
Sweden	730	9800
Switzerland	1550	3600
South Africa	200	11,800
United Kingdom	450	24,000

electric power for main line haulage was made in 1895 by the Baltimore and Ohio Railroad for the purpose of avoiding smoke conditions in its long tunnel under the city of Baltimore. The success of this undertaking and subsequent development led to the use of electricity by the New York Central, the New Haven, and the Pennsylvania railroads for their tunnels into New York City, by the Boston & Maine for the Hoosac Tunnel, by the Grand Trunk for the St. Clair Tunnel, and other installations.

SUBURBAN *and Terminal Service.* The development of the electric street railway and, especially, the use of electrically-operated trains on the elevated railways of Chicago and other cities, showed that electric operation was superior to steam in many respects for heavy suburban service. Electric motor-car, or "multiple-unit," trains accelerate more rapidly and hence can make better time than steam trains, even if the maximum speeds of both are the same; on running into a terminal they can be run out again without further switching, whereas several car movements are needed to reverse a locomotive-hauled train, which not only require time but may congest the tracks outside the terminal; they can run through residential districts without seriously affecting real estate values; and, of course, they can move freely in tunnels of any length.

For these reasons, electric operation was adopted by the Long Island and the New Haven railroads in the vicinity of New York, the Pennsylvania at Philadelphia, the Illinois Central at Chicago, and the railroads around London, Paris, Melbourne, and other large cities.

Mountain Grades. Of a group using electric operation for totally different reasons, the Virginian Railroad is typical. The chief business of this road is to haul coal from West Virginia to tidewater at Norfolk, Virginia. Its line crosses the Allegheny Mountains and at one point some very heavy grades against traffic are encountered. Under steam operation, these grades formed the "neck of the bottle" for the railroad. Even with the use of the most powerful of steam locomotives, traffic slowed down here and the capacity of this portion set the limit to the entire road.

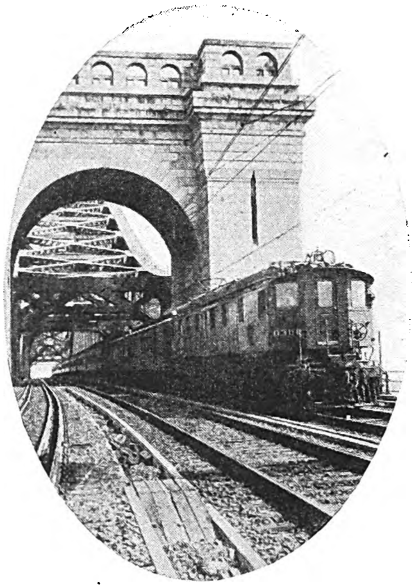
In order to increase this capacity, which was becoming more and more necessary, there were two alternatives: to retain steam operation and increase the number of tracks, or to increase the power for each train by using electricity. Owing to local conditions, the cost of additional tracks would have been exceedingly high, so electric operation was decided upon. Today, locomotives applying at times more than 20,000 horsepower per train are in use on this road, and trains are being moved up the steep grades at twice the former speed. The net result has been to increase the capacity of the road by more than 100 percent, with even greater capacity available if needed.

Other railroads using electric power for mountain-grade divisions include the Norfolk & Western and the Great Northern.

IT is obvious, however, that if these reasons alone influenced electrification in this country, we would see no general use of electric power here. The electrified areas would be confined to the great cities, the mountainous districts, and some special localities, but steam would be employed everywhere else. This, indeed, was the situation until very recently—until, in fact, the Pennsylvania Railroad announced its plans to electrify its entire system of all services from New York to Washington and as far west as the vicinity of Harrisburg, Pennsylvania.

In order to appreciate the full significance of this electrification, which is the most extensive and comprehensive one in the world, it must be considered in relation to our transportation situation as a whole.

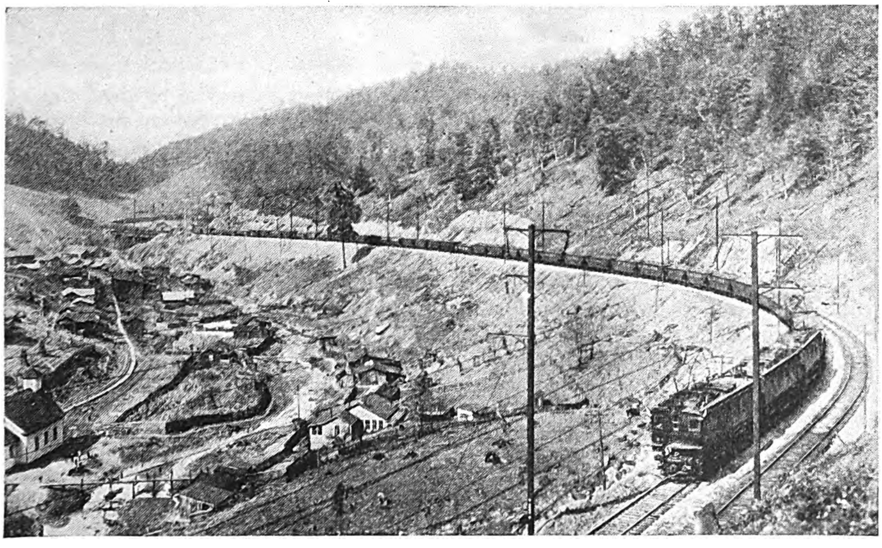
Railroad transportation is vital to the United States. Because of it, our vast territory has been developed and our people have been held together as a single nation. The moment our transportation service fails to meet our needs—as it did during and immediately following the war—everyone suffers: the price of everything we purchase and the cost of everything we produce promptly rise.



Crossing Hell Gate Bridge on the New Haven: The Colonial Express with its 178-ton electric locomotive

OUR demand for rail transportation far exceeds that of any other people. We require 4000 ton-miles per capita, whereas the British requirement is about 500 ton-miles. And this demand has shown marked growth: our ton-mileage for 1900 was 100,000,000,000, and today it is 440,000,000,000; and although with the present trend the aggregate is not increasing, this may be assumed to be only a temporary condition. It is true that a decrease in passenger movement has taken place recently due to the advent of the automobile, but this applies mainly to local and branch line service. On the other hand, there has been a pronounced increase of passengers traveling long distances and between populous centers. The automobile is, in fact, creating traffic by increasing the general movement of our people, by opening up areas for residence which were previously inaccessible, and by making us more travel- and speed-minded. The airplane is also acting in this same direction.

In spite of increase in the demands upon our transportation system, there has been practically no increase in the



A 6000-ton coal train on a 2 percent up grade of the Virginian Railroad, hauled by three 215-ton, 11,000 volt, single phase, Westinghouse-equipped power units

number of freight-train-miles or in the number of locomotives for the past 20 years. This means that our train units are becoming progressively heavier, and trains are being moved at higher speeds. The increase in ton-miles per hour has been nearly 50 percent in less than 10 years. The size of the locomotive has likewise grown, and the trend is conclusively toward more and more horsepower per train.

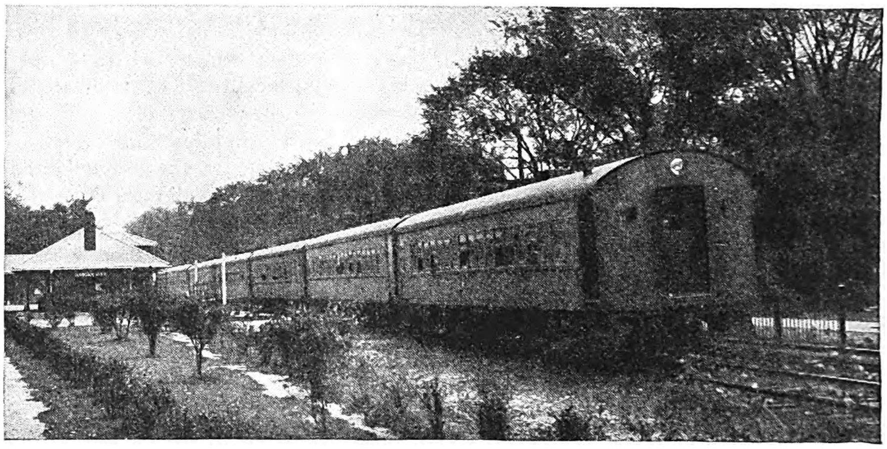
A crack silk train of the Chicago, Milwaukee, and St. Paul drawn by a 300-ton, 3000-volt direct current, Baldwin-Westinghouse electric passenger locomotive

Rail traffic, like automobile traffic, seeks those highways which are most advantageously situated. Half of our route miles carry about 90 percent of our traffic; while the great trunk lines, which constitute only about 10 percent of our route mileage, handle at least half the traffic. There is, therefore, an increasing pressure of traffic on these major routes which has been met by increasing the size and speed of the trains.

So far, the steam locomotive, which has recently undergone conspicuous and notable development, has kept pace with our needs and will continue for many years to be the mainstay for most railroad mileage; but there may be serious question if it can meet the demands of intensive trunk-line operation after the next 20 or 30 years. Double and even treble the present movement may conceivably be the requirement.

With electric operation, on the other hand, the amount of power that can be applied to each train is practically unrestricted, and electric trains of any size can be operated at any speed within the limits set by the road-bed, draw-bars, and other mechanical equipment. Hence, an electrified railroad has greater capacity than the same road under steam power. To electrify a rail highway is to broaden it.

Behind the great electrification undertaking of the Pennsylvania Railroad, therefore, may be seen a recognition of our future transportation needs, a vision of an unhampered and ever-expanding flow of traffic, and the desire to give the public the utmost in railroad service.



Multiple unit operation in heavy duty suburban passenger service on the Long Island Railroad. This is a familiar type of car in many metropolitan localities

Important also is the inauguration by the Reading Railroad of the electrification of its lines radiating from Philadelphia; and it is understood that ultimate extensions will be made for high speed and through service. Increasing interest is also being manifested by other railroads in electrifying sections of their main lines.

Parallel to the progress in developing the utility of railroad electrification, has gone on an evolution in the kind of electric power employed. All the early systems followed street railway practice and used direct current at 500 volts supplied by a third rail. In 1902, B. G. Lamme, Chief Engineer of the Westinghouse Company, announced the results of his experimental development, sponsored by George Westinghouse, of an alternating-current motor which could operate at all the various speeds and under the different conditions required by railway service. This announcement, which indicated the possibility of serving any track with a single working conductor at any desired voltage and of supplying power to trains in any desired amount, instantaneously and effectively, aroused world-wide interest.

In 1905, the New York, New Haven & Hartford, being governed by plans for future extension, adopted the new alternating-current system with overhead conductor at 11,000 volts. This method of operation has since been adopted and made standard by Norway, Sweden, Germany, Austria, and Switzerland, and, in this country, by the Grand Trunk St. Clair tunnel installation, the Hoosac Tunnel of the Boston & Maine, the Great Northern, Pennsylvania, Norfolk & Western, and the Virginian Railroad.

The success of the high-voltage overhead system of the New Haven stimulated the development of high-voltage direct-current equipment, and this current has been applied for various lines at 1200, 1500, 2400, and 3000 volts. Shortly after the war, the French Commission decided upon 1500 volts, direct current, as the official standard for France. The same system is in use in Japan, Java, Holland, and some other countries, while 3000 volts direct current is in use in South Africa, Chile, and Brazil, and by the Chicago, Milwaukee & St. Paul in this country.

The most extensive electrifications now being carried out in this country are with single-phase alternating current, as this system has greater promise for future advantage than any other.

ANOTHER PEKING SKULL DISCOVERED[1]

By PROFESSOR G. ELLIOT SMITH, F. R. S.

AT a meeting of the Geological Society of China in the last week of July, Prof. Davidson Black announced the discovery of another skull of Peking man.

In *Nature* of March 22, 1930[2], an account was given of the discovery of a series of remains of *Sinanthropus*, culminating in the recovery of an almost complete braincase by Mr. W. C. Pei on December 2, 1929, while clearing a sheltered recess of the main deposit at Chou Kou Tien. Some days before this skull was found, five human teeth were recovered from a spot higher up in the shaft, where they were associated with the skull of a large deer and some pieces of fossilised bone and blocks of stone, which were brought to the laboratory in Peking for examination.

This material was "developed" during the third week in June by the technical assistants working under Professor Davidson Black's supervision, and he found that there were enough fragments, which fitted together, to form the greater part of another uncrushed skull of *Sinanthropus*. He waited until the return to Peking of Dr. Wong (Wong Wen Hao), the Director of the Survey, before making the public announcement of his important discovery.

FOR reasons which are not yet clear to those who have not seen the actual specimens, Professor Davidson Black regards the skull found on December 2, 1929, as that of a young woman, and the calvaria, the discovery of which is now reported, is in his opinion that of a young adult male. It conforms to the same general type as the skull previously found, and its proportions are similar. But the braincase is not so thick and the frontal eminences not so pronounced. The most interesting new fact revealed in this discovery is the nature of the root of the nose, which is broad and flat, quite unlike that of Piltdown man.

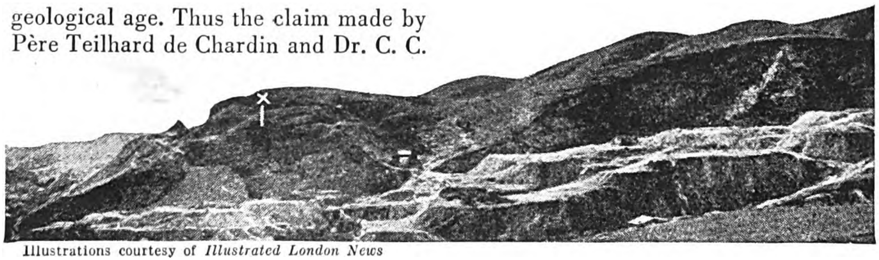
The newly discovered skull was found in association with a number of teeth which can be assumed to have belonged to the same individual. This fact adds to the interest of two mandibles found in 1928 in association with the crushed parts of the respective braincases.

The remains of four skulls of *Sinanthropus* and teeth of at least six other individuals have so far been found. Thus there is available for study in China a much richer material of early Pleistocene man than the fragments of the individual specimens of *Pithecanthropus* and *Eoanthropus* provide. Moreover, the geological age of the Chinese fossils can be established with more certainty than that of the other two primitive genera, which are assumed to be roughly contemporaneous.

The fossils from Java and Sussex were found in gravels, where they had been deposited by running water. Although there is little doubt which of the heterogeneous fossils found in these gravels were contemporaneous with the human remains, in the case of the men of Peking, who left their bones in the cave where they lived, there is less room for doubt that the bones of animals deposited alongside them provide more certain data for the estimation of their geological age. Thus the claim made by Père Teilhard de Chardin and Dr. C. C. Young that *Sinanthropus* lived in Lower Pleistocene times rests upon a surer foundation than the similar claims that have been made in the cases of *Pithecanthropus* and *Eoanthropus*.

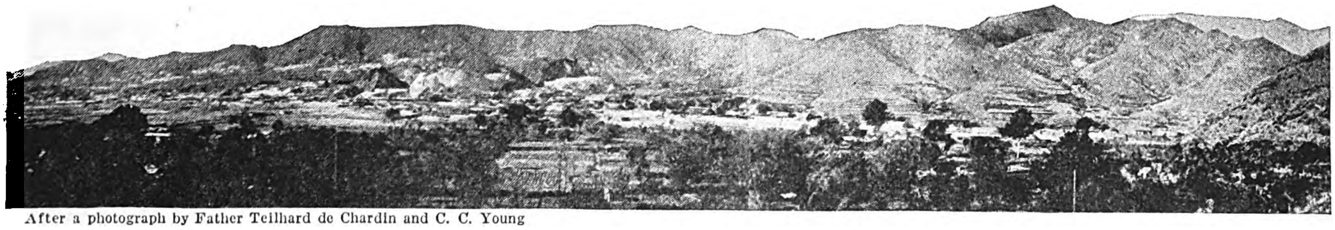
Further, the conditions under which the discoveries are being made at Chou Kou Tien hold out a greater promise of further evidence than in the cases where the fossils have been scattered by running water. Thus a series of fragments have already been recovered every autumn since the type tooth was recovered in 1927, and it is not unreasonable to expect that much more still remains to be found in this cave, and possibly in other fossil beds in the neighborhood. So far no worked tools have been found in the cave; but if such should be recovered, their association with the human remains will be less uncertain than in the case of the other Pleistocene men's implements.

FOR these reasons, in addition to the intrinsic interest and morphological significance of the skulls of *Sinanthropus*, the discoveries in China have an importance which is unique. It is a matter for congratulation that the investigation of this site should have fallen into such competent hands and that ample facilities and skilled assistance should be available for the work, which is being conducted with great thoroughness and insight.



Illustrations courtesy of *Illustrated London News*

Where the remains of *Sinanthropus*, the Peking man, were found—in a cave on the side of a steep hill, at the spot marked X in the picture reproduced above



After a photograph by Father Teilhard de Chardin and C. C. Young

A panorama of the region around Chou Kou Tien near Peking or, as it is now called, Peiping. The small hill at left of the center (with elliptical shaded face) is the one which shows, much larger, in the upper picture which is a close-up view

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[1] Reprinted from *Nature* (London) by permission.

[2] See also *Scientific American*, June and September, 1930, containing other articles on *Sinanthropus* by the author.—*The Editor.*

HOW PLUTO'S ORBIT WAS FIGURED OUT

By **HENRY NORRIS RUSSELL, Ph. D.**

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

NOW that the new planet has been detected upon photographs taken years ago we can be sure that we have a good idea of its orbit. But doubtless many people still are wondering why it took so long to be sure in what sort of path it was moving.

How astronomers can work out the orbit of a planet which they have been observing but a few weeks is a mystery to most people. Indeed we might go further, for even the graduate student of the science, who has gone through the long chapter of mathematical formulae to be found in treatises on the calculation of orbits and the still longer computations which actually apply them, has often no very clear idea of the *rationale* of the complicated process. He can not see the woods for the trees.

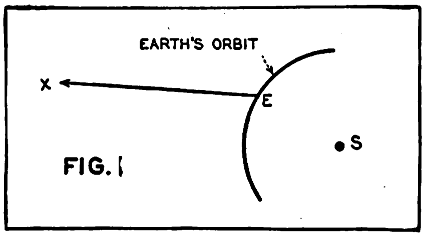

FIG. 1

Yet the thing is not really so hard to understand and, with due apologies to the reader whose tastes do not run along mathematical lines, let us for once consider the reader whose interests do, and try to explain as simply as possible how the apparently impossible thing is done.

FIRST of all we must realize what our planetary observations actually tell us. They give the apparent place of the body in the heavens among the stars; that is, each observation tells us very precisely in just what *direction* the planet lay from the earth (more precisely, from the particular spot on our planet where the observation was made) at an exactly specified moment. But an observation by itself tells us nothing at all about the planet's *distance.* Since the earth's motion about the sun can be accurately calculated we know just where it was at the time of observation (say at E in Figure 1). We can lay off this point on a diagram and also draw in the line EX which runs in the direction in which the planet was seen. (This line would usually run a little above or below the plane of the rest of the picture, but we may leave such details to the actual computer.)

But *where* is the planet upon this line? This is the main problem and it would be very difficult to solve if we did not know the laws according to which the planets move. Suppose that we have two observations, made at the time when the earth was at E_1 and E_2 (Figure 2). If the planet was standing still in space we could locate it at the intersection Y of the lines E_1X_1 and E_2X_2 on which it lay at these moments. But it was actually moving, and so can not have been at Y, wherever else it was.

NOW—to take a simple case first—suppose that the planet's orbit is a circle. We may then make any guess we please about its distance (say SR in Figure 2), draw a circle with this radius and find two points P_1 and P_2 at which the planet must have been if our guess was right. But *was* it right? We can test this by using Kepler's Third Law—that the squares of the periods of the planets are proportional to the cubes of their distances from the sun. We can find by measurement on our diagram, or far more accurately by calculation, what fraction the arc P_1P_2 is of the whole circumference. We know the time taken between these points and so can calculate what would be required to complete the whole orbit at this rate. If the result agrees with Kepler's law our guess was right. If not it was wrong and we try again with a new assumed distance SR′ and get two new positions P'_1 and P'_2. This time perhaps we find a motion slower than Kepler's law allows, whereas the first time it was too fast. The true value then lies between our two guesses and a few more tries will lead us step by step to the correct result.

Such calculations are often made in the case of a newly discovered asteroid to get a rough idea of its orbit and predict where it may be found a month or so later. Most of the characteristics of the general problem are well illustrated by this simple case. In the first place we see how the application of the law of motion turns an apparently hopeless problem into a very simple one. Secondly, we may note that a very small error in our observations may cause a serious one in our results. Suppose that we have got the direction of one of the lines, say E_2X_2, a little wrong. The distance P_1P_2 will then be wrong and, when we compute the time required to make the circuit of the whole orbit from that of this short arc, our error will be greatly magnified; and the same will be true of the final calculated distance. For this reason the computer must assure himself at the start that the observations which he uses have been made with skill and care before he wastes time on useless calculations.

AGAIN we may notice that our problem, as illustrated in Figure 2, admits of two solutions. Instead of starting with an assumed distance less than SY we might have adopted a greater one (SR″ in the figure). We would then have found the planet moving backward about the sun, but by the same process of trial and error we could have hit on an assumed distance at which the rate of motion would agree with Kepler's law. Two quite different planets, then, one relatively near the sun and moving forward, the other farther away and moving backward, each in a circular orbit, might both have been exactly on the observed lines at the correct dates. Later on, of course, their directions from the earth would differ and a third observation would tell which was the true answer (practically, since all of the thousand and more known planets move forward, no doubt would arise).

When the orbit is an ellipse (or a parabola or a hyperbola in the case of a comet) the problem of calculating it is much more complicated but the principles which have just been illustrated still hold good.

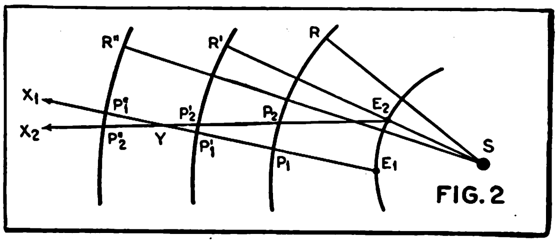

FIG. 2

In this case we must have three observations instead of two—which can be seen from very general considerations. If we have to find the values of a certain number of unknown quantities

—say six—we must have an equal number of equations (or, more generally, of known relations) from which to find them. No algebraical skill can get out the values of all six from only five independent data.

Now each observation of a planet gives us two such independent data, the right ascension and declination. To specify completely a circular orbit we require four "elements"—the node and inclination of the orbit plane, the planet's distance from the sun, and its position on the orbit at a given instant. Two complete observations giving four data to work on should therefore just suffice to work out a circular orbit; as they do. For an elliptic orbit there are two more elements to be found—the eccentricity and the longitude of perihelion, making six in all; and three observations will give us just what we need for a solution.

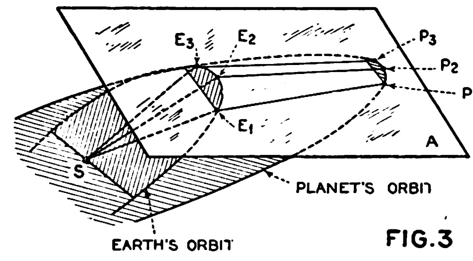

FIG.3

Once again the principal problem is to find the planet's distance. How it is done may best be explained by going back directly to the law of gravitation. We have now to take account of the fact that the orbits of the earth and the planet are in different planes both passing through the sun, as shown in Figure 3. $E_1E_2E_3$ and $P_1P_2P_3$ are the positions of the earth and planet at the three dates of observation. It is always possible to pass a plane A (the least shaded one in the figure) through the line E_1P_1 in such a way that E_3P_3 is parallel to it (though in the case represented lying higher) and E_3 and P_3 are at equal heights above the plane. Now the sun attracts both the earth and the planet, so that their orbits are curved and E_2 and P_2 lie higher than the other two points on each orbit. But since the earth is nearer the sun than the planet, the sun attracts it more strongly and curves its orbit more, so that E_2 will be farther from the one line than P_2 is from the other, and will be higher above the plane A than P_2 (the more so because the earth's orbit is more highly inclined to A than is the planet's). Hence the line E_2P_2 will not be parallel to A, but will slope downward and meet it at some point beyond P_2.

THE angle of this slope may be found from our observations, which tell us just where the three lines are—though not where the points P lie on them.

Now, making any convenient assumption about the distance E_2P_2, it is possible to calculate the influence of the sun's gravitation in curving the planet's orbit (that on the earth's is of course known) and hence to find what the slope of this line should be. Successive trials would then lead us to the correct value. When, as in practice, the arcs E_1E_3 and P_1P_3 are but small parts of the orbit it is possible to set up an algebraic equation which saves the time-consuming process of solution by trial and error and gives the desired distance directly. This equation is of the eighth degree but its solution has been made much easier by the calculation of special tables and presents no great trouble. When once the planet's distance at the time of one observation has been determined, its distances at the other two dates may be found by another equally simple application of the laws of motion under gravity (which, however, we have not space to describe in detail). To calculate the orbit about the sun is then easy enough. It may be noticed that, though the planet's orbit is drawn as an ellipse in the figure, the same reasoning would apply in the case of a hyperbolic comet. In fact the solution leads automatically to a determination of eccentricity of the orbit and the size and shape, whatever they may be.

ONCE again a small error in any of the observations is likely to be greatly multiplied in the results of the calculation. A "first orbit" based on all three observations is therefore usually of low accuracy. It serves completely, however, for predictions good enough to keep track of the planet until, some months after the discovery, it is lost to observation in the vicinity of the sun. Then by utilizing the data obtained in this interval a better orbit can be calculated, sufficient for finding the planet next year, and sometimes, as has recently been illustrated, on old photographs; and then a still better orbit may be calculated.

The general equation for finding the planet's distance has sometimes one real solution and sometimes three, leading to three different orbits in any of which a planet could move so as to be on the three given lines at the given instants. Charlier the distinguished Swedish astronomer has, however, shown that when a body is observed near opposition there can only be one solution of the problem and this is practically always the case for planetary discoveries. For a comet observed near the sun there may be three solutions, as happened for the great daylight comets of 1843, 1882, and 1910.

For a distant body like the new planet Pluto the apparent motion is slow and the effects of even very small observational errors may be considerable until observations covering several months are available. The delay in calculations and publishing an orbit of this most interesting body is therefore good evidence of the full comprehension which its discoverers had of the problem, as well as their excellent judgment.—

Cortina d' Ampezzo, Italy.

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EDITOR'S NOTE: In the light of Professor Russell's lucid explanation of the standard method by which astronomers work out a new orbit, some notes on Pluto's orbit, by the astronomers Ernest Clare Bower and Fred L. Whipple of Lick Observatory, published in the August number of the *Publications of the Astronomical Society of the Pacific*, make interesting reading. These astronomers state that, between last January and June, more than 100 accurate observations of the orbital arc described by Pluto were made available by various astronomers, "but," they add, "these alone would not suffice were they not augmented by observations made possible by the identification of the object on plates taken before its discovery." This was because the January-June, 1930, observations would cover only about 1/500 of the full orbit—a pretty short arc from which to work out an accurate orbit. But at this juncture Mount Wilson, Yerkes and one other observatory came to the rescue with some old plates of the vintage of 1919, 1921 and 1927, which they had found in storage. With these "pre-discovery" observations the new arc now represented a span of 11 years or about 1/25 of the whole circumference of the orbit, a respectable base line from which to perform calculations. How closely Pluto now has been pinned down is shown by the fair agreement in the following results of various astronomers' calculations:

	By Bower and Whipple	By Nicholson and Mayall
Perihelion passage due	Feb. 27.473, 1989	June 5.5, 1988
Eccentricity of the orbit	0.253741	0.2575
Inclination of the orbit	17°8′57″	17° 09′
Period of revolution	249.1661 years	251.80 years

TELEVISION NEEDS NEW IDEAS—AND LESS BALLYHOO

The author

By A. DINSDALE, Assoc. I. R. E.

EVER since I reached the hospitable shores of the United States, nearly every person I have met has asked me: "Well, how long do *you* think it will be before we get television?" I never have felt any particular urge to assume the rôle of prophet, and it seems to me that prophesying about television is about as thankless a job as that possessed by the weather forecaster.

To begin with, it depends largely upon what you mean by television and what you expect it to do. In Europe the public, educated by a vast amount of advance publicity designed to boost somebody's over-enthusiastic claims, has acquired definite and rather high standards about television. It has heard so much about being able to "see the world from your own fireside," to watch the finish of the Derby or the final of the Cup Tie (England's star football match), that it expects just that. And as nobody so far is able to provide the necessary apparatus and service, the public has become somewhat apathetic. It has metaphorically rolled over and gone off to sleep again until something startling happens to wake it up. Extensive lecture tours have shown me that there is no lack of interest on the part of the British public, but much disappointment at the non-fulfilment of promises. "Hope deferred maketh the heart sick."

IN America the position seems to be rather more complicated. In the first place, there seems to have been even more ballyhoo about television over here than there has been in Europe. There are more people working on it, some earnestly and scientifically, and some not so scientifically, some with laudable aims, and some with aims not so laudable.

Since I arrived here I have talked with most of the leading workers in the field, and I can find no unanimity as to what television must be able to do. Dr. Alexanderson, for instance, thinks that a limited form of television will be sufficient, while Dr. Ives looks to the time when television will be able to do all that the talking movie can do, and as well. He contends, however, and I think quite rightly, that the system of television as developed by the Bell Telephone Laboratories for use in conjunction with the telephone, is quite adequate for the purpose. But that is a specialized application. The public expects broadcast television.

With television workers themselves at variance as to what television must be able to do, it is not surprising that the general public has no definite notions on the subject. At least, nobody seems to be able to tell exactly what the public wants or expects. Under these circumstances, the obvious thing to do would appear to be to give the public what you have, try to educate them into liking it, and keep on improving on it.

THAT television today is up against an impasse is a fact acknowledged by most authorities, although sporadic articles in the daily press would lead the layman to believe that television is soon to be ready for general use. This impression is fostered by interesting experiments on a laboratory scale which have been heralded as forerunners of practical home televisors. But even the best television equipment available today falls far short of the desired home radio-movie goal, and it becomes increasingly apparent that new paths must be beaten before present-day mechanical and electrical difficulties are overcome. The author of the accompanying article, formerly editor of *Television* (London), presents a point of view that is refreshing after the deluge of misleading publicity of the past few years.—*The Editor*.

The general public, however, will have none of the present limited form of television, which can show only a head-and-shoulder view of some distant speaker or singer, and that imperfectly. The fans, who love tinkering with something, have taken to it, of course, both here and in Europe, but commercial sets just cannot be sold. In England, the Baird Company's attempt to sell machines has met with but scant success. They blame the limited broadcast facilities granted them by the B.B.C.: 11 to 11:30 A.M. five days a week, and midnight to 12:30 A.M. two nights a week. But over here, where broadcast facilities are available on a more liberal scale, I am told that attempts to sell inadequate televisors are meeting with no better success.

The real reason for this failure is not far to seek, and is very simple. There is definitely no entertainment value in the present head-and-shoulder images. Realizing that fact, the Germans have made no attempt as yet to sell televisors; they are devoting all their energies to further experimenting.

THERE are some who disagree with me about the entertainment value of the present image, and point to the fact that something like 75 percent of a talking film is composed of close-ups. True, but the film shows more of the individual, more than one person at a time, has a lot more detail, and the producers have had years of experience with their medium of entertainment and have learned how to make it entertain. On the latter score the television people have reached the point where they say that "a new technique will have to be developed." Nobody knows yet just what form that technique will take. And at this stage they can not be expected to know.

Others who disagree with me contend that a start must be made somewhere, sometime, and point to the crudeness of the art of radio-telephony when sound broadcasting first started. It is difficult to compare two things which are totally different, but I believe that sound broadcasting, when it started, had more power to interest, entertain, and attract than has the art of television at the present time.

Just what the public expects of television is a question nobody can answer. Some go so far as to express doubt as to whether the public wants television at all! I think there can be no doubt that, after what it has been led to expect of television, any serious attempt to stampede the public into patronizing the present limited form of television will not only meet with failure, but will do the youthful art irreparable harm. Some harm has already been done.

Let us, therefore, survey the present state of the art from a technical angle. Let us create a standard of performance and see if present methods will permit of its achievement.

But let me make one thing clear before I proceed further. In reading over what I have written it would appear that I am a thorough pessimist, more of an enemy than a friend to television. Far from it. There is no doubt at all in my mind that television will ultimately arrive. It will eventually be able to do all that has been promised. Televisors will one day be as common in our homes as radio sets are today, and a television industry will grow to the proportions of the present radio industry.

But before all these things can happen we shall have to think up a few new ideas.

It is an extraordinary fact that television has not, so far, developed any brand new ideas for its own exclusive use. All its ideas and apparatus are either borrowed from some other field of scientific endeavor, or they have been in existence, but not made use of, for many years.

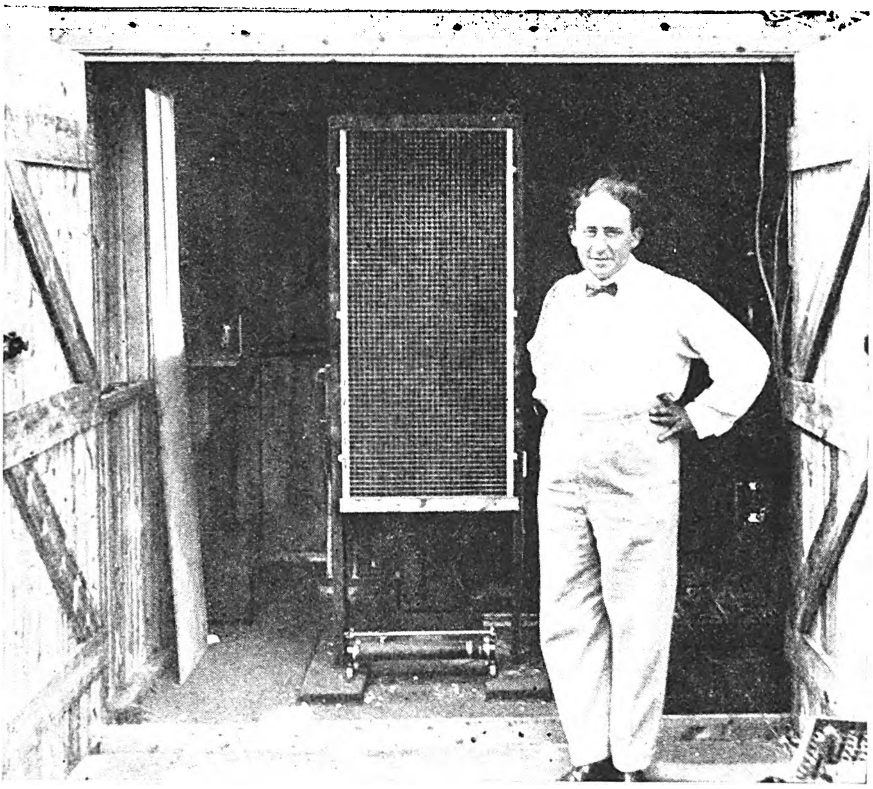
Take the scanning disk, for example. Invented by Nipkow in 1884, it lay idle until it was coupled with such modern inventions (taken from other fields) as the neon lamp, thermionic tube, and photo-electric cell, when television was produced. Nipkow could have done it in 1884 if he had had the use of these modern facilities.

THE large viewing screens of Jenkins, the Bell Telephone Laboratories, and Baird are reminiscent of the walls of selenium cells controlling distant electric bulbs, which were suggested by several early enthusiasts and actually constructed by Rignoux and Fournier in 1906.

The use of cathode-ray tubes was first suggested by Campbell Swinton in 1911, and they were experimented with soon after by Boris Rosing in Russia and Belin in France.

All these things have, of course, been vastly improved upon and made to perform incredibly well, thanks to modern facilities, but they have their limitations. What astonishes one is that all the present-known workers, knowing these limitations, are content to pursue the old methods. Some entirely new principle is needed, and needed badly. And it is quite on the cards that the present workers will get so stale and hide-bound that the new idea, when it does come along, will pop out suddenly and unexpectedly from a source never previously heard of.

Before we can proceed to an examination of the limitations of present television apparatus and methods, it is necessary to set forth some standard of achievement which must ultimately be met, and see how far toward that standard we can go with the means at present available.



Baird's large television receiving screen. The extreme complexity of devices of this nature is an important indication of the need for new ideas in the art

My guess is that television, for home entertainment purposes, will have to be capable of embracing a field of view, either indoors or outdoors, as extensive, complete, and flexible as is at present coverable by means of a motion picture camera, and the detail presented will have to be comparable with that of the motion picture also. After all, as an entertainment medium, television must go into direct competition with the motion picture, or couple up with it so that films can be distributed and simultaneously exhibited all over the country by television methods. It will displace the film for spot news, although the film will always be wanted for record purposes.

The home screen upon which the television images are depicted will have to be, for comfort and convenience, not smaller than nine by twelve inches, unmagnified. The magnifying lenses at present in use are undesirable for several reasons. Many of them are so badly designed and arranged that they distort the edges of the picture. Even if well arranged, they magnify all the defects in the image, cause loss of light, and, perhaps most important, limit the number of observers to two or three, and force even that number to locate themselves, often in discomfort, directly in front of the lens. The standard of comfort of the home movies must prevail on this point.

Having thus set the standards of field of view and size of screen, the next important step is to fix quantitatively the amount of detail which must be provided. Here it is necessary to guess a bit again. If scanning is to continue to be carried out in parallel strips or lines, my guess is that we shall have to provide 100 lines per inch. That means that, for a nine by twelve inch receiving screen, unmagnified, we shall have to resolve the image into $900 \times 1200 = 1{,}080{,}000$ picture elements. If we set the transmission speed at 15 images per second—a rather low figure—the frequency of the A. C. picture impulses which we must transmit, either by wire or by wireless, works out at

$$\frac{1{,}080{,}000 \times 15}{2} = 8{,}100{,}000 \text{ cycles,}$$

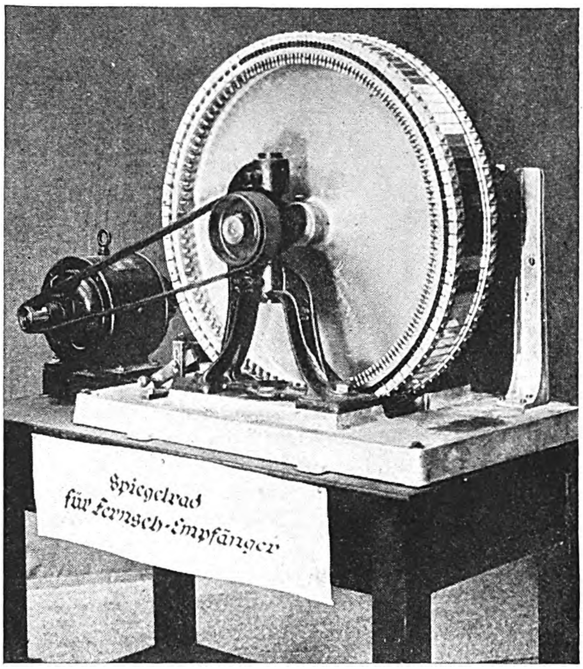
or 8100 kilocycles.

WE are now faced with two major problems: (1) terminal equipment capable of fulfilling the above requirements, and (2) channels of communication which will successfully transmit frequencies up to 8100 kilocycles.

Let us consider terminal equipment first. Remembering that the circumferential distance between the holes of a scanning disk must be equivalent to the long side of the picture, in this case twelve inches, and that there must be 900 of them, we should require a scanning disk nearly 300 feet in diameter to fulfill the requirements set out above! And if we used a flat plate neon tube, we should need one with a plate measuring slightly in excess of nine by twelve inches, and such a tube would require a prohibitive amount of amplifier power to illuminate it. The whole conception is preposterous and ridiculous.

The Jenkins drum scanner provides no solution to the problem; it also would assume unwieldy proportions. There remains the Weiller mirror drum, which would require 900 mirrors, and if these were only one inch wide the diameter of the drum would be something like 25 feet.

That exhausts all known mechanical methods of scanning which have proved at all successful. It is obvious, therefore, that we must either relax our requirements for television or seek other and non-mechanical methods.



The Weiller mirror wheel used in television scanning. For large images, this device becomes unsatisfactory

BEFORE the days of the thermionic tube, we achieved, or attempted to achieve, radio-telegraph communication by just such cumbersome "brute force" methods. Now we have thrown all our unwieldy machinery into the discard, and achieve our object a thousand times better by harnessing electrons. We shall have to discover some method of harnessing electrons to do our bidding in the television field. A stream of electrons travels with the speed of light, it is weightless and therefore inertialess, and it can be controlled electrostatically or magnetically.

The fundamental essence of the television problem may be defined as the time element, or, if you like, speed; so much has to be done in such a limited space of time. As we have already seen, 16,200,000 picture elements have to be dealt with *per second*. Obviously, only electrons are capable of handling such a gigantic number within the time allowed.

The only electron device at present known which seems to offer a ready solution to the problem is the cathode-ray tube. It has been experimented with for many years, and several workers are still busy on it, trying to adapt it for both transmission and reception purposes. As at present made and used, the cathode-ray tube has many disadvantages. It is expensive, both as to first cost and as to auxiliary equipment and operation, its life is short, and there are still difficulties in the way of adequately controlling the scanning movements of the electron stream. It remains to be seen, therefore, whether the cathode-ray tube is the best practical embodiment of the purely electronic method of achieving television.

So much for terminal equipment.

Coming now to channels of communication, one is almost tempted to say that it will never be possible to transmit 8100 kilocycles over either a wire or a radio circuit. But in scientific matters today's impossibility is tomorrow's commonplace achievement. At present it might be possible to transmit such an enormous frequency by radio, but only on wavelengths below ten meters. Obviously we shall have to discover some new technique or principle in radio communication also. That it is already long overdue is evidenced by the fact that the entire spectrum of wavelengths used for all radio communication purposes is already full to overflowing; radio communication cannot develop any further until it is released from its strait-jacket. Personally, I think the new principle discovered by Dr. J. Robinson of England, and incorporated in the Stenode Radiostat receiver, will not only solve the overcrowding problem but also make it possible to transmit the enormously high frequencies required for television.

That is my conception of the problem of television as it stands today. A gloomy picture, you may say. Or again you may ask me: "How long will it be—?" As I said at the outset, I am not going to be inveigled into prophesying, but I feel very optimistic about the future development of television. It is clear that much remains to be done, and it is equally clear that television is going to provide yet another example of the survival of the fittest. So much remains to be done that only those who are backed by almost unlimited resources in the shape of money, brains, and laboratory facilities stand any chance of winning through and reaping their reward.

The work which has been done to date, and about which there has been so much ballyhoo, must be regarded in the light of a preliminary canter over the course. Already there is evidence that the most serious contenders in the race for television are abandoning present methods and working quietly behind locked doors on something different. In Germany, Dr. Karolus, working in conjunction with the Telefunken Company, has been silent, but not inactive, for a year.

IN this country, the television staffs of the General Electric and Westinghouse companies have just been concentrated in the R. C. A.-Victor plant at Camden, New Jersey. That the R. C. A. group really means business is evidenced by the utterances of its executives, and if further evidence is required of the imminence of television on a really commercial and entertaining scale, there is the projected 250,000,000-dollar Rockefeller radio city which Merlin Hall Aylesworth, President of the National Broadcasting Company, says is to be built around television. It is estimated that this building will be ready in three years, and that is as near as I will go to prophesying when television will be ready to make its bow to the public, not in so perfect a form as I have outlined as being ultimately necessary, but at least some way towards it.

And finally, I have been asked who will win the race, Europe or America. Well, one of the essential qualifications of the competitors, mentioned above, has to do with financial resources, and America has more money to spend on television than has Europe, and America seems to be more determined. So with that I will leave the American workers to it, and wish them the best of luck.

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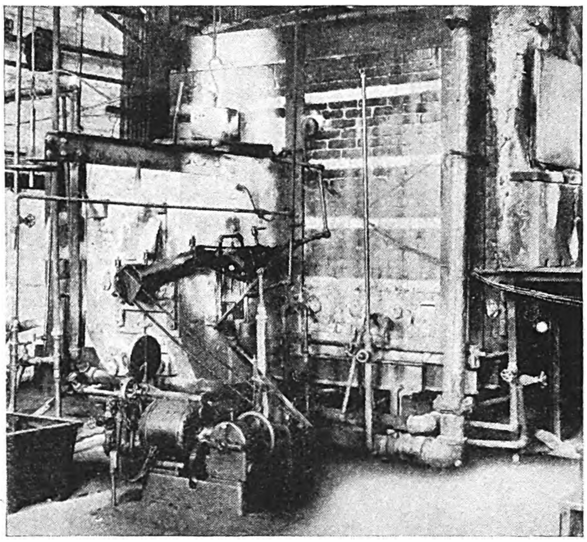
¶ *Editor's Note.* Although we are in hearty accord with Mr. Dinsdale in the general tenor of the foregoing article, we can not help but take exception to the statement ending at the top of this column. There are thousands of amateurs in this country who are learning the fundamentals of television by experimenting with their own equipment. And it is well known that the radio amateur is never content to follow the beaten paths. His record in the development of the short waves justifies this statement, and we do not feel that we are too optimistic when we express the opinion that the ranks of amateur radio will contribute some of the new ideas needed for the development of television.

GLASS TUBING BY THE MILE

THE old method of making glass tubing by blowing, while the hollow cylinder was pulled out and cooled, was an exceedingly crude process and the variations in the size of the bore were great. Now, however, by the aid of cleverly designed machinery, although under the principles of the archaic methods, glass tubing is made by the mile. The machines operate continuously, drawing the molten glass from the furnace, cooling it at a distant point and cutting it off in pre-determined lengths, automatically, by a special mechanical device. In this method, as in the hand process, there is a long line of easily broken tubing in constant motion between the blow-pipe and the far end where the cutting operation takes place.

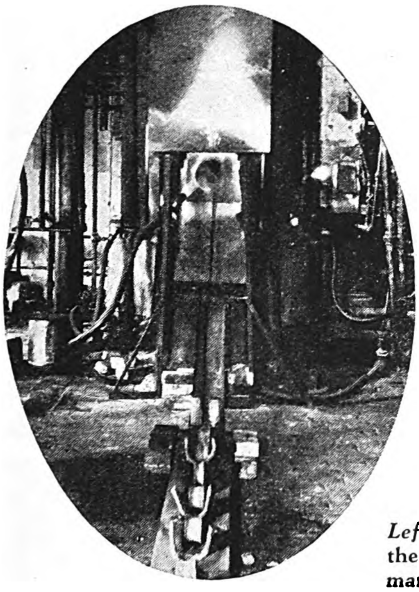
A tank furnace supplies a steady stream of molten glass. As the viscous glass flows to the aperture, it is kept very hot by the glass blow-pipes. The glass forms a tube over a hollow mandrel by the aid of air which is forced through it. The air pressure is slight, being only one or two ounces per square inch. If this air should be cut off, a cylinder of solid glass would form. After the tube is formed comes the drawing process which is dependent on a machine which pulls away, continuously, the rapidly cooling tubes of glass. Two endless chains serve to carry pressure plates which grip the tube without fracturing it. The motion is positive and in one direction. The cooled tube is drawn away from the furnace, dragging away more of the molten glass which is to form the tube over the hollow mandrel which purveys the air for blowing. The machine is dealing with a very peculiar substance and the slightest tendency to buckle up would fracture the tubing. The speed of the pulling chains may be adjusted at will.

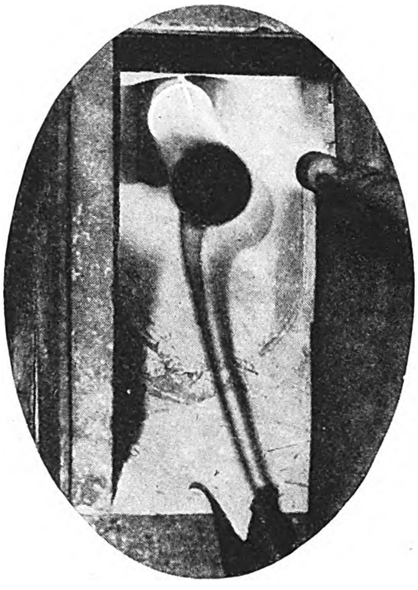


View of the rear of the glass melting furnace

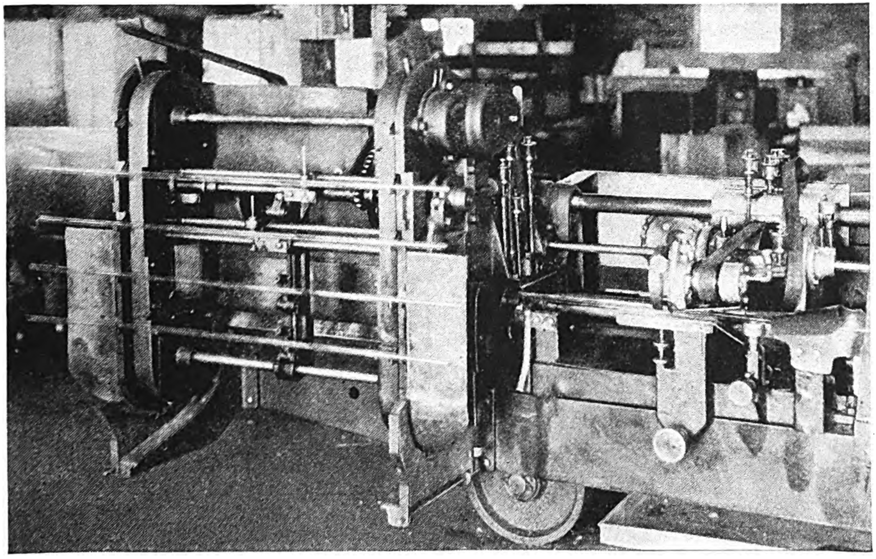
The pulling machine is supplemented by a device for breaking off the tube in pre-determined lengths as it is pulled along. After the tube leaves the endless chains it encounters a second set of guide-rolls mounted on vertical spindles. Next it passes over a pressure table which yields vertically. Then it enters a part of a special wheel and is broken off to the proper length. This length is finally delivered from the machine for inspection and packing. The cutter wheel co-acts with the pressure table. That is to say, the cutter wheel moves downward and comes into contact with the work at the beginning of its own stroke. The cutter wheel cuts a surface groove on the glass. It is not designed to effect a complete severance of the glass but to make a point of weakness. A second wheel revolves intermittently and exerts a transverse pressure against the work at a point in advance of the cut, thus breaking it off at the groove. The demands for uniform glass tubing, in science and industry, are many.

We are indebted to the Libbey Glass Manufacturing Company of Toledo, Ohio, for permission to inspect the interesting process.

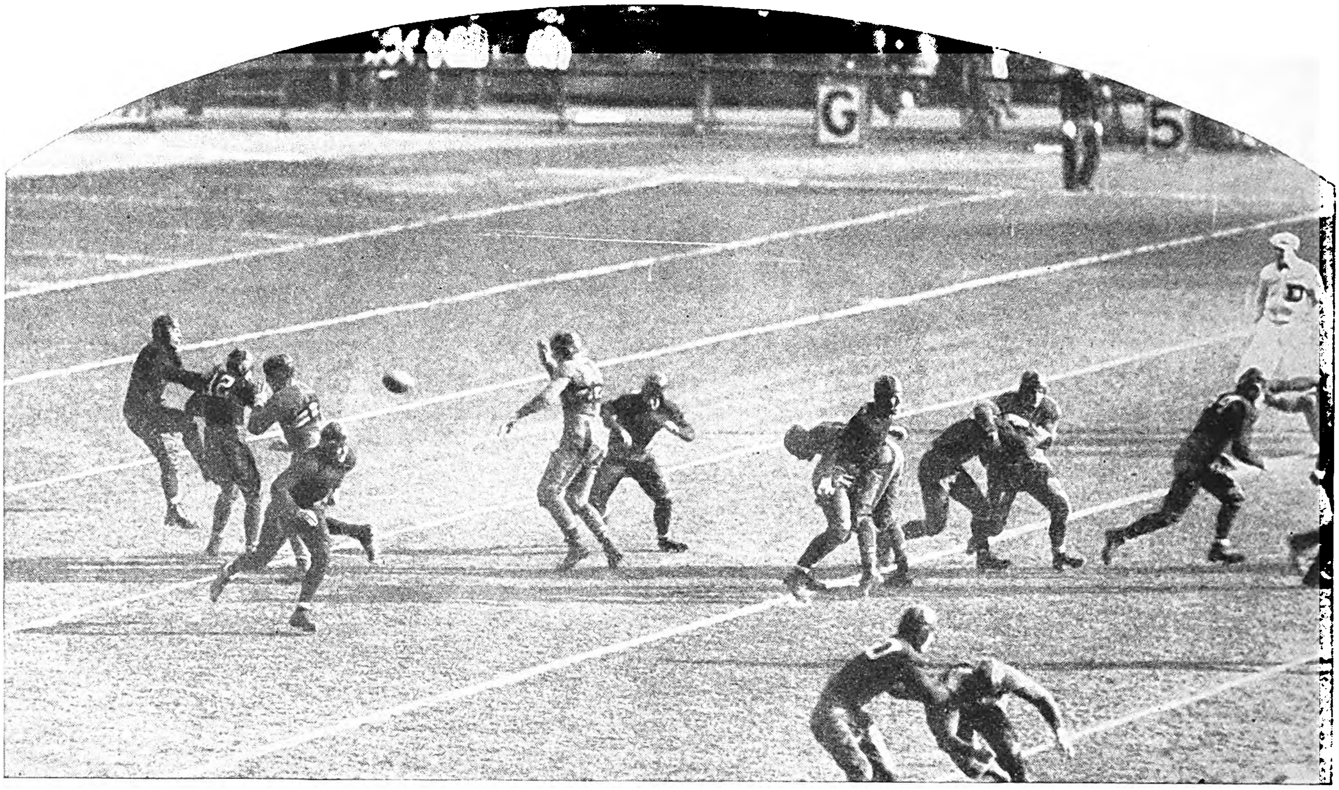




Left: Discharge end of blow pipe from which the glass is drawn. *Right:* Heater muffle and mandrel forming the continuous glass tube



After the glass tube has been drawn from the furnace with the aid of a "pulling" machine, it is cut off with this machine and the broken-off length is delivered



The Army blocks a Notre Dame punt in their famous 1929 game

HOW MANY MINUTES OF PLAY IN THE AVERAGE FOOTBALL GAME?

By HUGO L. RUSCH
Supervisor Technical Data Section, Johns-Mansville Corp.

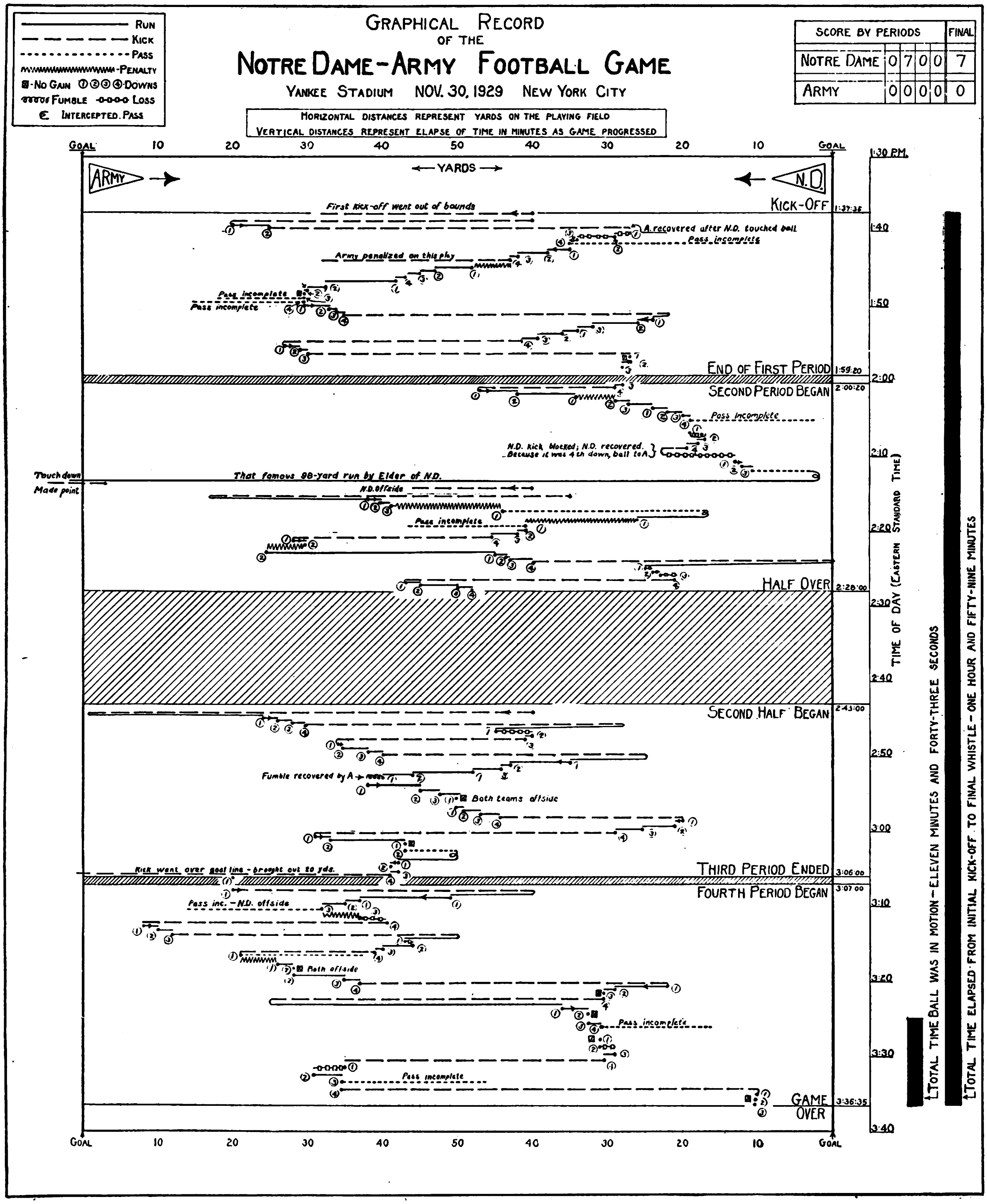
YOU pay at the rate of $24.25 per hour to watch football! It costs hundreds of thousands of spectators this amount for their amusement every autumn. The time the ball is officially in motion during an entire game—clocking each play with a stop-watch from the instant center snaps back the ball until the end of the play—totals the astoundingly short period of about 12 minutes. To be exact, the actual playing time in eight important games during the 1927, 1928, and 1929 seasons in which Notre Dame, the Army, Yale, Harvard, Princeton, Stanford, Ohio State, Columbia, Indiana, and Syracuse participated was an average of 12 minutes and 22 seconds per game. With your ticket costing you five dollars you paid at the rate of $24.25 per hour. If you were able to buy a ticket for three dollars, your hourly rate was only $14.55. If you were one of those spectators who paid sixty dollars a pair for the coveted pasteboards, figure out your own rate per hour.

The official playing time of one hour—four quarters of 15 minutes each—includes time for signals, formations, and shifts. The rest period between the first and second quarters, and the third and fourth quarters, is one minute; the time between halves is 15 minutes. Including periods for "time out," the total lapse of time from the initial kick-off to the final whistle, for the eight games mentioned, averaged 2 hours 20 minutes and 9 seconds.

TAKE the case of the Army-Notre Dame game at the Yankee Stadium on the last day of November, 1929—the game in which Elder of Notre Dame thrilled 83,000 spectators and many more thousands of radio listeners, when he intercepted one of Cagle's passes and ran 98 yards for a touchdown. For this game, many folk arrived half an hour before the kick-off and people were still leaving the stadium more than an hour after the final whistle, which blew 1 hour and 59 minutes after the kick-off. Hence some spectators spent about 3½ hours at the field to see the ball actually in motion less than 12 minutes (to be accurate, in this game it was 11 minutes and 43 seconds).

The time studies of the eight games proved that the period the ball is in motion during each play averages only 4½ seconds. This is based on a total of 1328 plays, all of which were carefully timed with a stop-watch reading to tenths of a second. As might be anticipated, some of the plays lasted four times as long as the average. And it was indeed apparent that the amount of spectator excitement was in proportion to the time the ball was actually in motion. The spontaneous cheers and yells were all concentrated in these very short intervals and all eyes were figuratively glued on the field.

On November 30, 1929, at the Yankee Stadium, in the second quarter, the Army had blocked one of Notre Dame's punts but Notre Dame recovered the ball. Since the play was on the fourth down, the ball went to the Army on Notre Dame's 13-yard line. Things looked fine for the Army. Two plunges by Cagle and Murrell netted a few yards, and then Cagle whisked a delayed pass over the left side of his line. Elder of Notre Dame rushed in boldly and, instead of playing orthodox football for a goal line defense and knocking the ball to the ground while covering receivers of the pass, he snatched



the ball from the air on his two-yard line, lost a precious split-second in regaining his balance, and then tore madly up the side line. Two Army men dove for him but missed—by a few inches. He ran unmolested until he reached the Army's eight-yard line when another West Pointer failed—by inches—to catch his elusive prey.

The fleet Elder raced over the goal line for a touchdown. But no one knew then that he carried the game with him. Carideo booted over a placement for the extra point, ending the scoring for the day. The crowd had been held spellbound. For 18½ seconds—the time of that play—they forgot the bitter cold. It was the longest play recorded in the eight games analyzed.

In the Army-Stanford game at the Yankee Stadium on December 1, 1928, there was another long play. Here also Cagle had a hand in it, but this time he did the carrying. The Army had the ball on their own 34-yard line. It was snapped back several yards to Cagle, who made a dazzling zig-zag run through the entire Stanford team, dodging tackler after tackler, to Stanford's 44-yard line for a net gain of 22 yards. It was a thriller. The play lasted 15½ seconds, the longest play of the game, and second longest in the eight games at which the time studies were made.

In the play which ranks third in point of time out of 1328, the performance of Christian Cagle of the Army is again encountered. This time it is in the Yale Bowl on October 22, 1927. With the ball on Yale's 48-yard line, Cagle received it about 12 yards back of the scrimmage line, and, by avoiding and throwing off Yale tacklers, down on his knees and back up again but never completely stopping, he carried the ball on another brilliant run of over 32 yards to Yale's 28-yard mark for a net gain of 20 yards. The total time of this play was 14½ seconds—14½ seconds bristling with thrills and gasps.

The average play in football—about 4½ seconds—hardly gives the spectators time enough to work up to a state of excitement. It remains for the long plays, such as the kind just described, to give the greatest thrills. It is these long plays that we like to see and read about. During each second of actual play the suspense is tremendous, and this is what really makes football the game it is for the spectators.

WITH the exception of the unusual plays such as those described, the punts consumed the greatest amount of time. They averaged about nine seconds, and the straight line plays three seconds. The average forward pass, counting those completed and also the incomplete, averaged about six seconds. The adoption of the pass has helped to spread the players more, and has served to increase the average time per play, thereby increasing the period of suspense and true excitement. Hence this change was a most important one from the spectator's standpoint—the standpoint that made half-million dollar gate receipts per game possible. Years ago the spectator saw little more than two struggling groups of 11 men each, pushing up and down the gridiron. The object was sufficiently apparent, but not the method of attainment. Consequently the game's power to draw paying spectators was not at its present height.

But what of the fact that the total time the ball is in motion during an entire game is only about 12 minutes? Shall we establish rules which will double or triple this period—the time during which the players are giving their every ounce of energy and the spectators are really getting the excitement they crave? No, it would not be wise to do so from either the spectators' or players' standpoint. Have you ever noticed that you are quite tired at the end of a football game, and particularly so if you are keenly interested in the outcome? As the ball moves back and forth on the field, you unconsciously push in the direction you would like to see the ball move. When the losing side cuts the air with "Hold 'em" they are unconsciously pressing their shoulders against an imaginary wall.

Students of public speaking and oratory tell us that a speaker who gets his audience extremely interested not only sways them mentally but also physically. It is said that the entire group of spectators at a football game actually moves with or against the ball, and by careful observation these waves of motion can be detected. Therefore, even though you may be paying at the rate of $24.25 per hour to see actual football, perhaps it is best for you that there is only 12 minutes of it. If you kept this tension steadily for an hour, you might have to be carried out of the stadium.

Cagle takes the ball

And now from the player's standpoint. A man running the 100-yard dash in 9-3/5 seconds is expending energy and moving at a rate which he could not maintain for 30 seconds. He would become so fatigued, if he tried it, that his pace would slacken before he traveled 300 yards. So it is on the gridiron. The men are giving every ounce they have, while a play is being executed, and it is undoubtedly good that the time per play *is* only a few seconds. Under the present rules, the players—all of them who have played hard—are usually nearly exhausted when the final whistle blows. The law of fatigue holds for everyone, regardless of his physique; the time for fatigue to take effect varies, of course, in the individual.

Consider the wear and tear upon human endurance during the game, when men line up for action 140 to 180 times. Little wonder that a rugged physique and heroic courage are required of the players. Hence it now can perhaps be better understood why, toward the end of a game, some of their performances are not quite up to standard.

Scientists tell us that when a muscle is stimulated, lactic acid is liberated in certain parts of the muscle. As this stimulation continues, an alkaline solution neutralizes the acid, which tends to relax the muscle. The process can continue until the available supply of alkali for neutralizing the acid is depleted. Then the excess acidity of the muscle stops its further activity and a state of complete exhaustion has been reached. Our whole voluntary muscular movement depends on this chemical reaction with lactic acid. There is a very definite limit to the extent any individual can use his muscles before complete exhaustion sets in.

The best way to win a mile run is to continue at a pace which will just produce exhaustion at the tape. If the pace is raised beyond this point, untimely exhaustion is certain to take place and the race is lost. Naturally, the longer the race the slower will be the average speed for each individual. Consequently, if the present rules and method of playing football results in near-exhaustion of the players at the end of the game, a change in the rules so there will be more actual playing time, without increasing the total time between the initial and final whistles, would mean a slackening of the speed and deftness with which each play is executed. Such a change would certainly not improve the game for the spectators.

A STUDY of the tabulated results of the eight games, with the number of plays and the time elapsed, provides some very interesting and instructive data. The number of plays per game averaged 166. The average number of plays per quarter varied between 40 and 43. This indicates that the proposed plan to play the game on the basis of 40 plays per quarter, in place of a definite time interval, will give us just as much football per game as at present. And, according to Mr. Harry R. Coffin of Harvard and other advocates of the new system, there are some very definite advantages. They claim the suggested period-by-play method has the following merits:

(1). It will eliminate the frantic use of the forward pass by the losing team during the final minutes of play.

(2). It will do away with any possibility of suspicious timing by officials.

(3). It will increase the interest of the spectators.

This system of playing was employed in the game between Brown University and Boston University in Providence on November 7, 1925, in which Brown won easily, 42 to 6. The consensus seemed to be that the score was too

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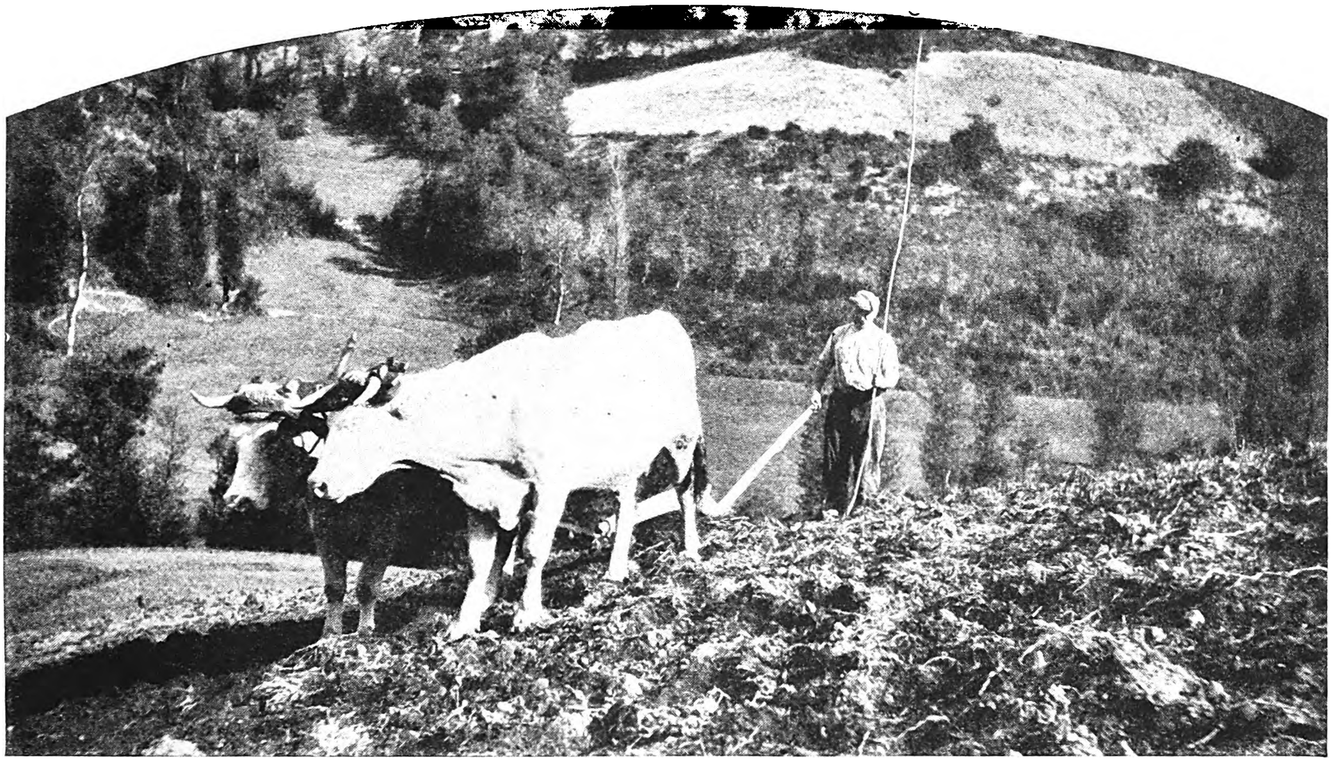

A member of the *Scientific American* staff also visited Glozel, as did the author of the accompanying article, and made this and other photographs. According to one account the original "discovery" at Glozel was made while the young farmer, Emile Fradin, was plowing with cows. By chance, on the day of the visit, one of the Glozelians likewise was plowing with cows and within a few feet of the famous discovery site, which was at left just out of the picture

THE STORY OF GLOZEL—A CHAPTER IN CREDULITY[1]

By **DAVID RIESMAN**

Professor of Clinical Medicine, University of Pennsylvania

THOSE who have read something about Glozel may wonder why I speak of it here. Is it not a dead issue? No, for as a study of human credulity and as a commentary on the hot-headedness (or should I say pig-headedness?) of many men of science it will always occupy a prominent place in the history of civilization.

Although many are probably familiar with the main facts, I want to give a brief synopsis of the involved story. I say "story" advisedly for from the very outset the mystery of Glozel has formed a fascinating tale; very much in the genre of our best thrillers, with plot and counter-plot, gum-shoe detectives, and all the pertinent paraphernalia.

Glozel is a small hamlet of four farmhouses, about 15 miles from the famous French spa of Vichy. Emile Fradin, then a youth of 18 and belonging to an old local family, was one day working in his grandfather's field when a cow suddenly slipped into an unsuspected hole. Fradin went to investigate and found that the hole led into an oval pit containing a variety of remarkable objects—bricks, tablets, vases—which he gathered and as soon as possible showed to the village school mistress, Mlle. Picandet. The latter in turn showed some of the tablets to M. Clément, a school teacher in la Guillermie.

EVENTUALLY the news of the discoveries came to the ears of Dr. Albert Morlet, a surgeon of Vichy and an amateur archeologist. Thereafter Dr. Morlet and Emile Fradin together began to excavate at Glozel and brought to light more and more buried objects which they collected in grandfather Fradin's house and which Dr. Morlet described in detail in an endless series of articles in a literary journal, the *Mercure de France*. It was through this magazine—the *Atlantic Monthly* of France in more senses than one—that I became interested in the Glozelian discoveries. My interest was especially aroused by the claim of Morlet and others that an alphabet had been discovered at Glozel which antedated every other alphabet then known. I therefore decided while spending a vacation in the Auvergne to see Glozel for myself, but before doing so I determined to interview Dr. Morlet in Vichy.

At first he suspected me of being an archeologist but when in answer to a direct question, I denied the soft impeachment and proclaimed myself merely a doctor, he became cordiality itself and showed me his collection of Gallo-Roman and Glozel antiquities. He told me that he as well as others had been inclined to consider Glozel as belonging to the Magdalenian age because of the presence of harpoons and of stones engraved with reindeer and other animals long extinct in France, but further studies had led to the conclusion that Glozel was Neolithic. Dr. Morlet kindly asked me to

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[1] Presented before the American Philosophical Society.

The little museum in the Fradin farmhouse. The crude sign mentioned by the author shows over the doorway. The picture was taken by a *Scientific American* staff member while perched on an "island" in the nearby manure-pile-quagmire, an entity which provides the cheery aspect from the typical French farmhouse. To see the exhibits he paid a few francs, as did the author of the accompanying article and, like him, was watched every instant by one of the Fradins; like a cat watching at a mouse-hole

stay over until the following day and dig with him and Professor Björn of Sweden, but I was unable to do so.

After leaving Morlet I motored, together with two American friends, to Glozel. Emile Fradin received us and at once offered to take us to the field of excavation. It was at the bottom of a deep ravine and was surrounded by a barbed wire fence. He showed us the original oval pit and the two tombs subsequently discovered. As it was raining hard and as the clayey ground was slippery, I declined his invitation to crawl into one of the tombs but asked instead to see the Museum. After paying two francs each we entered through a low door above which was a crude sign with the pretentious words, "Musée de Glozel," and found ourselves in a square low-ceilinged room with shelves on the walls and very primitive glass cases standing on the floor. The objects exhibited on shelves and in cases were astounding in number and variety—vases, tablets, engraved stones, ornaments (especially pendants), some pieces of glass, and harpoons, the last not nearly as artistic as those of Magdalenian age I had seen in Les Eyzies and at Laugerie-Basse.

Three articles attracted my special attention—vases or vase-like pottery ware having eyes, nose, and ears but no mouth, which Morlet has called death masks, explaining the absence of the mouth by assuming that the primitive makers wanted to express the silence of the grave. Secondly, a squarish object suggesting the female figure with a cylindrical projection from the forehead interpreted as the phallus—this Fradin told me was a bisexual idol; and most striking of all, clay tablets with graven signs looking in every way like alphabetical characters. I was struck by the clean red color of these tablets. When I spoke of this to Fradin, he explained it by saying that the soil in which the tablets had been found was such that it did not readily fuse with the clay and hence was easily brushed off. There were also some large casts of the human hand which differed from the imprints of the hands in the Spanish and French caves in having all the fingers present.

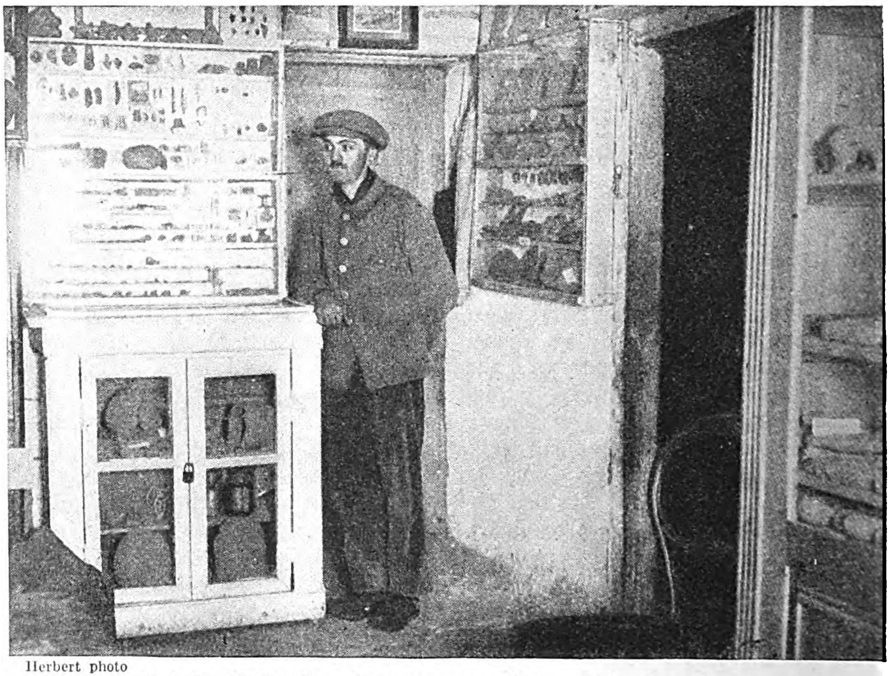
I offered to buy some of the articles, especially a tablet, but Fradin resolutely refused to sell. During the whole of our stay in the Museum, the grandfather stood silent and motionless in a doorway leading to an inner room.

The reputed discoveries of an alphabet dating back to Neolithic times, of which I had now seen the alleged evidence in abundance, created a tremendous sensation in informed circles. Altogether about 136 characters had been distinguished, representing every letter of the alphabet except the letter B.

Hitherto the credit for creating an alphabet had been given to the Phoenicians but the oldest known Phoenician record, found at Byblos a few years previous, dated back only to about 1300 B.C.; Sir Arthur Evens' baffling Cretan inscriptions to about 3000 B.C. If Morlet and those who agreed with him were right, then Glozel was truly what M. Reinach called it—one of the greatest archeological discoveries of all time.

ALMOST immediately after the first appearance of Morlet's reports, doubts began to be voiced about the authenticity of Glozel, though in the early period of the controversy there were perhaps as many scientists who accepted the discoveries in good faith as there were doubters. Soon the pro- and anti-Glozelians became personal and attacked each other with a vituperative vehemence and a destructive sarcasm for which the French language appears to be the ideal medium. Reputations were shattered, old friendships broken, and as one of the French dailies remarked—even butcher boys came to blows on the streets of Paris. In fact Mrs. O'Leary's cow did no greater damage to Chicago than Fradin's to the reputation of some French savants.

Before long the leading French pre-



Herbert photo

The principal, Emile Fradin, about 21 years of age at the time the site was investigated by the Committee. Although a humble peasant he had done better than average in school; he also was artistic and had done water color paintings. Perhaps it was a coincidence that the Glozel forgeries improved in technique from time to time as the schoolmaster Clément loaned Emile different pieces of literature on prehistory. The output of discoveries also corresponded with books given him by other interested dupes; it even accommodated itself in nature to the hopes and objections they expressed. Oddly, all periods of prehistory were represented by the objects discovered, from the Old Stone Age to historic times, and it is another coincidence that the illustrated textbook of prehistory in Fradin's possession covered the same scope. Picture taken in the museum historians with only an occasional exception began to deny the authenticity of Glozel and to declare the excavated articles to be forgeries. A number of Englishmen were likewise unconvinced. However, Dr. Foat, a London scientist, makes the categorical statement that "if the finds of Glozel are not authentic, it is equally necessary to consider as false all that I have seen in museums between London and Constantinople." Several Scandinavian, Belgian, and Portuguese scientists also supported Dr. Morlet, and a German, Dr. Wilke, in a recent article enthusiastically upholds the standard of Glozel.

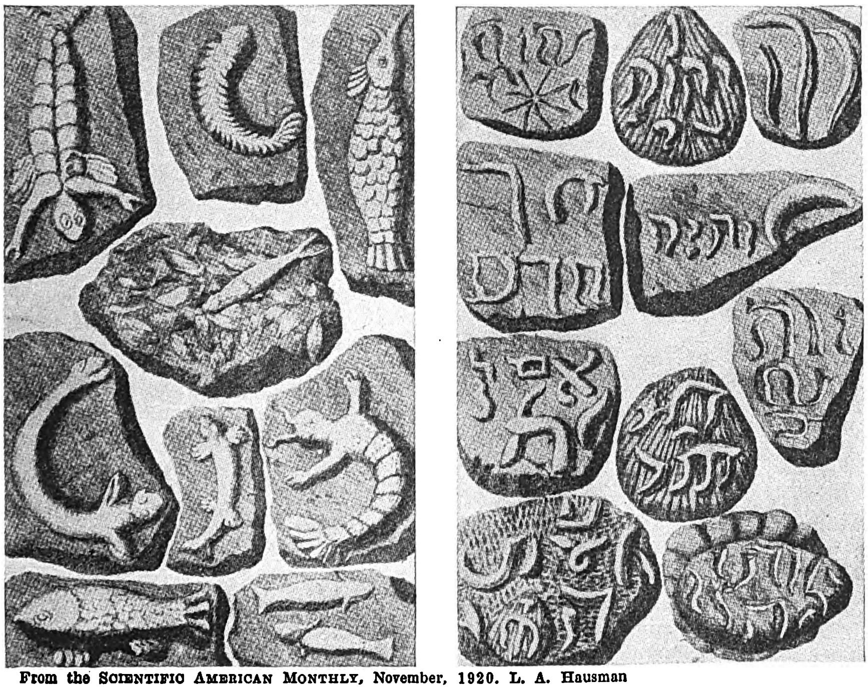
SCIENTIFIC AMERICAN staff photo

The actual site of the famous finds, at the lower end of a steep field above the valley of the Vareille stream. An attractive setting. The barbed wire fence around the site shows in the picture. It is easy for the tourist to reach Glozel; one goes to Vichy, where there are fine hotels, and hires a car to nearby Glozel

ARE Dr. Morlet's supporters right or is Glozel but one more of the long series of frauds that history recounts since Jacob imposed upon his father Isaac? Many will come to your minds—Thomas Chatterton, our own Dr. Cook, Constantine Simonides, the pretended author of the *Codex Sinaiticus*, the forger of the Mecklenburg Declaration, the Lincoln love letters in the *Atlantic Monthly*, the Tiara of Saitapharnes, and countless others.

One of the most interesting cases and the one having the greatest analogy to Glozel, if Glozel be a fake, is that of the so-called "Figured Stones of Würzburg." In the first half of the 18th Century there lived in Würzburg, in Bavaria, an ultra-pious physician named Johann Bartholomaeus Adam Beringer. He is not remembered for any great discovery or contribution to science, but for his share in a remarkable scientific hoax. At the time in which Beringer flourished an active discussion was going on as to the source and meaning of fossils. Although Leonardo da Vinci had understood their true nature—even Herodotus, 400 B.C. had a correct idea—the scientists of 200 years ago accounted for them as the result of "stone-making forces" of "formative qualities" or as growths from seeds. We may be inclined to smile, but with Dayton in Tennessee to chasten us, we can not throw stones at the Würzburg of two centuries ago nor at the Sorbonne which a hundred years later deprived the great Buffon of his chair because of his heterodox theories.

Beringer had committed himself publicly to the belief that fossils were the capricious fabrication of God, hidden by Him in the earth for some inscrutable purpose. His zealous maintenance of this fundamentalist position led some of the students, together with members of the faculty and wags of the town, to make numerous "fossils" of clay which they buried in the side of a hill where they knew the Professor was wont to search for specimens. Beringer, chancing upon these objects, was completely deceived. The jokers became bolder and buried the most extraordinary and extravagant figures their whimsical imagination could suggest. They fashioned tablets bearing inscriptions in Hebrew, Babylonian, Syriac, and Arabic, and buried them not far from the original spot. Beringer was overjoyed to find such abundant confirmation of his doctrines and forthwith in true German fashion proceeded to write an exhaustive treatise.



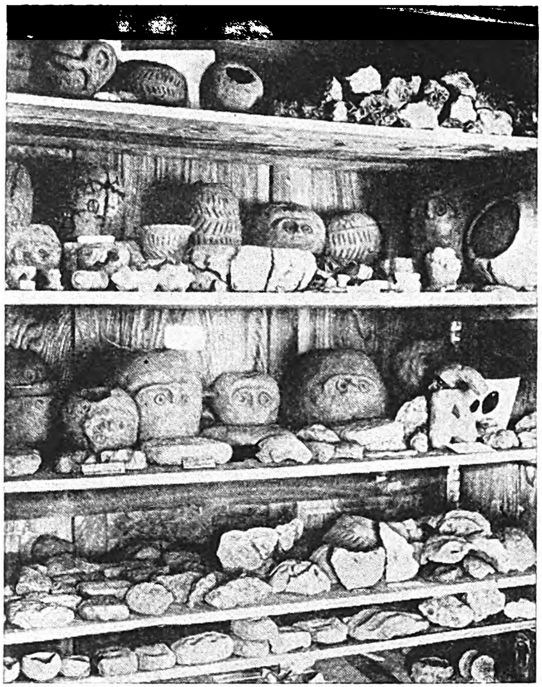
From the SCIENTIFIC AMERICAN MONTHLY, November, 1920. L. A. Hausman

Some of the famous Beringer fakes

THE wags now began to realize that they had gone too far. They expostulated with him and even told him the whole truth. Instead of believing them Beringer became more than ever convinced that the story his frightened colleagues told him was a ruse to rob him of the honor of his discoveries. No one could stop him. At great expense he published in 1728 the "Lithographiae Wirceburgenses."

Only too soon the shout of laughter with which the book was greeted brought the truth home to him. In chagrin and despair he exhausted nearly his entire fortune in a fruitless endeavor to suppress the edition and to buy up the copies already issued. He died soon afterwards, it is said, of a broken heart.

Is Dr. Morlet, like Johann Beringer, the victim of deception? Upon me personally he made the impression of an honest man. In certain quarters he was accused of fraud, for example, by the "Journal des Debats" and by the French Society of Prehistory. He promptly brought suit against them and won a



Herbert photo

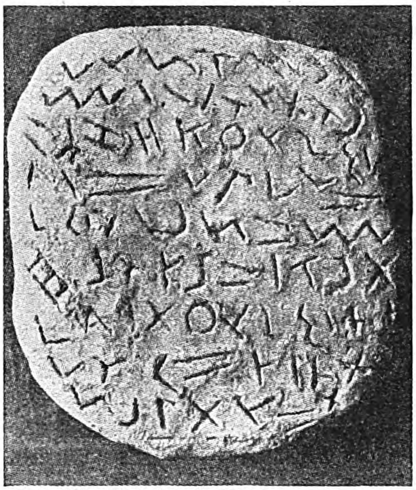
Exhibits in the museum of Glozel. Some are pots having eyes, nose, and ears but no mouth, as Dr. Riesman relates in his article. The "idol" to which he refers may be seen. Most of the objects in this picture are of pottery but the other finds have a wide variety— engravings on bone and stone, chipped flint and bone artifacts, and so on, representing a prodigious amount of industry on the part of (?)

verdict of 1000 francs damages. The defendants carried the case to the Court of Appeals at Riom, the native town of Willa Cather's lovable archbishop. In confirming the verdict, the Court gave expression to an amusing quibble. It held that Morlet, being a surgeon by profession and only by avocation a prehistorian, was not injured in the eyes of his real colleagues but only as an amateur archeologist. But as the defendants had not actually proved fraud, they were declared guilty though the fine was reduced to one franc and costs.

ANOTHER humorous episode might be mentioned. Regnault, President of the French Society of Prehistory, sued a Monsieur X because he, Regnault, had been compelled to pay the sum of four francs to see a collection of fake objects. As part of this legal action, the police of Moulins broke into Fradin's premises and took away a number of objects which were afterwards submitted to the public expert, M. Bayle. The latter reported that the tablets were of recent manufacture. Pieces of clay from a tablet crumbled readily in water; hence it was not conceivable that the tablets could have resisted the moisture in the ground had they been there for many years. Furthermore, a bit of grass picked out of a piece of earthenware showed under the microscope the vegetable cells, and some of the bone instruments still contained marrow. Bayle was soon afterward shot to death by one Philopponet against whom he had testified in court.

The Fradins themselves brought suit against M. Dussaud, member of the Institute, who in a trenchant brochure had called them fakers.

Let us now delve a little more deeply into this mystery so that we may understand better the basis of the controversy. The first serious doubt as to the authenticity of Glozel was based on the heterogeneity of the articles in Fradin's museum. How could one explain the presence of so many disimilar and unrelated objects—the 2000 or 3000 at the time of my visit have now grown into 5000 in one small field of excavation. No other archeologic site offers a parallel.



From "Glozel" by Dr. A. Morlet

One of the many inscribed tablets. After a fancied resemblance to the old Phoenician alphabet was mentioned the subsequent "discoveries" oddly came more and more to resemble Phoenician. Later, M. Bayle, the "Sherlock Holmes" of France, found minute strands of cotton colored by aniline dye in one of the clay objects. Perhaps, however, the apologists for the Glozel incident would say this proved that Neolithic man of Europe (5000 to 11,000 years ago) understood the synthetic chemistry of dyes

Morlet answered this by saying that Glozel was a *Champ des Morts*, a cemetery; and that, as among many primitive peoples of later times, everything belonging to the dead had been buried with him. C. Jullian, who considers Glozel a Gallo-Roman station, accounts for the multiplicity of objects by the assumption that Glozel was a sorcerer's sanctuary. He has added greatly to the gaiety of nations by attempting a full translation of the inscribed tablets from the published illustrations. Dr. Morlet showed me with much amusement a crack in one of the tablets which Jullian had translated as a character.

Aside from the puzzling complexity of the collection, it has been pointed out that the tablets first exhumed bore fewer and less perfect characters than the later ones. Further, as soon as some one had made a criticism, the objects next exhumed were free from the criticized defect. Quite often certain features appeared that could be traced directly to scientific articles published shortly before. These facts seem, of course, very significant. Moreover, the scratches on stones, whether representing animal figures or alphabetic characters, were without the patina covering other parts of the stones, suggesting a recent production. Much was made of the penetration of roots into vases or tablets; but upon examination these roots were not found to be properly fossilized, which would have to be the case had the objects been in the ground for long ages. The utensils—harpoons, hand axes, scrapers—are far less artistic than those in other Neolithic stations. Vayson de Pradenne and Abbé Breuil indeed contend that none of them could ever have been used.

DR. MORLET and his chief supporter Van Gennep did their best to answer all these objections. The former at the height of the verbal battle-royal made a request for a governmental commission which was speedily granted, but when he found that a bitter anti-Glozelian, the well-known archeologist Capitan was a member, he objected and the Commission was never sent. Eventually, at the International Anthropological Congress at Amsterdam an International Commission was formally appointed to investigate Glozel. The Commission consisted of Absolon, Director of the Archeological Museum of the State of Moravia; Bosch Gimpera, Professor in the University and Director of the archeological work of Barcelona; the Abbé Favret; Forrer, Director of the Prehistoric and of the Gallo-Roman Museum at Strassburg, Miss Dorothy Garrod, Member of the Royal Anthropological Institute and of the French Prehistoric Society; Hamal-Nandrin, Lecturer on Prehistory in the Museum of Liège; Peyrony, Director of the Museum of Les Eyzies; and Pittard, Professor of Anthropology in the University of Geneva. Absolon was prevented from taking part in the work of the Commission.

After spending three days at the site the Commission issued a unanimous report which was kindly sent to me by Miss Dorothy Garrod. This report states unequivocally that the articles are for the most part of recent manufacture and have undoubtedly been planted in the ground by some one whom the Commission does not name; and that Glozel is neither prehistoric nor authentic. Vayson de Pradenne in a devastating brochure in which he declared the Glozel finds fakes, also accused no one by name but put the blame upon the "Esprit de Glozel;" in other words upon a fairy.

ONE might think that with the leading French, English, and American scientists—Peyrony, Pradenne, Abbé Breuil, Sir Arthur Evans, Dussaud, and, I believe, Professor MacCurdy—arrayed against Glozel, and with the destructive judgment of the International Commission, Glozel would cease from troubling the scientific and the lay mind. Though all due obsequies have been performed, Glozel refuses to remain in its sepulchre, and the literary battle continues. Dr. Morlet constantly sends me newspapers and pamphlets[2] and a distinguished pro-Glozelian of Belgium, Professor Tricot-Royer, has just supplied me with his defense of Glozel which is particularly interesting because Professor Tricot-Royer was present during the visit of the International Commission.

What keeps Glozel alive? First we have the fact that when men take sides in print they are loathe to recant, fearing ridicule—the more untenable their position, the more stubborn their resistance.

Secondly, six months after the International Commission's visit Dr. Morlet called together a Comite d'Etudes consisting of Dr. Foat, Bayet, and Tricot-Royer of Belgium, Reinach, J. Loth, W. Loth, Van Gennep, Deperet, Ajcelin, Roman, Audollent of France, and Soderman of Sweden; all sympathetic to Glozel. At their meeting they pronounced unanimously in favor of its genuineness.

Another reason is found in the attitude of a group of French and German scientists who are opposed to the traditional belief that *ex oriente lux*—that civilization is of oriental origin. The alleged Neolithic alphabet of Glozel and similar finds at Alvao in Portugal are grist to their mill.

In addition quasi-political factors have entered into the controversy—Fradin an obscure peasant, Morlet a provincial doctor without much influence, have a definite appeal for the proletariat and for a large section of the press.

And finally, it must be remembered that the Academicians are not always right—that they ridiculed Pasteur and Boucher des Perthes; and even Koch and Lister met a similar fate in the beginning.

All these elements co-operate to keep the spark of life in Glozel. Within the past few weeks the publication of an exhaustive treatise by Dr. Morlet has been announced.[3] This, however, I fear, can throw no new light upon the subject.

As a detective tale the story of Glozel remains unfinished and will remain so until a Sherlock Holmes discovers the person or persons who manufactured the articles and put them in the ground. What was his motive? How are we to explain the extraordinary industry that has fashioned 5000 or more articles, and how is it that he, the "Esprit de Glozel," escaped detection in a community of 29 souls where everyone knows everyone else's business. Or how, if there are witnesses to the dark deed, can we explain an unbroken neighborly silence extending over a period of six exciting years?

Herbert photo

"The International Commission" of scientists making an official investigation

Herbert photo

Dr. Morlet demonstrating his claims at the site, before the members of the "International Commission" of investigation. Vayson de Pradenne, president of the Prehistoric Society of France, in *Antiquity*, characterises him thus: "Still young and endowed with wild energy, with an inflexible resolution and a naïve and immoderate self-esteem; devoid on the other hand of competence and of the critical faculty, he threw himself whole heartedly into the fray"

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[2] Similarly, the enthusiastic Dr. Morlet has sent clippings, newspapers, and pamphlets, and his publisher a book by the doctor, to a member of the *Scientific American* staff who, when passing through Vichy, attempted to see him, but who was given to understand by some one within the Morlet household that the doctor was seeing no one, and who left his card. Residents of Vichy suggested that the doctor was finding it expedient to "hide out" at the time, until the legal storm might blow over. —*The Editor*

[3] "Glozel," by Dr. A. Morlet, a copiously illustrated work published by Georges Desgrandchamps, 23 rue Boissonade, Paris (XIV^e). The especially interested reader will find a 20-page article entitled "The Glozel Forgeries," by A. Vayson de Pradenne, President of the Prehistoric Society of France, in the journal *Antiquity* (Gloucester, England), Volume 4, No. 14. Several *Cahiers de Glozel*, some by Dr. Morlet in his own defense, have been published by Paul Catin, 3 rue Sabot, Paris (VI^e); other matter, by Octave Belin, 26 rue Pasteur. —*The Editor*

BY-PRODUCTS FROM INDUSTRIAL WASTES

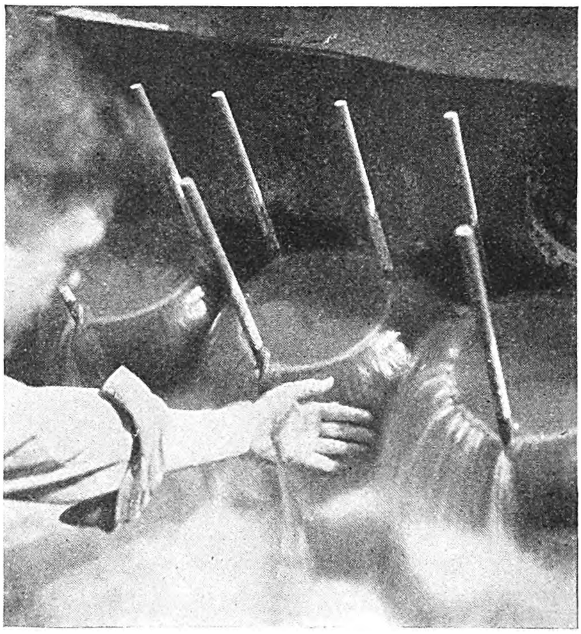
By ERNEST W. STEEL
Professor, Municipal and Sanitary Engineering,
Agricultural and Mechanical College of Texas

A STATE legislator not long ago seriously advocated the abolition of the state health department, and by inference all health departments, on the ground that at best they were wasters of public funds and nuisances. Persons of the same opinion may be surprised to learn that the complaints of health officials have stimulated industries to reclaiming large amounts of valuable materials which were wasting unheeded into streams and municipal sewage.

The liquid wastes of many industries are of such a nature that they cause serious troubles in streams and at municipal sewage treatment plants. In the streams, fish are killed and the water is made unsuitable for water supplies and recreational uses. At the sewage treatment plants, the biological action may be upset by antiseptic substances, or the enormous volumes of organic matter from the industry may overload the plant to such an extent that it must be increased in capacity or must by-pass untreated liquid into streams. Accordingly, many industries have in the past few years been notified by cities and state health departments that the burden of waste treatment must be assumed by the industry, either completely or in large part, before final discharge into sewers or streams is permitted.

SUCH notices have been received with apprehension by the industries concerned until study of the problem showed that what appeared to be a liability was capable of returning profits. An example of this is the Corn Products Refining Company of Argo, Illinois, which manufactures starch and other corn products. Final disposal of its liquid wastes is a matter of much concern to the Chicago Sanitary District. The chemists of the District found that the wastes of this plant were so large in volume and contained so much organic matter that they were equivalent to the sewage of a population of 800,000. The treatment of this waste was, of course, too great a burden to place upon the taxpayers. The alternative appeared to be the construction by the company of a special treatment plant, estimated to cost 2,900,000 dollars.

Investigation of the plant with respect to sources of the waste indicated that a considerable portion of valuable product was escaping into the waste pipes through poor control of certain processes. Improved mechanical equipment and weeding out of heedless operators remedied this. Result: a 10 percent decrease of the waste, and an increased output.



Clear overflow from equipment that reclaims an appreciable amount of wood fiber from the discharge water in a paper plant. Where this is not in use, the discharged water pollutes streams and kills fish

The greater portion of the waste, however, was composed of the liquor in which the corn is first steeped and softened. By installing comparatively inexpensive equipment the steep-water can now be evaporated to such a consistency that it can be used for making a stock feed. Result: an annual return of 500,000 dollars which was formerly lost through waste, and a reduction of volume and concentration of the plant waste from a population equivalent of 800,000 to about 50,000. The present wastes owe their strength to the organic matters distilled over in the vapors of the steep-water during the concentration process. It is possible that some valuable constituents can still be extracted, and further experimental work is being carried on.

Another industry which has frequently been embroiled with health departments is that of coke making. Coke is made by distilling coal, and many valuable products are in the distillate. After these are removed, there remains a liquid containing tar acids and phenol, or carbolic acid. The latter is especially troublesome, particularly if the stream or lake which receives the wastes is a source of municipal water supply within many miles of the point where the waste enters. If the water supply is chlorinated, the phenol taste is particularly bad. The disagreeable medicinal taste of the combined phenol and chlorine has been noticed when the water contained only 1/25 of an ounce of phenol to a million gallons of water. Methods of recovering phenol from the still-waters have been developed and now it is possible to extract it and obtain salable phenol in amounts sufficient to pay the cost of extraction.

THE phenol problem has also received much attention on the part of scientists of France, Denmark, and Germany to prevent pollution of the relatively small rivers of those countries. From their studies comes a new and startling solution. It has been found experimentally that if the phenol-containing liquid is applied to the soil, the injurious constituents are converted into ammoniacal compounds which can be utilized by soil bacteria and act as crop fertilizers. The conversion process takes about two weeks. Previous to the change, of course, the phenol is injurious to plant growth and accordingly the liquid must be applied a proper length of time before sowing. A very important advantage claimed is that, while the phenol is still active, it will destroy weeds and injurious insect larvae present in the soil. The combination of fertilization and weed and insect killing properties may change entirely our methods of disposing of this troublesome waste.

In the bituminous coal mining regions of the eastern states there have been many disputes between mine operators, cities, state health departments, and fish conservation commissions. The drainage water of coal mines contains little or no dissolved oxygen and hence will not support fish life. It will so lower the oxygen content of streams into which it discharges that fish cannot live in them. Mine wastes are even more troublesome because of the acid and other chemicals which they have dissolved out of the coal beds. Acid is a killer of fish and in addition makes the polluted streams black and evil smelling and unsuitable for municipal water supplies. The only remedy found so far has been to require owners of mines to seal up those abandoned workings from which drain water trickles down the hillsides. Lately, however, the Kaplan process is reported from West Virginia. It consists of adding to the mine waste a complex chemical which combines with the undesirable chemicals to form a useful blue pigment, which has a far greater value than has the chemical reagent added. Appropriately enough, the new pigment has been called Monongahela blue.

IN all of the forested states are mills engaged in turning wood into various grades of paper. The process requires much water—to break down or digest the wood into fiber, to wash it after digestion, and to convey the fiber around the plant through pipes and channels. Indiscriminate discharge of the wastes has changed streams which traverse regions of great scenic beauty into black and evil-smelling open sewers. Fish are destroyed. Regions which are ideal for camping, fishing, and vacationing are spoiled.

The paper industry, however, after exertion of much pressure by state health and game officials, is doing much to remedy the situation. Study of plants indicated that much of the conveyor water with its valuable fiber was escaping accidentally or through remediable carelessness. Some fiber unavoidably escapes from the paper machines. This waste is being reclaimed by special patented sedimentation processes which allow return to the plant of the rescued stock. At some plants the water, after removal of fiber, can be returned for further use. This is especially profitable where the water must be pumped long distances from the original supply or must be filtered or otherwise treated before it can be used.

The wastes from the digesters and washers contain much chemical matter that is especially undesirable in streams. The chemicals need not be lost, however, and most paper plants are now installing systems for evaporating this waste. After evaporation, the residue is burned and the chemical is regained in a modified form. The magnitude of this procedure is indicated by the fact that 7000 gallons of water must be evaporated for each ton of pulp manufactured.

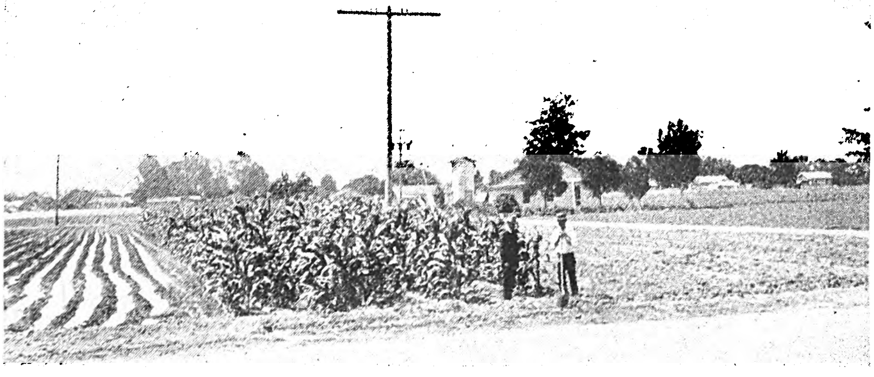
Most troublesome of all problems to the paper industry is the disposal of the highly corrosive liquid wastes from the sulfite pulping process. Some progress has been made by some plants which are converting the waste into adhesive and other by-products having commercial value. Experimentally, investigators have found that alcohol, road binders, linoleum cements, dyes, fertilizers, and many other products can be made. The difficulty is that sulfite waste is produced in such enormous quantities that if all of it were converted into by-products, the market probably could not absorb them all, although alcohol manufacturing may possibly be the final solution.

THE textile industries also produce troublesome liquid wastes. Foremost among these in difficulty of treatment is wool-scouring waste. It contains much dirt, wool fiber, and grease. Wool fibers can be caught on fine screens and returned to the plant. Grease is highly undesirable at sewage treatment plants, and wool-scouring establishments are required, or at least encouraged, to remove all grease before discharging wastes into sewers. After removing grit and heavy dirt, the waste is treated with sulfuric acid which changes the grease into a thick scum and sludge easily removable from the liquid. The scum and sludge are then pressed and the grease is squeezed out. The grease so obtained is very largely lanolin, which is much used as a base for medicinal ointments. The cake that is left behind after grease extraction has some value as a fertilizer.

The most frequently encountered waste is that from plants which handle milk or manufacture milk products. At sewage disposal plants, milk waste sours and upsets the normal bacterial action. Discharged directly into streams, the usual results of stream pollution, nauseous odors, and killing of fish follow. The whey from cheese-making plants is especially troublesome in this respect. Whey has been found to be a valuable hog food and is returned to farms for that purpose. The ordinary milk wastes contain much casein. It can be precipitated by small amounts of sulfuric acid and the resulting thick sludge fed to chickens or hogs. Since casein has many uses in the industries and can be converted into glue, or into poker chips and other artificial ivory objects, it is highly probable that the large condensed milk and cheese factories will eventually salvage this material.

IN spite of the progress which has already been made, stream pollution by industries is a rapidly growing problem. This is due not only to the increasing industrialization of the country but also to the tendency of industry toward decentralization. Formerly industries grouped in certain regions or in the large cities. Their wastes, together with the domestic sewage of the large concentrated population, were discharged into the large rivers, lakes, or harbors where centers of population naturally developed. Comparatively few bodies of water, therefore, were grossly polluted. Now, however, factories of all kinds are scattered over the country. Advantageous as this may be to the industry and to its employees it has been harmful to many streams.

Possible damages to streams should be a matter of concern to all industries contemplating relocation. Town and city officials who are tempted to bid eagerly for a new industry would do well to inquire into the nature of the wastes which it may unloose upon the countryside. Should deleterious wastes be features of the particular manufacturing process, an agreement as to their disposal may prevent unpleasantness. Finally, where wastes are already causing trouble, scientific inquiry, carried on by the industry in co-operation with the proper governmental authorities will probably bring about a solution to this problem, the growth of which is measured by the growth of industry.



Milk wastes discharged into streams cause harmful pollution. This photograph shows creamery wastes being used to irrigate a farm

THE YOUNG GIANT: NATURAL GAS FUEL*

THERE was a slight trembling as, 480 feet below the surface, the crude string of tools dropped into a pocket. The trembling became a dull rumbling, like distant thunder, and the rumbling a rapidly swelling roar until there burst from the mouth of the rough casing a mighty column of mud, oil, and water, borne on the driving fist of a tremendous pressure that rocketed tools and equipment high into the air.

The drillers cheered. At last, after two years of slow, plodding effort, they had struck oil. They were rich.

But their cheering was short-lived. The dark stream soon thinned out and then disappeared altogether, leaving only a colorless substance escaping into the air and a roaring noise that seemed to mock them. The well was a failure, it seemed, for they had struck, not oil, but a gas pocket.

For days the terrific pressure blasted millions of cubic feet of natural gas into the atmosphere in an ignorant waste that would make the gas producer of today weep, while the owners of the well stood around disconsolately and wondered if any oil would follow. Finally, after weeks of waiting, they gave up hope. Some months afterward the roaring gas jet was ignited and the towering torch lighted the countryside for miles around, symbol of a later day when natural gas would be burned for heat and power in home and industry.

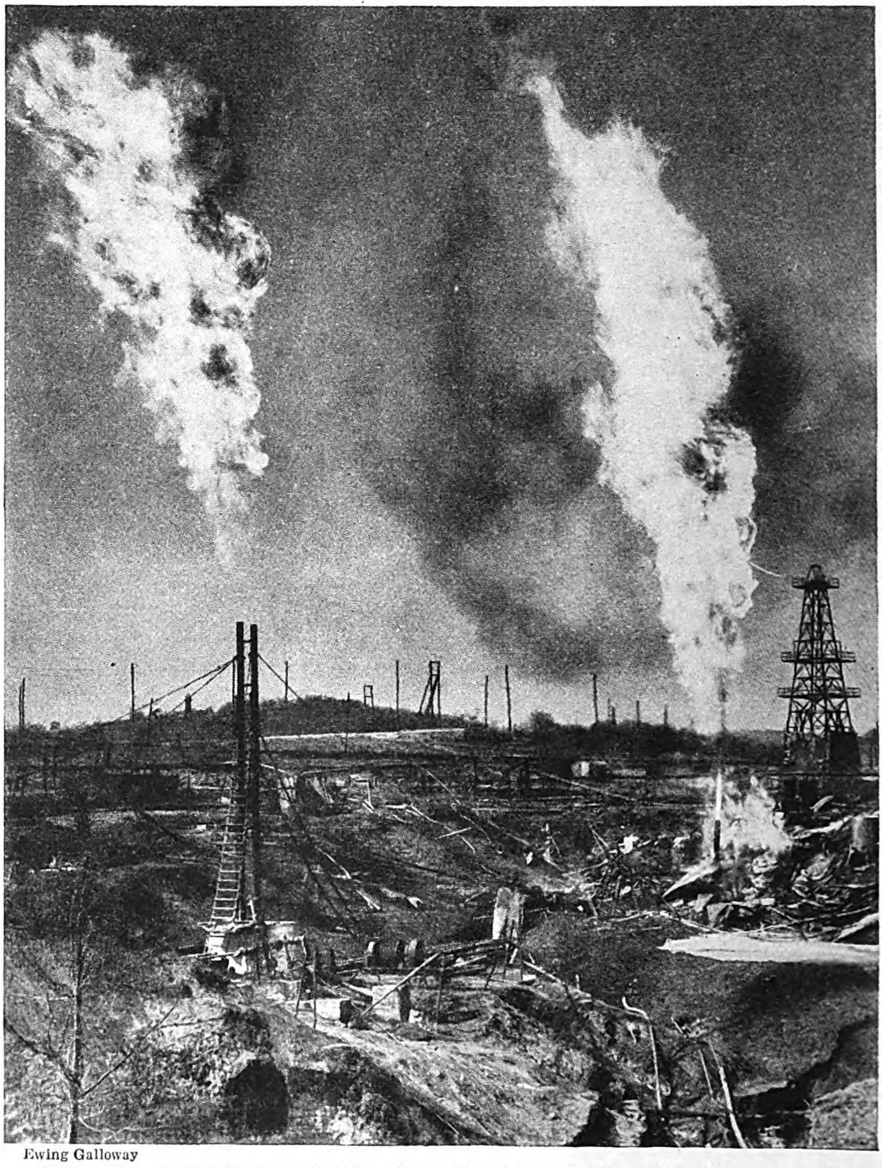
THE above incident, which is typical of hundreds, probably, in the early boom days of the petroleum industry when oil was the gold men sought, actually took place at West Bloomfield, New York, in 1865.

As a matter of fact, natural gas is as old as petroleum in the experience of men. But because it was often practically invisible, ignorance shrouded this masquerading giant of power in a veil of superstition for many centuries. The ancient oracle of Delphi is said to have been situated near natural gas fissures. According to the story, a shepherd noticed that some of his goats wandered about queerly in a certain spot. Going over to investigate, he felt a certain lightness coming over him. Villagers came at his call and immediately experienced the same dizziness, talking in disjointed sentences. So they concluded that a god must live there who had cast a supernatural spell on the place, and accordingly built a temple on the spot.

The Chinese and Japanese may have been superstitious too, but apparently they didn't let their fears blind them to the useful nature of the product. Plenty of evidence has been found to show that these people burned natural gas and even transported it in crude lines made of bamboo or animal intestines. History is full of similar instances. But it was not until 1821 that the first gas well was sunk near a spring at Fredonia, New York—a good 38 years before Colonel Drake's historical oil well at Titusville. Like petroleum, however, gas had been discovered before while boring for salt.

Between superstition, ignorance, and, later, mechanical difficulties of production and transportation, it has taken man many centuries to tame the "wild spirit" of prehistoric times and put it to work for him. A natural gas pipeline map of the United States would show a connecting maze of gas lines in many parts of the country, yet not so very many years ago natural gas was only a by-product, a waste that had to be blown off sometimes before the oil came; or, at best, something that held the pressure which carried petroleum to the surface and saved a certain amount of pumping.

Natural gas operations represent literally an "industry within an industry." Yet the business of producing, transporting, storing, and marketing this


Ewing Galloway

A scene typical of many during the early days of oil well drilling: a well comes in with a roar of gas which, accidentally becoming ignited, is wasted

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*Reprinted through the courtesy of *The Lamp*.

product differs widely from that of petroleum in many respects.

Consider production. In appearance, a gas field looks very much like an oil field to the layman. There are much the same derricks, tools, toolsheds, and pipelines. But the problem of pressure is much more vital in gas operations. The producer cannot put his well on the pump, as the oil man can, when the pressure fails. And the first well down in a new field, naturally enough, gets the full pent-up pressure of the entire area, which may be considerably reduced by the time other bits reach the gas-bearing sand. On the other hand, pressure is not always an indication of how prolific a field is likely to prove. Many an apparently promising area has come suddenly into being, yielded abundant stores for a year or more and then just as suddenly gone dead.

Just as difficult is the problem of transportation. Where the oil man can ship his product by pipe-line, tanker, tank car, by barge, in barrels, or in any other way that emergency may suggest, the gas producer has only one channel of transportation—pipe-lines.

ONE of the most perplexing problems, however, which the industry has had to face—one which has largely been solved by developments entirely without its sphere—has been that of marketing. As might be expected, the first use of natural gas was in the home. In areas within reasonable distance of producing fields, natural gas could be supplied cheaper, very often, than the manufactured product. But here the industry was up against the problem of seasonal demand. Inevitably, extremely cold days multiplied the drain on his pipe-line system eight to ten times. Just as surely, morning and evening drew heavily on the lines, with consumption comparatively slack during the day. Natural gas can not be manufactured as needed. If the supply is too great, the product must be kept in the ground. If it runs short, the producer has to find new fields if he expects to stay in business.

Let's see what the industry has done to get around these obstacles.

First of all, there is far less waste than in the old days. Seldom does one see gas blown wantonly into the air from wells sunk into strata containing both gas and oil. The former is far too useful for re-pressuring oil sands—to say nothing of its commercial value—to throw away. Next is the matter of storage. The producer today has found that by far the most efficient and economical method of storing his product is right in the ground from which it came.

A rugged ten miles of scenery on the Denver gas line. In distributing gas from the fields, pipe-lines must be laid across mountains and through rivers

It has been the widespread growth of industry and manufacturing, however, which in the last analysis has changed the whole outlook of natural gas markets, given the producer an incentive for seeking new and richer fields, and economically justified the huge capital expenditures for lines from producing areas to industrial centers.

The United States is the greatest manufacturing nation in the world. Nor are the factories and industrial plants of the country now crowded into the northern states, as they were in former years. Today industry thrives in the south and west where formerly cotton pickers crooned in the sun and cattle roamed the plains. The natural gas business was quick to realize that here was a chance for mutual development. Its new customer would consume gas in large quantities, and at a comparatively uniform rate throughout the year. In return, the industry could offer him the cleanest fuel known to science with a high heating value of approximately 1000 B.t.u. per cubic foot, one that burns completely with no smoke or ash.

It has been estimated that there are over four billion dollars invested in the United States today, in the various producing and marketing areas scattered over the map, with thousands of miles of trunk and feeder lines, like spider webs in a garret. The output of energy from natural gas burned in the United States during 1929 was estimated to be equivalent to 527 billion kilowatt hours—nearly six times the total production of electricity for the same period. Known fields, with improved methods of computing reserves, give the industry almost unlimited supplies of raw material to work with. Texas Panhandle and the Monroe-Richland field alone can assure the industrial markets of the south and middle west of adequate resources for many years to come. Yet all these assets of supply, scientific methods, and expanding markets which Nature, their own inventiveness, and evolving conditions have given the men engaged in natural gas operations, might well prove to be so many stones, yielding no profit, were it not for one thing. The industry has found to a remarkable extent the way to real practical co-operation.

The natural gas business is not a one-man job, so to speak. The product itself is easily susceptible of waste; and producing areas, unless scientifically drawn upon, may lose much gas that never reaches the market. The laying of lines from field to market involves the expenditure of millions of dollars. In distributing the product to numerous towns along the right of way, as well as at the destination of the main line, countless local interests have to be taken into consideration.

Here, then, is an invaluable natural resource. To bring it from its age-old prison, thousands of feet under the earth, to the burners of various industries in widely separated parts of the country, calls into play hundreds of varying interests. Producer, landowner, engineer, municipality, consumer, scores of others, all have their rights; all must be considered. The tiniest cog can wreck the whole machine.

So the tremendous projects which have been successfully swung by the natural gas industry speak volumes for the fine degree of co-operation, orderly exploitation, and scientific development within its ranks.

The eastern section of the United States was the cradle of the natural gas industry in America. From the producing fields in West Virginia, Pennsylvania, and east Ohio has crept a maze of pipe-lines carrying fuel to the scores of industrial centers throughout that territory, until the map takes on the appearance of a jig-saw puzzle. Today those eastern subsidiaries of the Standard Oil Company (N. J.) operate something like 16,000 miles of main and feeder lines, with estimated distribution for 1930 of 104 billion cubic feet of gas.

Yet, even before eastern markets for natural gas had developed to their present proportions, the wildest gambler would never have undertaken to pipe the product to Baton Rouge, St. Louis, or any of the great centers of the south or middle west. The industry would have laughed at him. And—at that stage of development—it would have been right. Production methods were not as scientific as they are today. Nor were the compressors and lines of a quarter century and more ago as efficient as they are today. Men had no way of estimating with any degree of accuracy the potential output of a field, and the industry could hardly be expected to gamble an investment which it would have to carry 10 or 20 years on the chance that the elusive material in the sands under their wells would last that long. Finally, many of the markets in the south and middle west were not yet ready for natural gas.

So fate played a fortunate trick on the industry in hiding from geologists the prolific Monroe-Richland and Panhandle fields until a time when the engineer and consumer had prepared the scene for more extended use of their treasures.

Panhandle is undoubtedly the greatest natural gas producing field in the world today, with the Monroe-Richland area not far behind. It is almost impossible to estimate how much gas lies locked in the sands of these two fields, needing now only the turn of a valve to release it. But a fair idea may be gained from the fact that the combined capacity of lines already tapping them runs up to several hundred million cubic feet daily.

Amarillo field alone, in the Panhandle district, was thought two years ago to hold some 10¼ trillion cubic feet—enough to keep a line of 100,000,000 cubic feet per day capacity operating continuously at full force for nearly 300 years. That this great natural wealth may be expected to last many years is plainly testified by the investments of many millions which have gone into the construction of 300-, 400-, and 500-mile lines.

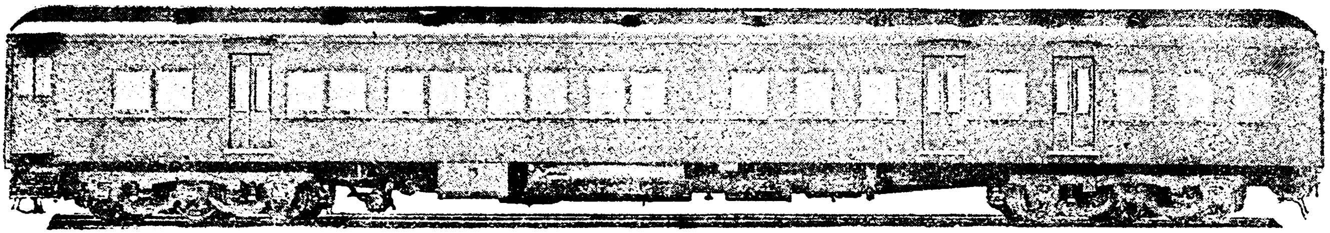
There are three main projects through the south and southwest in which Standard Oil Company (N. J.) subsidiaries have an interest, the most recent being the Mississippi River Fuel Corporation's 431-mile line from Monroe to St. Louis. In addition to the main line, branches will make the gas available to industrial plants in Crystal City, Missouri; and in East St. Louis, Granite City, and Alton, Illinois. Other industrial consumers within reach of the main line through Louisiana, Arkansas, and Missouri also will be served.

In 1927, the Interstate Natural Gas Company completed its line from Monroe to Baton Rouge. The Interstate also contracts to furnish gas from its Monroe reserves for the Southern Natural Gas Corporation's line to Birmingham, Alabama; Atlanta, Georgia; and various adjacent points, as well as to several other interests. Over in Texas the Canadian River Gas Company transports the fuel from Amarillo Field, in the Texas Panhandle district, to Clayton, New Mexico. Here it is purchased by the Colorado Interstate Gas Company (N. J.), and brought to Pueblo and Denver, Colorado, as well as to other towns along the way. In addition, the Colorado Interstate supplies gas for a line north from Denver to Fort Collins.

And so the natural gas industry has grown. Once a "wild spirit," represented by mysterious pillars of fire that issued from fissures in the earth to terrorize natives, then an incidental by-product of oil drilling, natural gas today not only has found its way into homes in many districts, but more and more is replacing its brothers, fuel oil and coal, for numerous industrial purposes. Glass, ceramic and cement plants, steel mills, brick, lead, enamel ware and vitrified clay manufacturers, oil refineries, power plants, and all other industrial users within reach of existing or projected lines are giving ample illustration of the value of the product.

To what extent new producing areas, further improvements in drilling and transporting technique, and the possibility of mixing natural with manufactured gas for maximum economic usefulness in larger centers may justify extending the web of pipe-lines to other parts of the country, plans already announced and others in formation will reveal in the next few years.

Back to the primitive. In swampy land such as this, oxen and mules have proved to be about the best motive power for transporting pipes for the pipe lines



Photographs courtesy The Pullman Company

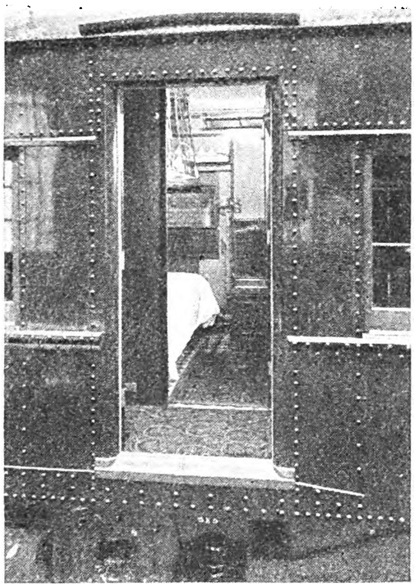
Invalids to or from the Mayo Clinic at Rochester, Minnesota, may ride in comfort in this special car

THE SICK MAY RIDE IN PULLMANS

THERE have recently been built, for operation on the Chicago and Northwestern Railway, two Pullman cars specially designed for the comfortable transportation of invalids. These cars will be operated between Chicago and Rochester, Minnesota, home of the famous Mayo Clinic.

Besides the regular platform entrances at the car ends, three doors are placed on one side of each car for the direct entrance of stretchers. These special doorways are 30 inches wide and two of them are so located that a patient on a stretcher may be carried directly into the room he is to occupy; the third provides access to the open-section division of the car. The rooms thus reached are extra wide, and provided with extra wide doors, so that the transfer from stretcher to bed can be made with the least discomfort to the patient.

Each car contains eight open sections, one drawing room, and four rooms; each room having a stationary single bed and an upper berth, as well as folding lavatory arrangements. The upper berth is available for occupancy by an attendant. At the section end of the cars is the lavatory for men, while that for women is at the opposite end.



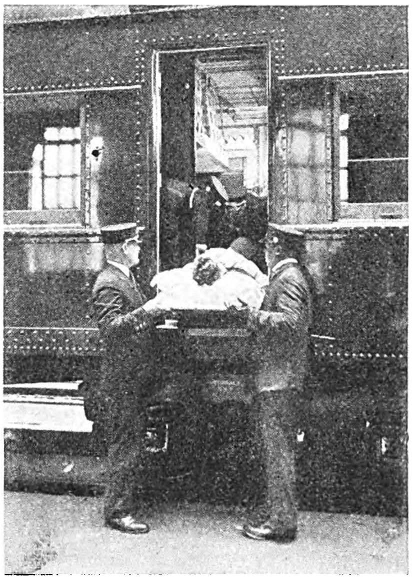
The side door, 30 inches wide, gives access to one of the private rooms

Particular attention has been given in the construction to eliminating as much as possible the noise of travel. Diaphragms at the car ends are spring-hung from the top, the arrangement greatly reducing the amount of car-end rattle. Further, rubber insets have been placed between car trucks and bodies at points of contact, to absorb shock and further reduce noise. The cars are also equipped with roller bearings.

Of invalids who require to travel, the proportion who are entirely bed-ridden is small; nevertheless a considerable number are either bed-ridden or require support in getting about; for these latter a short stretcher, really a canvas seat, 30 inches long, has been devised. This stretcher can be easily handled on entering or leaving the car, because the corridors have been widened for the special purpose of accommodating them. In the ordinary car it has often been necessary to remove a window sash in order to permit a person on a stretcher to be lifted in or out.

The third side-wall door, for patients whose space is in an open section, opens into the crosswise corridor which separates the men's lavatory from the aisle between the sections. Thus only one turn has to be made in carrying the patient in or out, and the use of the platform door and vestibule is avoided.

In a number of other details these cars have been arranged to accommodate this special service; for example, electric heating pads are provided. The cars were designed under the supervision of Dr. Thos. R. Crowder, Director of the Department of Sanitation and Surgery of the Pullman Company. They are appropriately named the *Ephraim McDowell* and the *Joseph Lister*, in honor of two men whose contributions to surgical science have been particularly notable. Ephraim McDowell was not only a country doctor, but a country doctor of pioneering days; he practiced in and about Danville, Kentucky, and there, in 1809, successfully performed the first major abdominal operation ever undertaken, for the removal of an ovarian tumor. There in the backwoods, before the days of anesthesia, unassisted, and with only the crudest of facilities, his boldness and skill combined to bring success in an operation of a type which, now commonplace, has since been the means of saving uncounted lives. Dr. Joseph Lister was the English surgeon who discovered and developed the principles of antisepsis.



The loading and unloading of invalid passengers bound for the Mayo Hospital is rendered easy by the side doors which permit the direct transfer of the patient on a stretcher to the car

NO SMOKING
2

A typical scene taken during the filming of a talking motion picture. The microphone is the cylindrical object suspended by cords in the center of the set

THE TECHNICIAN TALKS ABOUT THE TALKIES

By RAYMOND FRANCIS YATES

SINCE the silence of the silent drama has been so effectively—or shall we say devastatingly?—broken, much has been said pro and con concerning this new magic of the movies. It must be confessed that, as measured by the box office receipts, "talkies" have, within the startling space of two years, emerged from the state of an uncertain experiment into that of a bombastic success. How deserved this success has been from a purely artistic or esthetic viewpoint, or how lasting it will be is a matter of some conjecture even at this late stage of development. This much may be said, however. The movie makers have, by sheer luck, struck upon a ready-made, ready-to-use idea that has revitalized the whole industry and captivated a public that is still applauding with enthusiasm.

As large as the success of this new idea has been there are many dissenting votes and much disillusionment on the part of movie goers who want their drama on the hoof, and who demand something more dramatically and emotionally substantial than heated bedroom scenes and voices that sound as though they might be produced when noses are clamped with clothes pins. In short, the talkies have not been universally successful and the possibilities of reaching this point will become more and more remote unless our movie manufacturers see more quickly their folly in attempting to produce pictures to meet the fickle demand rather than a standard of artistic perfection. We have seen and heard the talkies in their unpolished nakedness, and now we want stark realism with a ring of real sincerity back of it.

THE movie manufacturers have still much to learn of technical control of sound recording. To put a bald record of voice or music on the sound track of a film or the wax of a record is one thing. To give that record the expansive breath and verve of life is quite another thing. Even a superficial observer of talkie technique cannot help but lament the obvious absence of realism that is so noticeable in the average production. Contrary to what appears to be the established opinion of the critics, the fault does not lie wholly in the technical limitations of the electrical equipment but partly in its manipulation. To draw an analogy: the movie makers are playing a Stradivarius with the technique of a fiddler at a barn dance. In their frantic effort to please a fickle public and to take advantage of a demand that has swept down upon them with unprecedented fury, they have failed to tap the resources of their equipment.

Situated between the microphone in the set and the recording apparatus there is what is known as a mixing panel. Here the monitor listens-in on all sounds passing over the circuit on their way to the wax and photographic film records. This vigil of the monitor is of vast importance for it is he who regulates the degree and intensity of the sound-laden currents passing over the circuit on their way to the "canning factory." The monitor is lord over all that he hears; he may by a twist of his wrist make a whisper out of a call for help, or he may on the other hand make a cough sound like an eruption of Mt. Vesuvius. It is all in the knobs!

At present it is the monitor who is the weak link in the chain. He is all technician when he should be part technician and part artist. He is interested largely in microamperes and the response curves of audio-frequency transformers when esthetic effects and realism should be uppermost in his mind.

SOME months ago the writer was seated in the studio theater of one of our largest producers, reviewing bits of a musical comedy that had recently been filmed. The novices present talked with a learned air about the "highs" and "lows" of the recording, at the same time being serenely insensible to the appallingly bad job of monitoring that had been done in recording the sound. There was a close-up of a young lady engaged in a normal conversation with a friend. While talking, this young lady turned her back to the audience, but there was no change whatsoever in the intensity of her voice. Here the simple turn of a knob might have added a valuable touch of realism for it is obvious that orientation has a pronounced effect upon the voice. During conversation, turning the head affects the volume of the sound reaching the ear of the listener. A small effect, to be sure, but not small enough to lose every vestige of importance. It is going to be through the painstaking attention to these small effects that the movies will eventually emerge into a state of polished and formal art. The paramount question is,

THE motion picture, and now the motion picture in its talkie form, has become such an integral part of the average person's daily life, that any suggestions for improvement take on a personal interest. In the accompanying article Mr. Yates points out some of the failings of the talkies, and how they may be overcome. His technical background in sound work gives the voice of authority to his statements.—*The Editor.*

"When will the talkies learn to talk?" The answer lies with the technicians whose esthetic sense is usually no keener or more susceptible than that of a coal-wagon driver or an ice-man. It is a far cry from the grid bias of a vacuum tube to the artistic niceties that will eventually put more interest in faithful reproduction.

Some of the efforts of our movie makers to produce realistic effects are painfully amusing to one who has any knowledge of the technical considerations involved. There is a scene on the screen showing a canoe being paddled down a stream in an enormous canyon. The canoe is almost an insignificant speck, a dot in the void of a great spectacle of nature. Strange as it may seem, one hears the dip of the paddle. One who knows the making of the talkies can visualize a stage-hand standing beside a tank of water placed under the microphone and dipping a paddle so that the great American movie audience will be treated to a bit of realism. The whole scene was incongruous enough to make a school boy laugh.

Realism in talkies will not come as an over-night development. It is something that must be fathered, something that must be nursed, something that must grow out of a multitude of unpardonable mistakes. It is something that must be first felt and then learned. However, when one considers that we have had nearly three years of unrestrained talkie making, one is inclined to believe that the perfection of realism has not been as rapid as it should have been. Let us take another example of bad talkie making.

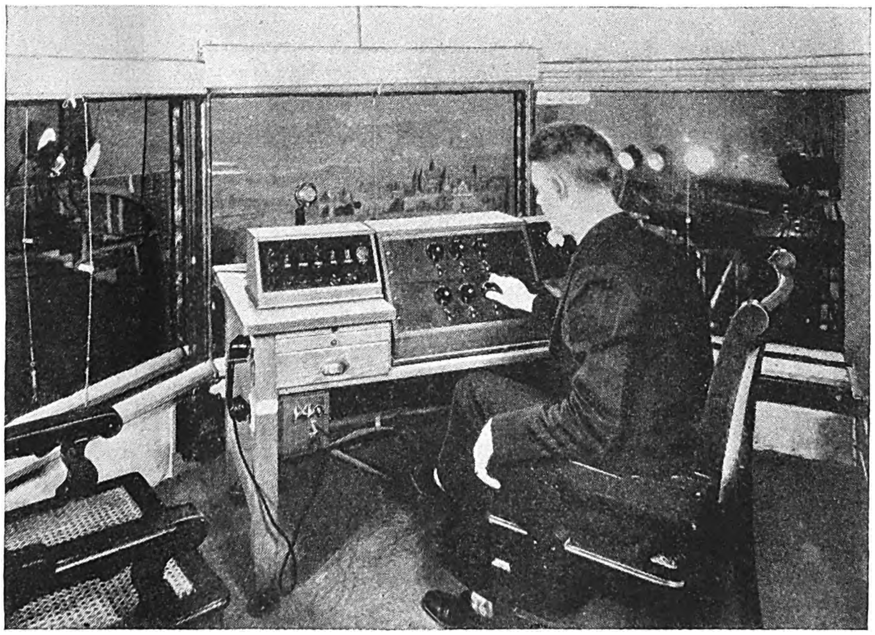
THE scene is a living-room. There is a normal conversation taking place between the occupants. The recording is, on the whole, fairly good. There is a quick flash to the platform of a railroad station. A locomotive with a string of Pullmans rushes into the scene and stops. The effect is terrible. What has happened? The sound produced by the approaching locomotive, a locomotive that one would think almost knocked the tripod from under the camera so closely did it approach, had a volume that was not much greater by comparison than the voices that immediately preceded it in the living-room set. The effect was strikingly incongruous. There was no dramatization at all. The locomotive should have thundered into the scene with a rattle of monstrous iron wheels, with the screaming of brakes and with the glamour and noise that always attends the approach of such gigantic pieces of mechanism. This particular locomotive really almost whispered its way into the scene.

It might be confessed here that the technical equipment in present use is not designed to handle the recording of an approaching locomotive the way the recording of an approaching "he" locomotive should be handled. There is some question as to whether or not this terrific high level of sound intensity could be passed through the amplifying tubes. The question arises: "Why would it not be possible to arrange an automatic switching in of additional amplifying equipment and additional horns so that the whole theater would resound with the thunder of the great iron horse?" It is true that sound amplification, when the sound takes the form of noise, can be amplified to a tremendous extent without the audience becoming at all aware of any distortion. When the sound of an orchestra is recorded the engineer must take care to keep the mould of distortion cut away but when he is recording noise such as the eruption of Mt. Vesuvius or a battle scene, the "sky is the limit." Perhaps we may look forward to the day when locomotives will be locomotives and battle scenes will sound more realistic than Boy Scout Troop No. 125 having their annual outing.

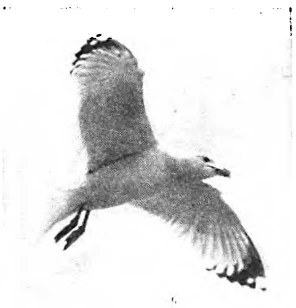
At the present time it is the general practice to place the ear of the "talkies," the microphone, in the center of the set. The technical reasons for this practice have never been made quite clear to the writer. Would it be unreasonable to assume that the microphone, representing as it does the ear of the audience, should be placed at the front of the set in a position bearing the same relation to the performers that the audience bears to the screen? With the microphone assuming this position it would appear that a portion of intelligent monitoring might, to a certain extent at least, be automatically solved.

A still more glowing example of bad manipulation of equipment was recently made obvious when a performer entering an extremely deep set from the back, walked into a close-up as he talked. The monitor had made no effort to fade him in. The sound effects were distinctly displeasing and somewhat incongruous when one realized that a sixty thousand dollar oriental rug adorned the floor and the room was furnished with a carload of expensive trappings fit for kings. There is no expense to which a well-managed studio will not go when it comes to supplying the necessary furniture and equipment and scenery for a major production. It makes one wonder why the smaller details of sound recording are permitted to pass by practically unnoticed.

IT would seem that sound recording is now in the same state of perfection that photography was in 15 years ago. This sorry state of affairs has been brought about by giving the technicians, the sound engineers if you will, too much of a free hand at the studios. Their judgment is in no case tempered with artistic sensitiveness; they cannot see the woods for the technical trees. They are interested in curves and technical precision and they have quite forgotten that technical precision is a far cry from artistic realism. It matters not to the man in the audience whether a tube is biased correctly or whether a resistance deviates one watt or 50 watts, he has come to the theatre to see life lived on the screen, to see an illusion that will be so perfect as to cause him to forget about his daily troubles, his trials and vicissitudes, and the sooner the talkies can deliver this message to him in the true, unvarnished voice of life, the sooner the talkies will be here to stay.



The monitor operator sees all and hears all. He should be part technician and part artist, for by a twist of the wrist he can improve or mar a sound record



Courtesy *Nature Magazine*

A herring gull in full flight showing the slots of its wings opened

A sailing kingbird flying slowly. Primary feathers are outstretched but the false wings forming slots are barely visible

BIRDS HAVE NATURAL SLOTTED WINGS

By RAY P. HOLLAND, Jr.

SLOTTED wings seem to be one of the most recent of the greater aerodynamic developments. It has been in comparatively recent years only that they have been used to any extent at all. As they are used on the airplane, they seem to be one of the man-made devices which have no parallel in nature. There are many such things that appear to have been developed entirely in a scientific laboratory or as the result of continual development of complicated theories. When the result is finally reached and the product is finished, the general opinion is that something entirely new has been made. Then, suddenly, it becomes known that the identical thing that man has worked so hard to attain has existed all the time in a rather simple and surprisingly perfect application in nature.

Slotted wings are an excellent example of this. In nature they are almost as old as flight itself. The earliest flying creatures had no feathers. They flew with a skin web as the supporting surface, as does the bat. With the development of feathers, the primitive slotted wing appeared. That which corresponds to the fingers of our hand became the long, stiff feathers that form the wing-tip of the bird. The thumb developed, on the bat, into a projection to aid it in clinging to walls. On the bird, it became what has been known as the "false wing" or "bastard wing."

The false wing consists of a small group of long, stiff feathers above the leading edge slightly less than half the distance to the wing-tip on most birds. In its normal position, it fits into the conformation of the wing so well that it is not easily seen. When open, it is plainly visible. Being directly in front of the more flexible portion of the wing, it is in a perfect position to direct the airflow over the lateral control surfaces. Thus, in its function it is like the airplane slot.

The manner of operation is slightly different. Naturally, because of mechanical reasons, the bird can not open its slot directly to the front as on the airplane. The means it uses is to move the tips of the slot feathers forward and downward with the joint where the group connects with the wing proper as the pivot. The portion of the wing left exposed by this motion is very well shaped to produce high lift. The feathers of the false wing are disposed so that the cross-sectional shape of the airfoil they form is easily altered. When the slot closes again, the feathers shape perfectly into the wing. It is the ability to change shapes and areas at will that gives the bird such a remarkable control of its flight.

The primary feathers that form the wing-tip of a bird have an aerodynamic action somewhat similar to that performed by the bastard wing. The quill of these feathers is close to the front edge. Each feather is an airfoil in itself. They are arranged so that in overlapping, the leading edge of one feather is above the trailing edge of the feather in front of it. The nearer the end of the wing they extend, the more they diverge, until before the tip is reached, there is space between the individual feathers. The effect is that near the wing-tip there are several airfoils at high angles of attack, one behind the other, the whole group forming one large airfoil. Although not exactly like a multi-slot wing, this arrangement probably has some similar characteristics.

IT is likely that the tips of the primary feathers, which are free to twist over certain limits, place themselves in positions with negative angles of attack when the bird is in certain attitudes. This would form a true multi-slot wing. Mechanical difficulties prevent man from using such a wing, although he understands its action perfectly. This type of wing using numerous slots has been tested in a wind tunnel up to over 40 degrees angle of attack without reaching its "burble" point. The bird probably makes use of the principle in landing and in slow flying. At that time, the tip feathers are spread wide. In rapid climbing, maximum lift is obtained in the same manner.

When high-speed level flight or a dive is desired, the bird's wing-tip moves to the rear in relation to the rest of the wing; folding closes the openings between feathers. In addition to closing the slots, this action furnishes a desirable sweepback. Moving a supporting surface to the rear will move the center of pressure in the same direction and steepen the dive. In extremely rapid dives, birds fold their wings until they are scarcely stubs on the sides of the body. In this means of airfoil modification, natural flight has one of its greatest advantages over artificial flight.

The very shape of the wing-tip feathers is strong evidence that they act as individual airfoils. They are flat and of practically uniform chord out to the point where they are spread wide enough to cause a space between them when the wing is spread. At that point there is a sudden tapering of the plan form. The part of the feather in front of the quill narrows down almost to nothing. The feather becomes an efficient airfoil instead of only a component in an arrangement that makes up one large surface. The cross-sectional shape of these feathers is usually similar to that used on our racing planes, but even thinner. It is so thin, in fact, that it would not be practicable to construct an airplane wing using the same proportions.

As an example of a bird which uses its slotted wings to great advantage, let us consider the wild duck. Certain species of them migrate from as far north as Alaska in the summer and southward to the Gulf of Mexico in the winter. When not disturbed, they prefer not to fly, unless they have a certain destination. In their flight to that destination, they travel in a straight line at a high speed. When disturbed, they must be able to climb almost vertically for their protection. Also, they possess a marked ability to change direction and speed suddenly when they see something that arouses their suspicion.

Suppose that an order should be received in an aircraft factory for a ship of very high wing-loading, the nearest thing possible to a racing plane, that would have a low landing speed, an ability to stunt, extremely good climb, and also be capable of long-range non-stop flights. It would be absurd to try to fill all the specifications in a single ship. Any one of the requirements could be fulfilled in a specialized job for that purpose, but no individual plane could possess all the qualities necessary. Nevertheless, a duck can do all those things.

After flying all night at a high altitude, the duck reduces its wing area to almost nothing, shifts its center of pressure to the rear, and begins a long bullet-like dive to just above the surface of the water. At that point, it increases its wing area and resistance at the same time. As its speed diminishes, the false wing moves forward from its position to form the slot. It maintains perfect lateral control up to the point when it becomes practically motionless in the air only a few inches over the water. Then, with a few flaps of the wings, it lets itself down easily. If it is disturbed, it springs from the water with amazing alacrity. A rapid and steep climb is maintained until the bird is out of danger. During this climb, the slots are continually open. They are, more than any other one thing, responsible for this performance. They increase the lift and prevent "burbling" in the attitude necessary for the climb.

DIFFERENT birds, depending on the degree to which they use them, have slotted wings developed to different degrees. Generally, the false wing is comparatively small on gliding birds. They are slow fliers that employ extremely efficient airfoils. Birds such as the albatross derive their efficiency from a supporting surface of very high aspect ratio. Their light wing-loading provides a sufficiently slow landing speed for them. Great climbing speed is unnecessary because they fly over level stretches of water with only slight changes in elevation. Their continuous gliding is made possible by the rising currents of air caused by the swells of the sea. Birds utilize these slopes of water in exactly the same manner that a sailplane uses a long gradual hillside.

Those birds which have a high-speed flapping flight have the slots developed to the greatest extent. They are birds of very high wing-loading. High-speed wing action is necessary in order to maintain flight. Nevertheless, a remarkable rate of climb and a reasonably slow landing speed can be produced. Quail, grouse, and pheasants are birds of this type. Examination shows that these birds have abnormally large bastard wings.

I have noticed that the position of the slot varies on birds of different sizes. To illustrate this, I will compare the Hutchin's goose, which weighs about eight pounds, to a representative small bird. The center of the group of feathers, on the goose, that constitutes the bastard wing, is approximately 58 percent of the distance from the body to the tip of the wing. On the smaller bird, it is only 37 percent of the distance out. The smaller bird's false wing occupies slightly over 20 percent of the leading edge, while that on the goose occupies only 17 percent of its leading edge.

HOWEVER, this latter comparison creates the wrong impression because the goose is a bird of high aspect ratio while the other is not. The slotted wing area of the goose is much larger in comparison to the entire wing area than is the case on the other bird. Its wing-loading is considerably greater also. The manner of flight, in the same way that it affects the size, is likely to have a direct bearing on the position of the false wing.

On the ruffed grouse, a bird of heavy wing-loading that flies with an extremely rapid wing action, the slot feathers are very close to 50 percent of the distance to the tip. On birds of light wing-loading it is usually less than half way out. These observations indicate that the bastard wing, viewed from a standpoint of size and position only, has a direct relation to the size and flying characteristics of the bird, and must be a part of its control system, and not merely a useless appendage.

If you would like to see a practical example of the actual means the bird uses to open his slotted wings, it is only necessary to obtain a bird's wing to experiment with. This should be easy, for there are many species of detrimental birds, such as the hawk or crow, that may be killed at any season. The wing of the bird, cut from the body, is all that is needed. There is a tendon just in front of the wing bone. As this is pulled the wing starts to unfold. Everything goes on normally with the false wing in its original position until the maximum wing area is reached. In landing, the bird would employ this position of its wing in order to have the lightest wing-loading, and consequently the slowest landing speed. It is also in landing that it makes the greatest use of the slotted wing. It is, therefore, logical that the action of the false wing should be governed by the tendon that holds the wing outstretched.

By pulling with slightly more force on the same tendon, the false wing will move forward and downward into its correct position to act as a slotted wing. When actually seen operating in this manner the function of the so-called bastard wing is very evident.

ACTUAL photographs showing the slots open on flying birds form the only more convincing evidence I know of. It is difficult actually to watch birds and see the system in operation, even with binoculars. The opening is slight and there is only a short period of time during which to observe it. It may be seen after much effort but not distinctly enough to be a proof. However, to take a wing in your hand and actually make the slot open, will make even the most stubborn doubter stand convinced.

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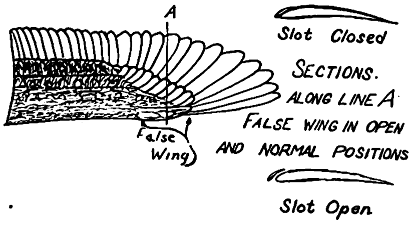
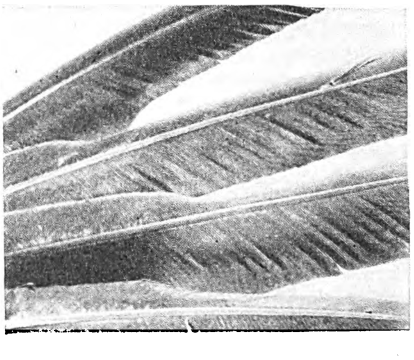
Instruction in "blind" flying is becoming increasingly important to the aerial transport industry. An article telling how it is carried out is scheduled for early release.

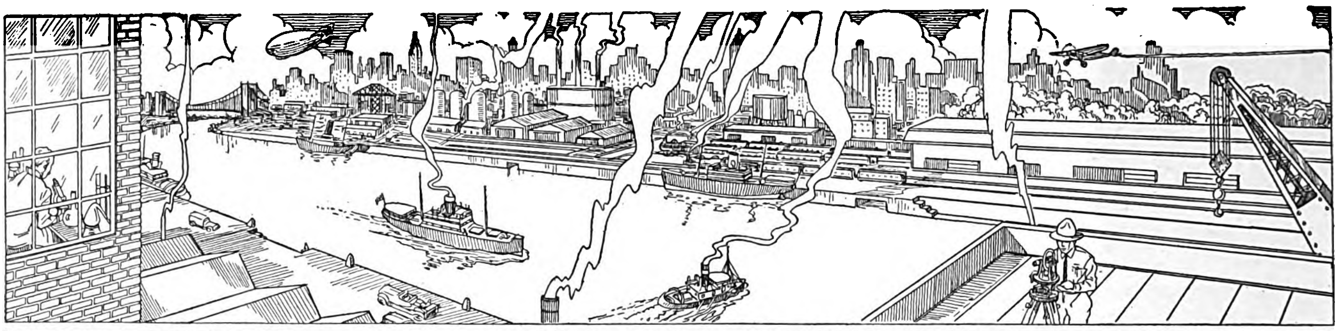


Goose wing showing similarity to airplane slotted wing arrangement

Left: **Comparatively small false wing on slow-flying, soaring bird**



Right: **The sudden tapering at the point where the primary feathers begin to act as individual airfoils**



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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Editor *Journal of the American Medical Association,* and of *Hygeia*

NOW YOU CAN BUY INSECTS FOR 10 DOLLARS A MILLION

TEN dollars a million for insects! Who'll buy? The average stung, bitten, and be-itched picnicker or camper may ask wearily why anybody should want to buy a million insects at that price when you get more than a million for nothing every time you show your nose out of doors.

But the insects that are worth 10 dollars a million are cheap at the price, for they prey on the eggs of other insects, thereby preventing the pests from ever seeing the light. They are the almost microscopic wasps known as *Trichogramma,* which are reared in captivity by Stanley E. Flanders, entomologist of the Citrus Experiment Station at Riverside, California. Mr. Flanders has been at this work for some time now, and has improved his rearing methods to a point where the tiny parasites can be produced at a thousand for a cent. They are shipped out in great numbers to orchardists, who release them to assist in their endless warfare on fruit-spoiling insect pests.—*Science Service.*

Recently developed safe, fireless lamp for flashlight photography

NEW PHOTO FLASH LAMP

A FIRELESS, smokeless, odorless, and noiseless photographic flash lamp has been developed by the incandescent lamp department of the General Electric Company, Cleveland. The flash is confined entirely within a bulb, with resulting advantages that are expected to revolutionize flashlight photography. Requiring only one-hundredth of a second to act, and being without hazard, it will make possible the taking of flashlight photographs in places heretofore practically impossible to "shoot," such as in trains, airships, and theaters, under water, and by insurance companies requiring night photographs under all weather conditions.

The lamp consists of a clear bulb of standard design, with the flashlight filament coated with a special preparation, and with a quantity of very thin aluminum foil in crumpled sheet form within the bulb. The bulb is oxygen-filled.

When the circuit is closed the filament is lighted and this, in turn, lights the foil. The lamp operates on any 115-volt house supply, or with dry, storage, or flashlight batteries. A new lamp is needed for each flash. The lamp is most efficient when used with suitable reflector equipment.

NEW PROCESS FOR CARBON BLACK MANUFACTURE YIELDS HYDROGEN

THE production of carbon black from natural gas has been, heretofore, a wasteful process, but experiments carried out by the United States Bureau of Mines give promise of an increased yield of more than 400 percent.

The old method, and the one in widest use, consisted of burning natural gases incompletely and collecting the unburned carbon on cold metal surfaces when the gases passed off. Sometimes the carbon black was collected by filtering the gases through cloth.

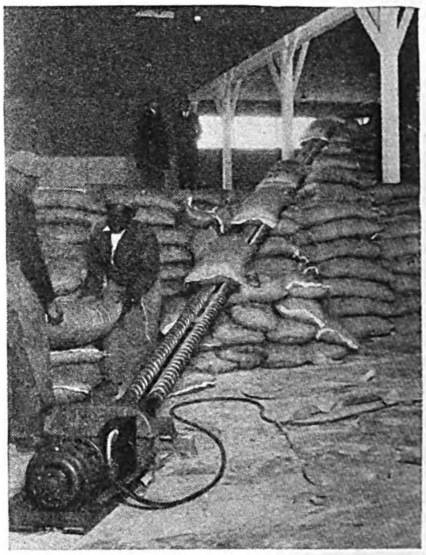
The new method calls for the passing of the gases through ignited coke. The coke is fanned to great heat by subjecting it to a forced air draft, after which the natural gas is passed through it and cracked.

An advantage to be gained by the new process is that, in addition to the carbon black, hydrogen may be recovered and used in some localities for the synthesis of motor fuel and the manufacture of ammonia and other products.—*A. E. B.*

DOUBLE-SPIRAL CONVEYOR

A NEW portable, flexible, power-driven, elevating and tiering conveyor has just been introduced and has already found many useful applications in a wide range of industries.

The TwinVeyor, as this new apparatus is called, uses a new principle: two external spiral tubes are turned toward each other by a power head. Anything placed on the conveyor travels forward rapidly, perfectly balanced. It is used for handling raw materials and finished products in bags, bales, and bundles. The equipment finds other applications handling crates and boxes, and experiments are being made handling the finished product itself, without packaging, where its shape and size permit the spirals to get hold of it. It carries bagged sugar up a 30 percent grade at the rate of 90 feet per minute, handling 1800 bags per hour.



Double spiral conveyor for bags and bales. It is motor operated

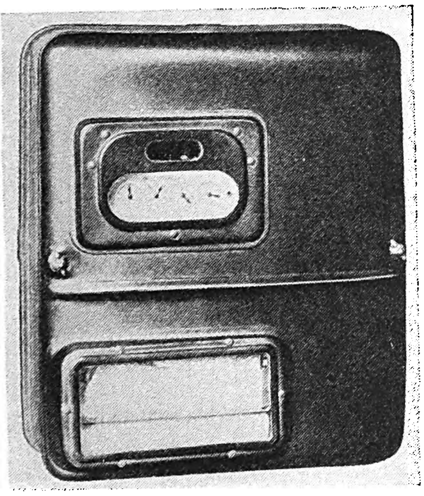
A standard unit consists of six eight-foot dual sections and a power head which draws current from any power line. Each section joins to the assembly with an automatic lock. It is easily shifted about by one man and the entire 50-foot line can be assembled or disassembled in six minutes. Flexibility is secured by the ability of any joint to take a 15 degree angle horizontally, 15 degrees up or 10 degrees down.

A hurdle section permits any number of TwinVeyor 50-foot units to be hooked together, forming a continuous line of any desired length. The traveling load hurdles each power head in the line. Right and left spiral chutes are provided for shunting the load from one TwinVeyor line to another without manual handling, thus making right-angle turns simple.

MEASURING ULTRA-VIOLET RAYS

THE element of danger in the indiscriminate use of the ultra-violet ray has had to do with the dosage, the amount of exposure, the proper measuring of ultra-violet radiation for the purpose at hand. It has heretofore been a difficult task to measure this amount exactly, but now there is an ingenious device for the purpose, an ultra-violet ray meter that records the amount of ultra-violet rays coming one's way as accurately as an electric house meter gives the amount of electricity one is consuming in the home.

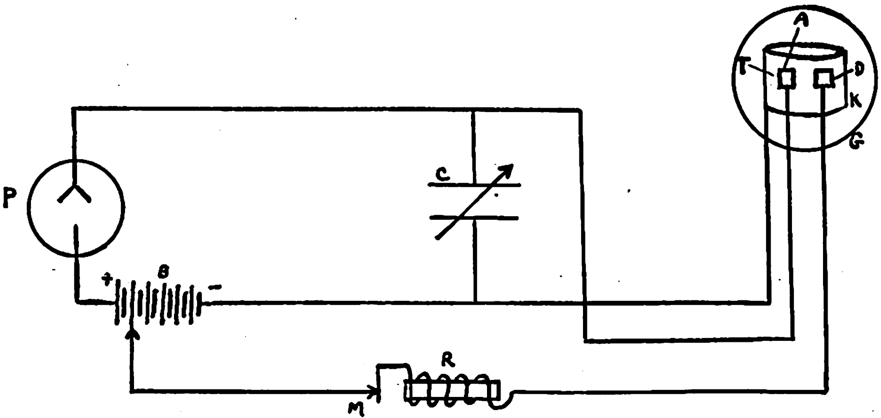
This indicator operates from dry cells within it. Its essential element, the "eye" of the instrument, is a photo-electric cell which was developed by Dr. H. C. Rentschler of the Westinghouse Lamp Company. The cell in this case is sensitive only to those light rays supposed to have therapeutic value or other effect on vitality—rays .0029 to .0031 millimeters in wavelength. The cell itself is the result of research findings that: (1) By a proper selection of the active material, a cell may be obtained that will not respond to light of longer wavelength than that desired; and: (2) By use of proper light filters it will not respond to light of shorter wavelength than that suitable for the purpose. (A cell of uranium metal and Corex D glass, for example, responds only to that band of light used in prevention and cure of rickets.)



Graphic meter for recording the quantity of ultra-violet on a chart

When the rays strike the cell of the meter, a certain amount of current passes through it, proportional to the intensity of the rays, and charges a condenser which, when fully charged, trips a counter. The operation is then repeated, each impulse measuring a definite quantity, irrespective of the light intensity. Since the unit of measurement has at present no name, the value taken is arbitrary. Over a given period of time the number of impulses per minute, each accompanied by a "click," thus indicates intensity, while the total number of impulses indicates quantity.

The principle on which the meter operates is as follows, referring to the diagram: A battery B charges condenser C at a rate determined by photo-electric cell P when light falls upon the cathode. Glow tube G has metal cylinder K for cathode and a primary anode A and main anode D. A small gap exists between A and cathode at T. When C is charged to a potential such that a discharge takes place between A and K, the cathode resistance of the glow tube is broken down and current flows between D and K. This operates the relay R, registers the count, and opens the main circuit M. The condenser is discharged simultaneously. The operation is then repeated. The total quantity of light falling on P is proportional to the total number of discharges registered.



The circuit of the instruments used in the ultra-violet ray meter

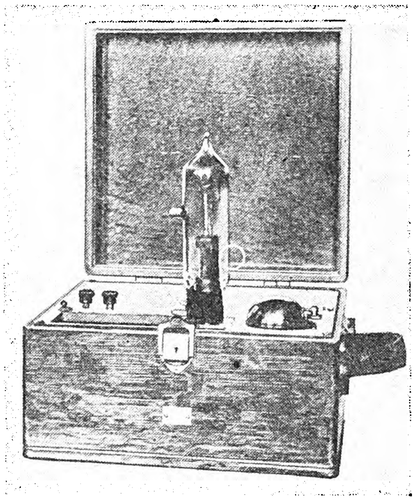
WOOD ALCOHOL

WITHIN recent years it has become possible to produce synthetically the wood alcohol that was formerly prepared only by destructive distillation of wood. The substance is now manufactured from water-gas and hydrogen at a cost which makes it possible to produce large quantities at a low price. Modern industry is, therefore, attempting to introduce the substance for a large variety of purposes, including its use as an anti-freeze mixture in automobile radiators. It is also used in the manufacture of quick-drying shellacs and varnishes. It has long been known that wood alcohol is a dangerous poison with cumulative effects. When taken frequently in small doses, it produces blindness; in large doses, it causes death. The added danger from this product is in the fact that the repeated inhalation as well as the drinking of very small doses of the poison may produce the most serious results.

If this substance is to be used as an anti-freeze mixture in the coming winter, employees of garages who will inhale large amounts of it from overheated radiators are likely to suffer serious injury as a result.

Cases have already been reported in which women and children who have used quick-drying shellacs or varnishes, made with methanol, in closed rooms have suffered harm as a result. In the great spray process used in automobile factories, the spraying is done under hoods and employees wear masks, so that they are protected against the hazard.

As is usual in modern industry, the name of the product has been concealed by the bestowing of fanciful names and the average person does not recognize under the name *methanol* or some other fanciful title the old, old hazardous wood alcohol.—*M. F.*



Ultra-violet indicating meter which uses a special photo-electric cell

FEATS OF SHORT WAVES

RADIO waves which will do the family cooking, provide wireless illumination for homes, alleviate pain, and cure disease are the goal of new investigations into the possibilities of the short-wave high-power vacuum tube, according to Dr. Willis R. Whitney, director of the General Electric Research Laboratories, in a research narrative issued by the Engineering Foundation.

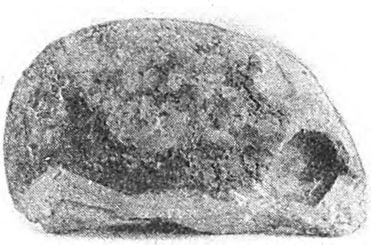
Control of this power for practical uses will immediately open up lines of advance in industry and therapeutics hitherto closed to science, it is stated. Simplified mechanisms and a reduction in the cost of producing large volumes of radio energy are the problems now facing solution.

Radio cooking has already been demonstrated in tests with the new tube.

"A wire was suspended over a table,"

Dr. Whitney states, "at a distance of a few feet from the radiating aerial, which was a copper bar about 10 feet long. A sausage in a glass container suspended from the end of the wire was soon cooked. Likewise an egg was 'fried' in this container, and an apple spitted on the end of the wire was thoroughly baked in a short time. .

"With suitable changes of utensils, cookies were baked and water boiled. There were no flames or other visible evidences of heat accompanying the cooking. The vacuum tube from which this weird power emanated was only two feet long and five inches in diameter.



Robert P. Robinson of the Skelly Oil Company, found this stone at San Angelo, Texas. Its resemblance to a human skull is striking, but since it came from rocks of the early cretaceous period, thus making it something like 115,000,000 years old, scientists are not inclined to take its human origin at all seriously

"As yet the high-power short-wave vacuum tubes are being used for experimental purposes only. To bring them into practical usefulness at reasonable cost and discover their many possibilities for service to mankind is now our task."

BLOOD PRESSURE

THE blood pressure of human beings is measured by putting an elastic cuff around the arm, inflating it with air, and then listening to determine the points at which the sound of the blood in the vessels is extinguished and the point at which it again appears when the pressure of the cuff is released. This simple test has been of tremendous importance, particularly in examinations for life insurance. A normal blood pressure is recognized as being approximately 120 millimeters of mercury. Insurance companies insure persons with pressures ranging from 100 to 140.

In order to make some more exact determinations regarding blood pressure of a considerable group under controlled conditions, Drs. W. C. Alvarez and L. L. Stanley took the blood pressure of all of the prisoners in the San Quentin prison in California. They are inclined to believe that there is a normal blood pressure for each person; that if a person has a high blood pressure at 20 years of age, he is likely to have a high pressure at 40. The lower limit of normal pressure they found to be 90 millimeters of mercury and the upper limit 140. They found the normal pressure about 115, which is lower than the figure usually found for men out in the world. The reason for this they consider to be the fact that the prisoners are not fatigued and worried by the struggle to make a living. They did not find that alcohol affected the blood pressure, but tobacco appears to raise it about 4 millimeters.

Men who have been convicted of murder in the first degree showed a blood pressure slightly higher than that of other prisoners of the same age. They found that the prison guards had a pressure considerably higher than those of prisoners, which they consider to be due particularly to overweight, and also to the fact that the guards were applying for positions at the time when the pressures were taken and that many of them were anxious for fear they might be rejected.—*M. F.*

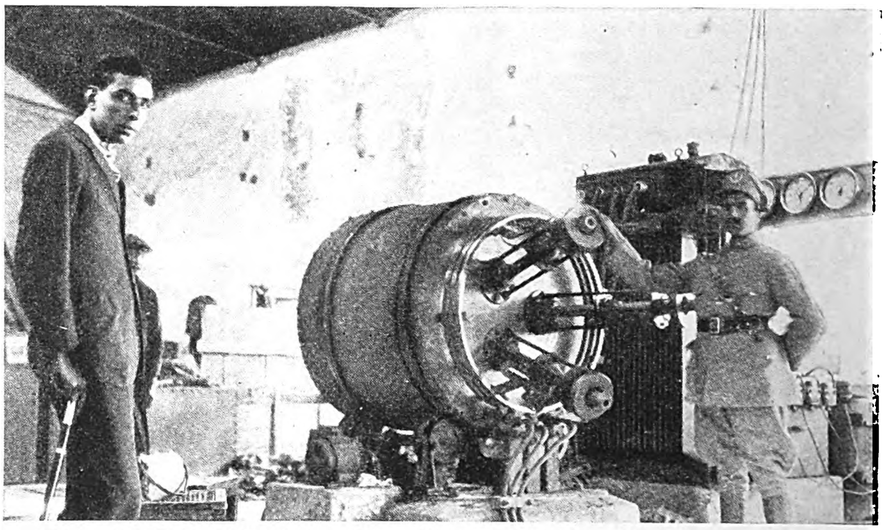
POTATO RUBBER

THE Firestone Tire and Rubber Company is experimenting on the commercial value of a new variety of rubber with potato starch as the base. The synthetic product contains no latex or plantation rubber. It is made by mixing the starch with chemicals which coagulate it into a gum-like substance differing from rubber only in that it is less elastic.—*Barron's.*

REFRIGERANTS FROM THE TROPICS

"YOUNG as we are," says Dr. H. E. Howe, editor of *Industrial and Engineering Chemistry*, "we can remember the days when sailing vessels carried cargoes of natural ice from Maine to Cuba, and we believe even as far as Calcutta. How times have changed!

"There is now en route to New York from Mexico one of three vessels, each of which has been equipped with a compartment insulated against heat exchange by 12 inches of cork board to bring solid carbon dioxide to the metropolis for refrigerating purposes. One of the petroleum companies in drilling for oil struck a supply of carbon dioxide which rushed to the surface at a pressure of 1000 pounds.



Even turbulent Afghanistan, where kings are made and unmade overnight, must have coins. Here is shown the electrical smelting machine, imported from America, which has just been installed in the mint at Kabul, the capital. Beside it stand an army officer and a modern young Afghan "intellectual"

"It is much too early to discuss the economics of this venture. Inasmuch as the solidified gas must be cleaned of its impurities before it can be re-made into commercially pure solid carbon dioxide, it is doubtful whether the natural high pressure will be of much advantage, and undoubtedly there have been some nice technical difficulties in the purification of this particular supply of gas. We have yet to learn, too, with what efficiency and what percentage of loss the solid gas has been stowed in the hold, transported, unloaded, and distributed. These are technical details concerning which no information has so far been made available. However, the whole venture is intriguing. The mere thought of preparing a refrigerant in the tropics for shipment into the temperate zone is so complete a reversal of the old established practice as to afford another example of how chemistry is helping to remake the world."—*A. E. B.*

NEW INSECTICIDE PRODUCED BY "CUBE ROOTS"

IT used to be a favorite wheeze at college to suggest to the room-mate who had prematurely squandered his allowance that he write home for funds with which to buy a cosine for use in mathematics class. We used to assume that Dad either had never been exposed to trigonometry or had forgotten that a cosine was merely a mathematical function of an angle and that he would "enclose check" rather than admit ignorance. We were forcibly reminded of that ancient practice by a recent statement in a publication of the staid United States Bureau of Agriculture, when we noticed the sentence "cube roots are not yet available commercially."

We still think Dr. R. C. Roark, of that department, had his tongue in his cheek as he wrote that sentence, but further investigation revealed the fact that "cube" is a South American plant and like most other plants, it has roots. (The plant's name, incidentally, is pronounced koo-bay.) In the course of this reading, we learned further that the cube plant has been found to contain a substance called rotenone which has been found to be an excellent insecticide. The Department is therefore urging the Malay States to grow rotenone-bearing plants on a commercial scale for

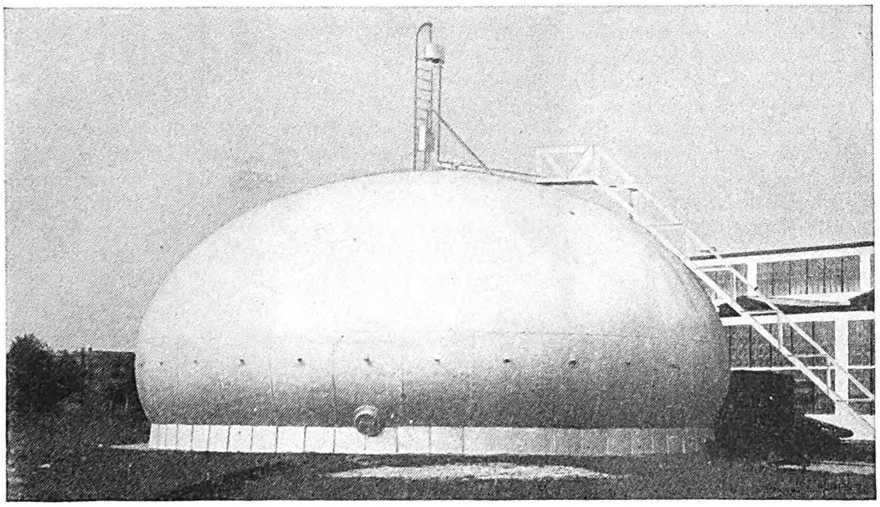
American trade. This new insecticide is found in quantities up to 7 percent in the root of the South American cube plant, up to 5.5 percent in derris roots, and to a lesser extent in three other plants. The cube plant now grows in a part of South America where the climate is similar to that of the Malay States and surrounding countries.

Tests by the Department of Agriculture indicate that rotenone is highly poisonous to both sucking and chewing insects. In tests conducted privately, rotenone was fed to dogs, cats, sheep, and chickens in quantities up to 1 grain per pound of body weight and no injury was noticeable.—*A. E. B.*

KETOGENIC DIET IN EPILEPSY

IN 1921 it was suggested that children with epilepsy might have the number of their attacks greatly reduced by providing them with a diet low in protein and containing large amounts of fat as compared with the amount of sugar taken into the body. This is called a ketogenic diet, because it tends to produce an excessive amount of ketones and their derivatives in the blood and in the excretions. The diet must be carefully watched, since an excessive amount of this substance produces serious symptoms.

Recently, Drs. Henry F. Helmholz and H. M. Keith have recorded the results of this diet on 272 children who had suffered with epileptic attacks. Two hundred forty-three children with epilepsy of unknown origin, in that the attacks could not be related to any disease or surgical disturbance, were treated by this diet. One hundred seventy-one of these children cooperated fully. One hundred forty-one children had been on the diet more than a year and 30 had been treated less than a year. Of the 141 patients treated for more than one year, 43 patients had remained free from epileptic attacks from one to seven years, and 32 others had shown definite improvement, as evidenced by the decided improvement in the number and severity of the attacks and by improvement in their general demeanor.

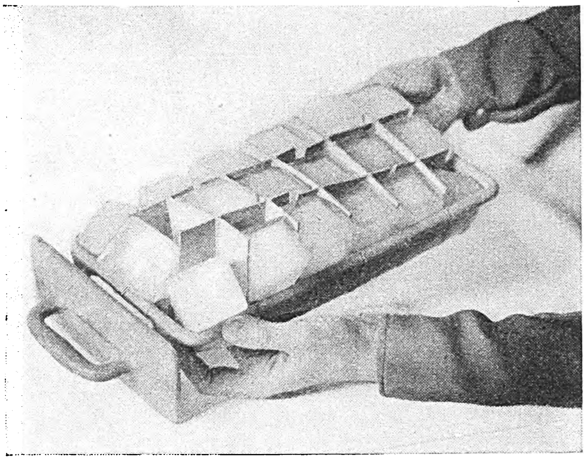


Looking like a huge drop of water on some oily surface, this Hortonspheroid holding 10,000 barrels of oil, was built for experimental purposes at Chicago

It has been argued by some observers that dehydration of the body is an important factor in the lessening of the convulsions. The investigators admit that this plays a part, but do not believe that it is the only factor.

Apparently 30 percent of the patients with epilepsy of unknown origin are freed from convulsive seizures by the use of this diet and, under completely controlled conditions, as many as 37 percent may be relieved of their disturbance. It is, of course, impossible to keep such children in hospitals over many years, and it becomes necessary for parents in the home to learn how to handle the diet and to take care of the child properly.—*M. F.*

Ordinary ice cube trays of automatic refrigerators are unsatisfactory because it is difficult to remove one or two cubes without emptying the tray entirely. A flip of the finger, however, is all that is necessary to remove just the number wanted from this new tray developed by the Frigidaire Corporation. It is made of strong rubber on a rigid steel rod frame



CHEMICAL PARADOX LEADS TO BETTER INSULATED WIRE

RUBBER is a non-conductor of electricity. Carbon black is a conductor. Therefore, it would appear natural that the admixture of carbon black in rubber would increase the latter's conductivity. In fact, this has been generally assumed to be the case until W. B. Wiegand and C. R. Boggs, in a recent issue of *Industrial and Engineering Chemistry* disclosed experimental evidence to the contrary. As a matter of fact, up to about 10 percent, by weight, of properly made and dried carbon black may be added to each 100 parts of rubber hydrocarbon present in rubber insulating compounds with marked improvement in dielectric strength, resistivity, and power factor, and without serious increase in dielectric constant of the rubber insulation.

The exact amount of carbon black required depends somewhat on which electrical property is to be brought to its maximum value.

This discovery is of importance to the makers of insulated wire who use a rubber covering next to the metal. In fact, these results would seem to render advisable the rewriting of many specifications dealing with rubber insulating compounds, and thus make it possible to apply the well-known beneficial effects of carbon black compounding—improved toughness, density, wearing resistance, imperviousness to light, tear resistance, and so forth—to the electrical insulation field, from which it has hitherto been barred.—*A. E. B.*

NEW OIL TANK HAS UNIQUE SHAPE

IF you were to visit certain oil company properties in Texas you would see unusual steel structures which have the appearance of giant mushrooms breaking through the ground. They are a new type of storage tank designed by the Chicago Bridge and Iron Works.

The Hortonspheroid, as this unusual shaped tank is called, is used to store high-test gasoline and other volatile oils. Such liquids are placed in the tank and the tank closed tight to prevent evaporation loss taking place.

It is possible to close the Hortonspheroid tight because it is designed to withstand a certain pressure, usually 10 or 15 pounds per square inch. As the temperature rises, the pressure increases but no vapor escapes. Each installation is, of course, equipped with a safety valve.

But why the unusual shape? It is simply the shape which a flexible container would take if filled with liquid and subjected to a few pounds pressure. It is the most natural shape for such conditions and, by the way, the most economical one, as all of the metal used in its construction is used effectively.

SWORD SWALLOWERS

THE sword swallower is able to pass a long knife down his throat by developing a special agility in the movement and by developing also the ability to breathe by movements of the ribs without moving the diaphragm. That fact was recently determined by three French physicians who subjected two sword swallowers to a

Seated within the cabin of a large airplane, the young lady above wears the parachute harness which is covered with a velour jacket. At right, she has snapped the simple parachute hook into the harness ring

physical examination, using both the X ray and the esophagoscope, an illuminating device which enables the physician to look into the tube through which food passes when swallowed.

The use of this device, the esophagoscope, revealed the fact that there were no special abnormalities of the esophagus nor was its lining full of scars as might have been the case if the swords had cut it. The evidence indicated that the sword is passed down by making a straight line through the mouth, throat, and esophagus, and that cutting is avoided by holding the diaphragm still in the manner that has been mentioned. In order to be a sword swallower one has to be especially built as well as trained for the purpose.—*M. F.*

A QUICKLY ATTACHABLE PARACHUTE

WITH more and more travelers using aerial transportation, the question of parachutes for passengers in cabin airplanes becomes increasingly important. The Russell Parachute Company has developed a quick attachable parachute which promises to be most useful.

The passenger wears a harness covered by an attractive velour jacket. The velour-faced parachute pack is placed conveniently in a metal rack. The pack can be instantly removed from its rack, grasped by the hand holds on either side and with one quick movement engaged to the single steel hook in the harness breast plate.

The pack is in no wise different from the ordinary Russell 'chute and acts just as efficiently and dependably.—*A. K.*

A ROTOR AIRCRAFT

RECENTLY *The New York Times* published an interesting story on a "rotor aircraft," a photograph of which we reproduce here.

Piecing together the newspaper story and what we can deduce from the photograph of the craft (built mysteriously on a barge moored in Long Island Sound off Mamaroneck, New York) we analyze it as follows:

In the center there is a short fuselage or nacelle in which there are: a tandem cockpit; a Wright Gipsy, 90 horsepower, air-cooled engine used to drive the rotors; and at the front end, another engine driving a conventional tractor propeller with three blades.

The nacelle is mounted on a conventional twin float alighting gear (built by the Edo Aircraft Corporation).

The tail surfaces are not mounted at the end of the nacelle, but are carried by booms and outriggers.

The front engine and propeller constitute the propulsive system, differing in no wise from the ordinary propulsive system.

The Wright Gipsy engine, by some species of gearing keeps two large rotors in movement, one on each side of the fuselage. These rotors have a combined span of slightly less magnitude than would be the normal span for a seaplane of this size. The rotors are two feet in diameter and carry sheltering circular disks four feet in diameter at their ends.

At the time of the Flettner visit to America in his rotor driven ship, *Buckau*, there was much speculation as to the possibility of employing a rotor as the sustaining element of an aircraft. Theoretically, there is nothing impossible in this. When a cylinder is rotated in an airstream it experiences a side force of considerable magnitude. The principle of this side force was discovered by a German scientist by the name of Magnus more than 60 years ago. The Magnus principle explains the swerve of a baseball.

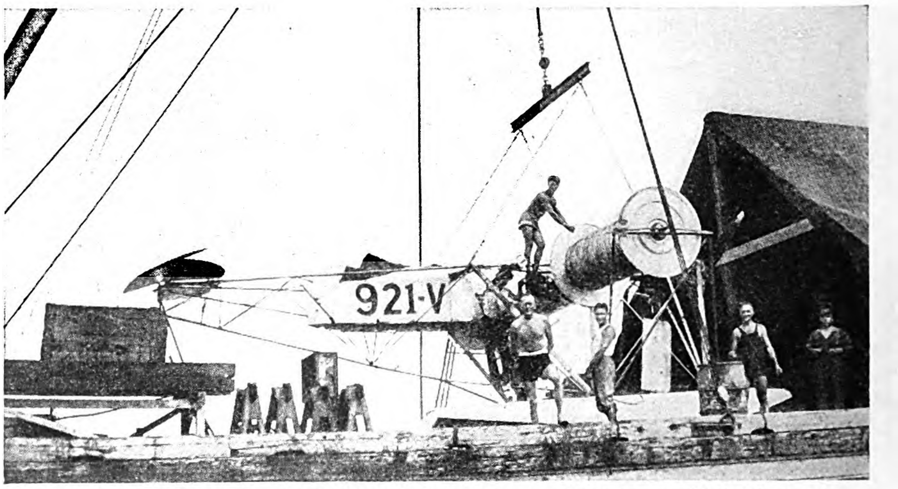
If the rotor aircraft is set in forward motion by the pull of the tractor propeller, and the cylinders are rotated so that the upper side is moving into the wind, the force acting on the lower side becomes a vertical or lift force.

For the same projected area of rotor, it is possible to obtain several times the lift of an ordinary wing—perhaps seven or eight times as much. Therefore the projected area of the rotor can be considerably smaller than the area of the equivalent airfoil and it is conceivable that for the same gross weight a more compact sustaining system can be used.

There are, however, two great difficulties to overcome. The ordinary airfoil, when the engine fails, acts very well in a glide. If the Gypsy engine should fail, the rotors ceasing to rotate would be deprived of lift and the craft might fall very rapidly. The other difficulty is one of efficiency. From experiments made by the writer of this note, it would appear that even when a long slim rotor is employed, and large sheltering disks are placed at the ends, the lift-over-drag ratio—the ratio of sustaining force to resistance of the rotor—is only five or six. For a good airplane wing, this ratio of lift to drag may be as high as 20. Therefore high speed and efficiency become difficult of attainment with a rotor as the sustaining element. It is clear that no rotating lifting element can be as efficient as a beautifully cambered wing. Perhaps the mysterious designers are perfectly aware of these facts and have already met the difficulties by advanced research. We shall await further news with real interest.—*A. K.*

GROOMING THE *DO-X*

THE Dornier *DO-X* is being actively prepared for its forthcoming flight across the Atlantic to the United States. Since its initial flight, the giant flying boat has undergone a number of important changes. In its early form, the power plant consisted of 12 air-cooled Jupiter engines



Wingless airplane, an adaptation of the Magnus principle on which Flettner's rotor ship operated, on the barge on which it was built in Long Island Sound of 475 to 500 horsepower each. The air-cooled engines were disposed in tandem in six nacelles. Some unofficial reports had it that the rear engines did not cool sufficiently well, particularly when taking off from the water. Other reports gave the giant boat a somewhat low performance. The change to 12 Curtiss Conqueror water-cooled engines of 600 horsepower would tend to substantiate the truth of both views.

With the water-cooled engines shown in the accompanying photograph of the *DO-X*, the radiator is in front in the slipstream of the front propeller, and both engines have an equal chance of cooling.

Those who remember the photographs of the *DO-X* published previously in this magazine, will note two other important changes. A small auxiliary wing, placed some four feet above the main wing, formerly connected all the engine nacelles. This wing has disappeared, and there is now but a simple streamline brace running from nacelle to nacelle in its place. Our opinion is that the interference between main wing and auxiliary wing was found to be detrimental to efficiency.

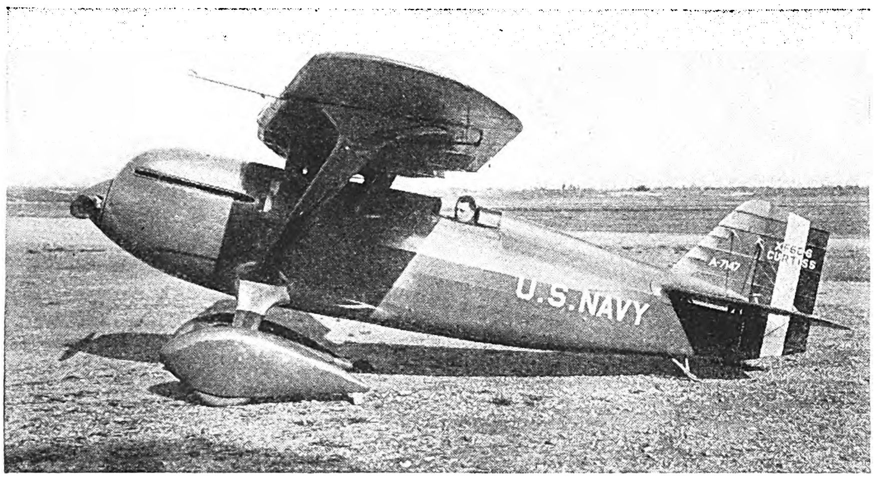
Another change is in the support of the nacelles above the main wing. This used to be in the form of a single gigantic streamline strut. Now this support is in the form of struts and braces of more conventional dimensions. Here, again, the large streamline strut probably diminished the lift and efficiency of the main wing. The large streamline support *per se* may have had less resistance than the present exposed nacelle bracing, but the interference between large strut and wing was another matter. The interior of the cabin has been re-decorated and re-furnished for the comfort of passengers on long flights. The interior now looks as comfortable as the salon of an ocean liner.—*A. K.*

THE SECRET OF AVIATION SPEED

CAPTAIN Frank Hawks, who recently crossed the continent in half a day, is an exponent of aviation speed. To an interviewer of *The New York Times*, he said, "I believe this last trip did prove that an aerial pony express on a 13- to 15-hour schedule between New York and the west coast is practical to-day. Why waste time loafing along at 100 miles an hour when planes can be built to fly 200 to 300 miles right now? Five hours to Miami, 15 hours to the Canal Zone, three to four hours to Chicago. That is the speed for our bankers who must send interest-bearing securities, and that is the speed our designers and engine builders must prepare for and prepare for soon."

The National Air Races at Chicago certainly backed-up Captain Hawks' point of view. This year saw the application of still more power, and also increased refinement in streamlining.

The picture of the re-vamped Curtiss Hawk pursuit plane serves to explain high plane speed. Here is a comparatively small plane, powered with a 600 horsepower Curtiss Conqueror engine. This engine, with tremendous heart, is small of body. It is completely enclosed in the beautifully streamlined body. It is water-cooled, yet we do not see a radiator! That is because the radiator is part and parcel of the wing. The cooling surface is also the covering surface of the wing, with water circulating in a multitude of concealed tubes. Cooling is thus obtained without any expenditure in head resistance. The wheels are streamlined in so-called "pants." There is but one wing, and the strut ends are carefully faired into this wing. The landing gear consists of but two cantilever struts, one on each side. There can be little further refinement in the attempt to gain speed.

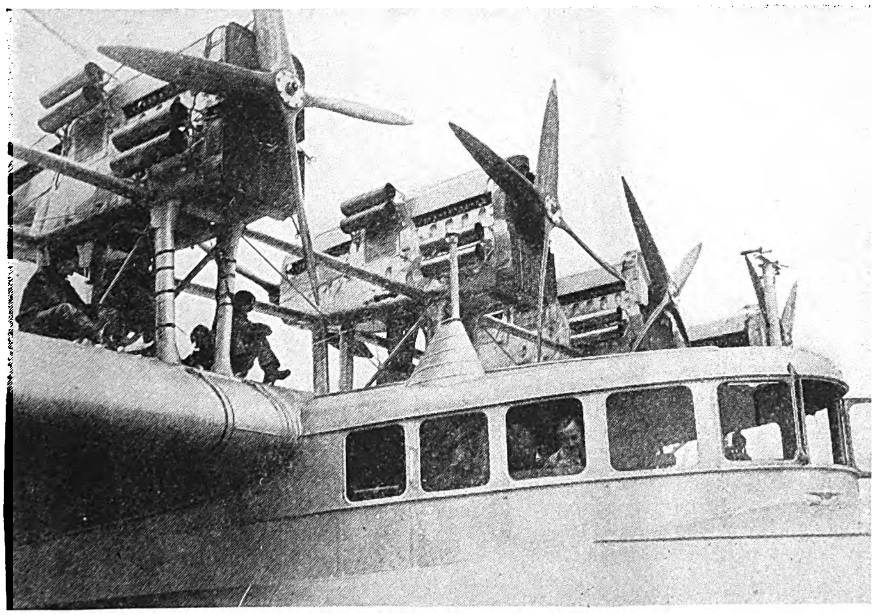


Trophy-winning Curtiss Hawk pursuit plane rebuilt for better performance. Most of the features described in the accompanying text are visible in this view

Such aerodynamic efficiency is part of the secret of airplane speed; lightness of structure is another part; and lightness of motor for high power is yet another. But there is one fundamental difference in principle which differentiates the airplane from all other methods of transportation as regards speed.

In all vehicles, be they surface vessels, trains, airships, or automobiles, the air resistance goes up as the square of the speed; the horsepower as the cube of the speed. That is why an ocean liner cannot be pushed beyond 30 knots or so, without the use of absolutely prohibitive power.

But in the airplane, the resistance is independent of the speed. It is dependent only on the aerodynamic fineness of the plane. If the fineness is high—if the ratio of lift to drag is 15—then one pound of weight will require only one pound of pull, no matter what the speed. Therefore speed can go up indefinitely. Some authorities claim 500 miles per hour to be the limit, because after that, air friction will set the plane on fire! But 300 miles an hour as a commercial speed is certainly within the limits of possibility.—*A. K.*

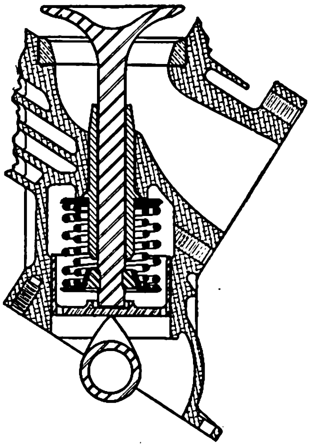


The Dornier *DO-X* in slightly revised form, with water-cooled Curtiss Conqueror engines, now being prepared for its forthcoming flight across the Atlantic

AVIATION FINANCES

AFTER the mad, though happy days of 1929, American aviation is suffering from the same depression that other industries are meeting. The President of Air Investors, Harvey Williams, paints a gloomy picture in his report summarizing 1929 and first-quarter-1930 conditions. The most important holding companies are probably United Aircraft and Transport, Curtiss-Wright, and Aviation Corporation. Aviation Corporation reported a first quarter loss of 863,651 dollars as compared with a loss of 1,441,000 dollars for the last six months of 1929. Curtiss-Wright suffered a loss of 1,620,920 dollars as compared with a loss of 668,000 dollars for the full year of 1929. United Aircraft and Transport reported earnings of 39 cents a share as compared with 89 cents for the first quarter of 1929. Inventories are still heavy, smaller manufacturing companies are disappearing, and production is very low. But there is a brighter side to the picture!

Colonel Clarence M. Young, Assistant Secretary of Commerce for Aeronautics, gives a totally different viewpoint in his report to Mr. Hoover.



Unconventional valve mechanism of the new inverted airplane engine

About 18 months ago, 35 companies were operating 59 different scheduled airlines over the airways and were flying a total of 69,000 miles every 24 hours.

At the present time there are 45 such companies engaged in the transportation of mail, passengers, and express, flying approximately 120,000 miles per day. These 45 carriers now operate 137 different routes.

Colonel Young foresees great progress when the provisions of the Watres Airmail bill are given full effect.

The first result under this bill will be the extension of the airmail to various parts of the country not now being served, because it will permit the Postmaster General to utilize the facilities of existing passenger lines.

Second; it will assist materially in the establishment of a more comprehensive passenger service throughout the nation by permitting present airmail carriers to go into the passenger transportation business.

While private flying is still lagging behind, this enormous and rapid growth in transportation will eventually give the manufacturers ample scope. More lines will mean more pilots, hence more students, hence more training planes.

No matter how gloomy the financial statistics of earnings, losses, inventories, assets, and so on, may look, the future of aviation is just as sound as ever. The slump is certain to be followed by a rapidly increasing prosperity of the whole industry. —*A. K.*

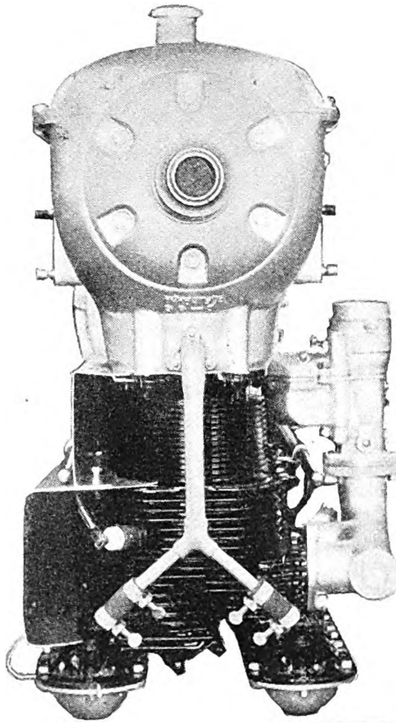
LOUIS CHEVROLET'S AIRCRAFT ENGINE

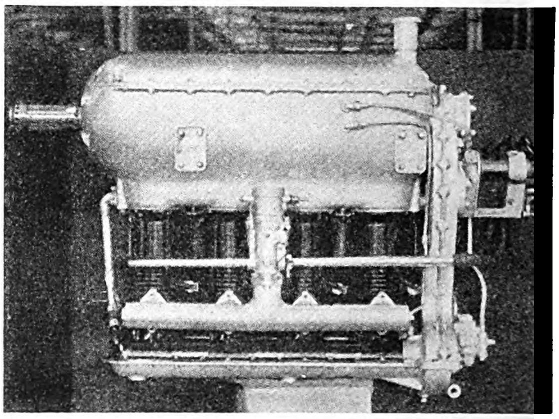
WELL known as the winner of many automobile races and the designer of racing automobiles, Louis Chevrolet has now designed an excellent aircraft engine, the Chevrolet "333." The fashion in low-power motors for aircraft now seems to run to the inverted, cylinders-in-line type, and it is to this category that the 333 belongs. The inverted engine, with the propeller-thrust line at the usual position, gives the pilot the best possible vision forward; the top of the crankcase is well below his eye, and there are no cylinders, exhaust stacks, or other impediments to sight.

The specifications of the 333 are interesting because they indicate that the popular four-in-line air-cooled type of engine is increasing in power and decreasing in weight.

Bore of the 333 is 4.5 inches; stroke is 5.25 inches; and piston displacement is 333 cubic inches (hence the name of the engine). It is rated at 120 horsepower at 2100 revolutions per minute and the weight (dry) is 260 pounds. Fuel and oil consumption is less than half-a-pound per horsepower-hour. (Aircraft engineers never think in gallons of fuel but in pounds, because weight is the important item rather than cost as is the case with the motor car owner.)

The air to cool such an engine must be carefully directed; the front view shows the scoop at the left side of the engine. Because of the special type of head, the cooling air passing through the scoop has no interference from the exhaust stacks—which are below—and strikes directly on the hottest part of the engine.





***Above:* Front view of the Chevrolet 333 engine showing, as a black square at the left, the scoop which directs the cooling air to the hottest part of the engine. *At right:* Side view of the engine. Looking over the smooth crankcase of this inverted engine, the pilot's vision is not obstructed**

The valve mechanism of the engine is unconventional and deserves special mention because the valves are actuated directly through lifter cups of Nitralloy steel. The cams strike the lifter cups a trifle off center, causing each cup to rotate every time it is struck. The valve springs are both wound in the same direction and each time the valve operates these springs have a tendency to twist the valve, thereby equalizing the seat. The entire valve mechanism is in a constant bath of oil and it is claimed that no adjustments are necessary. This should certainly be a great relief to the aircraft mechanic!

The special exhaust outlet enables the stacks to be placed under the engine, so that cooling air is not impeded and the exhaust pipe can be most conveniently located right under the engine. Carburetion is supplied by a Zenith down-draft carbureter. The down-draft principle is being rapidly accepted in aircraft practice.—*A. K.*

DO AIRLINES PAY THEIR WAY?

AIRPLANES do not pay their way, according to M. Henri Bouché, Editor of *L'Aéronautique* who presented a formidable statistical monograph to the first International Aviation Conference of the League of Nations.

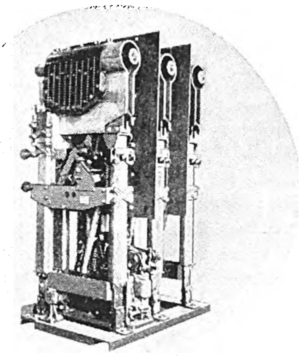
Each mile flown by commercial transport planes in 1929 cost British taxpayers about six dollars for lines going to distant parts of the Empire, and $1.28 for British-European lines. The French taxpayer suffered to the extent of $1.09 a mile, and the German 70 cents. In the United States we are proud of the fact that there are no subsidies to our airlines. But M. Bouché is of the opinion that, taking into account the high rates charged for airmail—considering weight, much higher than those paid by passengers—there is an indirect subsidy of about 70 cents per mile flown.

"The great size of the United States, its huge volume of urgent business, and other conditions make it the promised land of commercial aviation, yet even there the airlines enjoy only the undeniable promise of future prosperity and meanwhile live with the help of postal subventions and private subventions in the form of the large amounts of capital they were able to find during the last two speculative years."

This may be true, but the United States is reducing its mail contract rates, new capital is not being put into the industry, and traffic is growing rapidly and steadily. In a very few years American air transport will be an entirely self-supporting industry, which is far more than is probable in Europe.

M. Bouché has found, however, two entirely profitable airlines, both outside of

Whoa, there, You Ions...



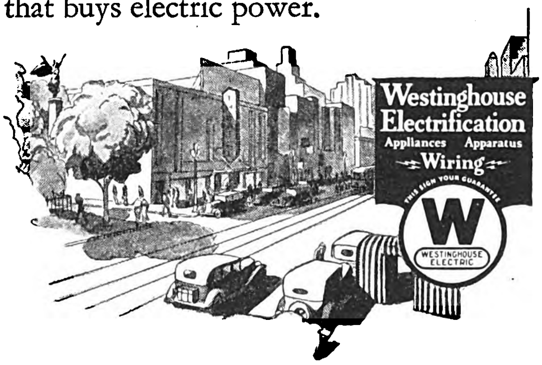
Out of the mercury arc tube — that odd-shaped bubble of glass with horns at the sides and a pool of quicksilver in the bottom — has come new light on one of the electrical industry's oldest problems.

For years research men had sought to control the arc that flashes between contacts every time a high-power electric circuit is broken. Several methods had been applied with practical results; yet the basic principles of arc formation and control remained unknown.

Then, not long ago, an engineer in the Westinghouse Research Laboratories, while working on applications of the mercury arc tube which demanded accurate arc control, concluded that the impetuous energy of any arc was due to the impetuous ions that compose it. "Harness the ions," he told himself, "and you harness the arc."

So successfully is this principle applied in the new De-ion circuit-breaker that heavy voltages can now be interrupted in open air with scarcely a flash. The electrical industry hails it as revolutionary. Important improvements are effected in a vital class of electrical equipment which the public rarely hears about—yet on which depends that smooth 24-hour-a-day flow of current now taken so much for granted.

Through discoveries and developments such as these Westinghouse research helps to give homes, industry, and transportation more value in exchange for the dollar that buys electric power.



Tune in the Westinghouse Salute over WJZ and the coast-to-coast N. B. C. network, every Tuesday evening.

Westinghouse

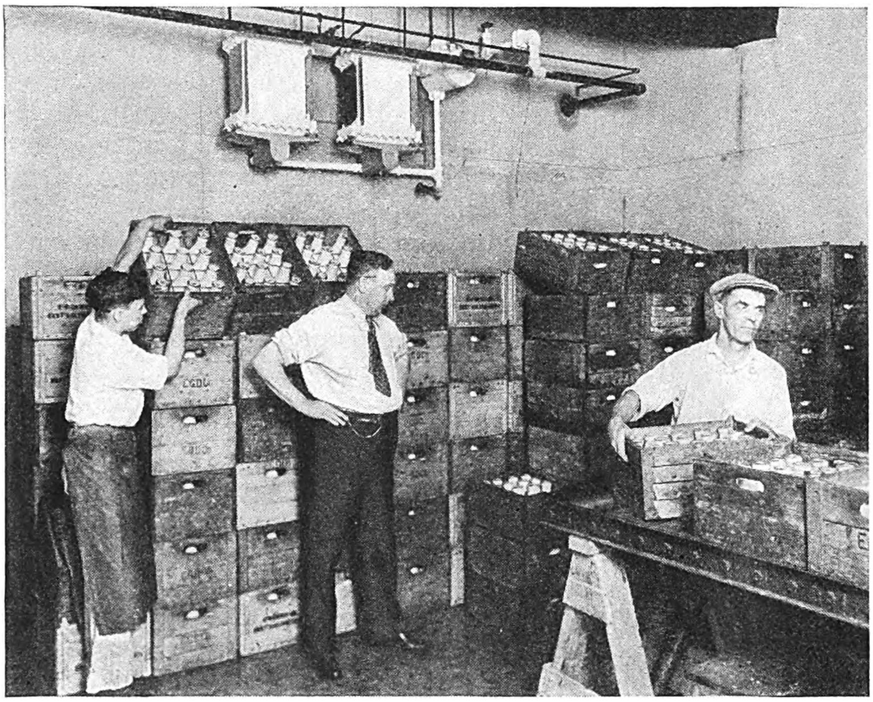
Europe and the United States. One is the German Scadta in Colombia, the other the Junkers Company in Persia. Exceptional geographic conditions enable these companies to charge what the service is really worth, namely three to six times the European air rates.

The statistics for 1929 will be very encouraging to American readers. During that year, the world had 137,000 miles of regular airways on which 2000 planes carried 600,000 passengers and 14,000 tons of freight. The United States carried 165,000, or more than one fourth of this number of passengers, and had a scheduled flying mileage of 21,000,000 while the next in rank, Germany, had only 7,000,000 flying miles during the same period.—*A. K.*

STORAGE PLANT REFRIGERATION UNIT

THE science of food preservation, which has passed through a series of marked refinements during the past few hundred years—from the days of spice application to the present era of automatic electric refrigeration—is still very much the object of the engineer's attentions.

An ingenious piece of apparatus that represents another step in the improvement of refrigerating equipment has just been perfected by the Grinnell Company. This device, known as the Unit Cooler, takes the place of the maze of pipe coils that form a regular part of the refrigeration system in milk plants, storage rooms, meat plant storage rooms, warehouse vegetable quarters, and many other commercial rooms that require conditions conducive to food preservation. The dimensions of this cooler are only 18 by 18 by 19 inches, as contrasted to the 600 lineal feet of pipe employed in the old system, and weighs but 300 pounds as contrasted to three tons of pipe coil.



A refrigerated storage room which has no maze of pipes nor any drip of condensed moisture. The automatic refrigerating unit is shown on the wall at left

With the Unit Cooler, an automatic defrosting process is carried on throughout the day. The air in the room is therefore always sweet and refreshing. In addition there is a uniformity of temperature in the room that was lacking in the old system, and that is highly desirable in a commercial installation.

The liquid refrigerant that feeds an automatic refrigeration system is controlled in this apparatus by a new device known as the liquid level control. This prevents an overfeeding of refrigerant to the system.

The small size of the Unit Cooler also makes it applicable to domestic usage. The device may be easily transported from one location to another, a feature which makes entirely feasible a system of household refrigeration and humidification comparable to some of the installations now employed so successfully in theaters and retail stores.

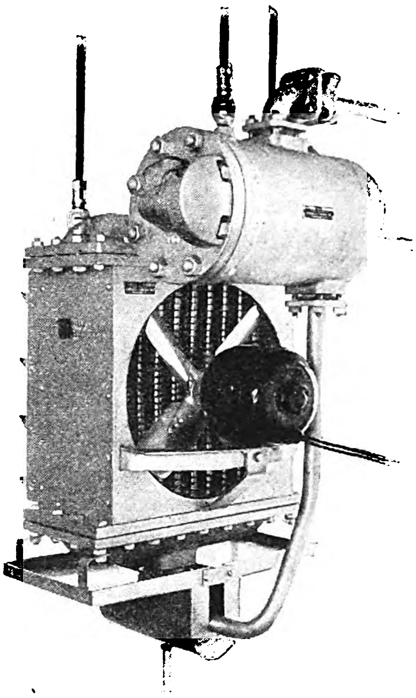
AIRCRAFT PARTS FROM SALT WATER

SALT water is the source of a metal that gives promise of playing a vital part in aircraft construction in the future. The salt brines of Michigan constitute the important raw material for magnesium production in the United States, according to John A. Gann in *Industrial and Engineering Chemistry*.

The natural brine, containing magnesium chloride, is pumped from wells 1200 to 1400 feet deep. By a series of treatments, the other salts in the brine, namely sodium chloride, sodium bromide, and calcium chloride, are removed, and the remaining magnesium chloride is evaporated to a white powder, dried, and finally fused in an electrolytic cell, where the metallic magnesium is made.

The most striking property of this metal is its extreme lightness. With a specific gravity of 1.74, it is only two thirds as heavy as aluminum, one fourth as heavy as iron and, one fifth as heavy as copper. By proper alloying and heat treatment, magnesium alloys are obtained with strength and toughness that permit them to compete successfully with other engineering metals. These properties, coupled with their high specific heat, electrical conductivity, and thermal conductivity, immediately point out many practical fields of application.

Simultaneously with the development of aeronautics has come a demand for metals with a maximum strength and minimum weight. This call was first answered by the light aluminum alloys, and now more recently by the ultra-light magnesium alloys. The more important possible applications in this field include crankcases, oil pans, seat frames, superchargers, instrument housings, control levers, impellers, and pistons. Results to date on both laboratory and flight tests indicate a big development in the forged propeller business. The properties that fit these magnesium alloys for aircraft use are their extreme lightness, high strength, and good fatigue endurance —that is, their ability to withstand repeated applications of stress.



Rear view of entire refrigerating unit showing the fan which plays a stream of air on the cooling pipes

The advantages derived from the use of light magnesium alloys are by no means limited to aeronautics. Distinct improvement in performance has been obtained when using them in many of the reciprocating parts of machinery.—*A. E. B.*

FINDS NERVES MAY CAUSE EYESTRAIN

EYESTRAIN, so-called, is more apt to be the result of "nerves" than of any disease of the eyes, Dr. George S. Derby of Boston told members of the American Medical Association at their meeting in Detroit recently. Dr. Derby described a number of cases he had seen in which the patient recovered from his eyestrain when his bodily condition was treated and when the psychologic cause of his eyestrain was explained and he was persuaded to use his eyes normally.

"If the general public could learn that

eyes are seldom strained, this would be a much happier world to live in," he said. "The fact of the matter is that the eye is provided with a large factor of safety and that healthy eyes do not become diseased even by excessive use."

Most of these cases of ocular neurosis, as Dr. Derby called it, are found in sensitive nervous persons. Fear is the commonest factor in these cases. Some ocular pain or discomfort makes the patient afraid that he is injuring his eyes permanently, that he cannot continue his occupation and perhaps will become dependent. Many of Dr. Derby's patients had given up their work and many pleasures, and were devoting themselves to resting their eyes as much as possible.

Dr. Derby asked opthalmologists not to overlook the psychologic factor in causes of eyestrain, and to treat the mental condition of their patients as well as to correct their vision with eyeglasses.—*Science Service.*

DIAMOND MATCH 9 FOR 1 SPLIT-UP

A PLAN for recapitalization of the Diamond Match Company provides for the formation of a new company with a capitalization of 1,000,000 shares of 6 percent cumulative participating preferred stock of 25-dollar par value and of 1,500,000 shares of no-par common stock, this stock to be distributed to present shareholders at the rate of five shares of preferred stock and four shares of common stock for each share held. In addition, if the plan is approved, a dividend of 25 dollars in cash will probably be declared prior to the transfer of the properties, good will, and business of the Diamond Match Company to the new corporation.

Stockholders were asked to deposit their stock with the Bank of America (N.A.) or Continental Illinois Bank and Trust Company on or before October 15.—*Barron's.*

10,000-DOLLAR RADIO IDEA CONTEST

WITH the opening, on September 25, of the Westinghouse Radio 10,000-Dollar Idea Contest, the Westinghouse Electric and Manufacturing Company extended to all America an invitation to join its cabinet designing staff. At that time, the company opened a nation-wide suggestion box with an offer of prizes totalling 10,625 dollars as an incentive for offering ideas for cabinets.

Anyone may compete except employees of the Westinghouse Electric and Manufacturing Company. The contest closes December 24, 1930, and all ideas must be in the mails before midnight December 24. The winners will be announced January 19, 1931.

The rewards for which those who accept the invitation and join the Westinghouse Radio "Idea Department" will compete, range from the first prize, a trip to Europe with all expenses paid or 5000 dollars in cash, to 25 prizes of 25 dollars each; and include between these limits the second prize, a 2000 dollar automobile of the winner's choice or 2000 dollars in cash; the third prize, a 1000-dollar check; five prizes of 200 dollars each; five prizes of 100 dollars each; and 10 prizes of 50 dollars each.

How to provide a RETIREMENT INCOME for yourself

Say good-by to money worries forever

THIS new Retirement Income Plan makes it possible for you to retire at any age you wish, 55, 60, or 65. You may provide for yourself a monthly income of $100, $200, $300, or more.

Suppose you decide to retire on an income of $200 a month when you are 60. Here is what you get:

1. An income of $200 a month, beginning at age 60 and lasting the rest of your life. You are assured a return of $20,000, and perhaps much more, depending upon how long you live. If you prefer, you may have a cash settlement of $27,000 at age 60 instead of the monthly income.
2. Upon your death from any natural cause before age 60, your wife or any other heir you name receives a cash payment of $20,000. Or if preferred, your wife receives a monthly income for life.
3. Upon your death from accidental means before age 60, your wife or other heir receives a cash payment of $40,000. Or if preferred, your wife receives a monthly income for life.
4. If serious illness or accident stops your earning power for a certain period, you will thereafter receive an income of $200 a month during such disability, even if it lasts the rest of your life.

How much does it cost?

A Retirement Income is paid for in small installments of only a few dollars a month. The exact amount depends on (1) Your present age (2) The age at which you wish to retire (3) The amount of monthly income you will want.

One of the great advantages of this Plan is that it goes into operation the minute you pay your first small installment. Even though you should become totally disabled, you would not need to worry. Your installments would be paid by us out of a special reserve fund.

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The Phoenix Mutual Company is one of the oldest, most conservative institutions in this country. It was founded in 1851, and has assets of over 135 million dollars invested in bonds and first mortgages and other high-grade securities.

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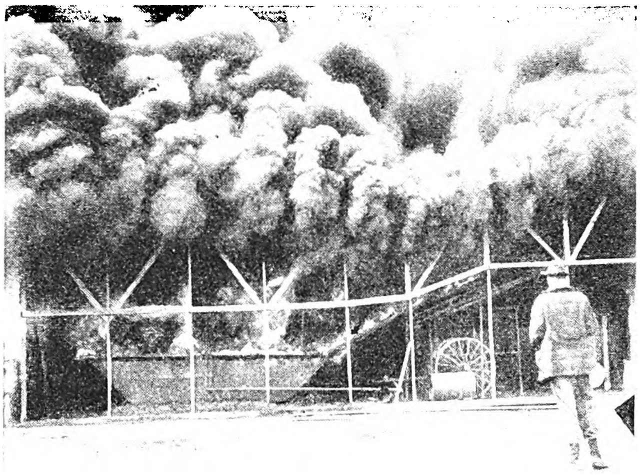
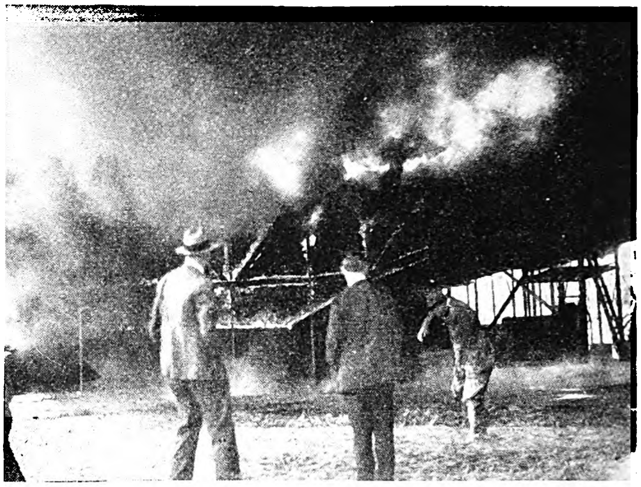
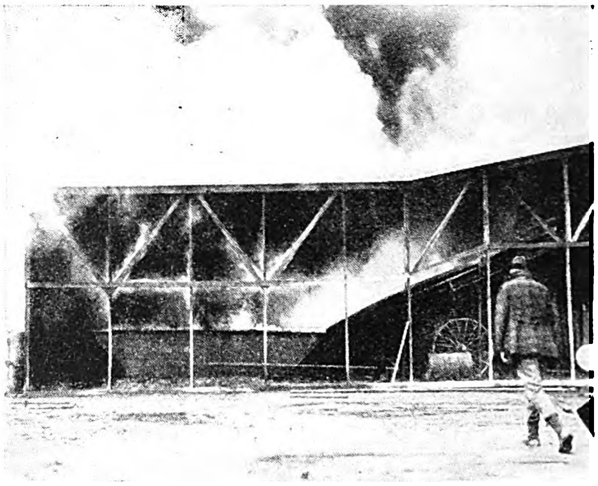






***Above, left:* Fire in a lacquer dip tank and drain board, such as is used for finishing automobile parts**

***Above, right:* Foamite is being released automatically, and is starting to smother the roaring flames**

***Right:* The dangerous fire entirely subdued. This photograph was taken 28 seconds after the one at the left above**

These prizes will be awarded to those submitting the best 48 original and acceptable ideas for beautifying radio cabinets. If a winning idea is submitted by more than one person, the full prize will be awarded each contestant. All prize winning ideas will become the property of the Westinghouse Electric and Manufacturing Company.

It will not be necessary to submit drawings of the ideas one enters in this contest—a written description is all that will be required; however, sketches may be submitted if desired, in which case they should be accompanied with explanatory text. A person may submit as many ideas as he wishes; each suggestion should be on a separate sheet with the originator's name and address.

The judges for the Westinghouse Radio Contest will be: Miss Helen Koues, Director of Good Housekeeping Studio; Miss Neysa McMein, famous artist; Miss Rosamond Pinchot, prominent actress; Raymond Loewy, famed Parisian artist and designer; E. B. Ingraham, Vice-President, Times Appliance Company, Inc., New York City; and A. W. Robertson, Chairman of the Board, Westinghouse Electric and Manufacturing Company.

Contest entry blanks and leaflets giving helpful suggestions for conceiving acceptable ideas are available at any Westinghouse radio dealer's store.

Ideas should be mailed to Westinghouse Electric and Manufacturing Company, Radio Department, 150 Broadway, New York City.

TOILET WATER DERMATITIS

THE intricacies of modern civilization have brought new diseases and unusual hazards into modern life. However, the use of cosmetics seems to go back to the beginning of woman's vanity, and certainly that was the beginning of woman herself! Among the most frequently used cosmetics are toilet waters. Recently specialists in diseases of the skin have been seeing occasionally cases of unusual pigmentation or brown streaks running down the back of the neck. The cause of these unusual disfigurations was not understood until a specialist discovered the relationship between pigmentation and the use of eau de cologne.

Freund applied eau de cologne to the forearm of a boy and exposed this surface to the sun and to sea water. The boy developed inflammation of the skin with pigmentation. The investigator then asserted that the offending ingredient was chiefly oil of bergamot. He then rubbed oil of bergamot on the forearm of the boy and obtained the same result. Since that time numerous cases are being reported by physicians to whose attention they have come.

There are, of course, other instances in which the ingredients of perfumes and toilet waters produce irritations and pigmentation without exposure to sunlight. In these instances there is a special sensitivity which manifests itself immediately after the perfume is used. The oil of bergamot is, however, the substance primarily responsible for the special form of irritation with pigmentation that is now called "toilet water dermatitis."—*M. F.*

CHEMICAL TRICKS WITH SUGAR LUMPS AND LACQUER

WE were eating luncheon together the other day, a fire-prevention engineer and a mere chemist, the latter hoping to pick up some novel kink in the spectacular science of fire-fighting to pass on to SCIENTIFIC AMERICAN readers through these columns.

"Speaking of fires," said the specialist, "did you ever try to burn sugar?" And taking a lump from the sugar bowl he applied a match. The sugar melted but did not burn. At his invitation, we tried to ignite another lump with the same results.

"Now," announced our friend, impressively, "I will make a few magic passes over this same lump of sugar and behold it burns, readily, and even fiercely."

"Marvelous!" we applauded. "How did you do it?"

Pressed for the explanation, the student of conflagrations explained that he had surreptitiously touched the corner of the sugar lump to some cigarette ashes after which it immediately caught fire. Having satisfied ourselves that a tiny smudge of cigarette ash "did the trick" every time, we began speculating as to the chemical cause of its action. After some high-spun theories had been hazarded, the expert explained that any salt of potassium seems to work the same way and that the ashes induced the flame simply by virtue of the potash they contain. This seemed sufficient explanation to our informant, so we refrained from the question which we longed to ask—why does potash induce burning? We were pretty sure he didn't know why because the only explanation we've ever heard is that the potassium acts as a catalyst, promoting oxidation and combustion. And we didn't want to embarrass our friend, lest he might neglect to give us the "story" we wanted. As proof that our tact was fruitful, we reproduce herewith three exclusive views of a recent spectacular test of a modern Foamite fire extinguisher.

The conflagration was started in a large dip tank and drain-board, such as is used in automobile factories for dipping such parts as mud guards into the highly inflammable enamel. One photograph shows the blaze gaining headway and threatening the complete destruction of the "factory." In the second one, the automatic foam engine has begun to apply a blanket of thick "suds." The last one shows the blaze completely subdued, just 28 seconds after the Foamite application began.

All of which would indicate that the fire prevention engineer is adept in the magic of chemistry applied either to sugar lumps or blazing enamel.—*A. E. B.*

GREATEST AERIAL BEACON RIVALS SUN

THE Lindbergh beacon, the most powerful aerial light ever erected by man, has been installed on a tower on the Palmolive Building, 602 feet above the city streets, to guide fliers to Chicago.

Equivalent to a half inch section of the sun and hypothetically equal to the brilliance of two billion half-inch candles set side by side, the lamp has a visible light beam of 500 miles, lighting engineers declare. They point out that while two billion candles would occupy the area of a city block, this amount of light is concentrated in a 60-inch carbon lamp weighing a little more than a ton.

While the light's beam is visible 500 miles away, at this distance, because of the curvature of the earth, it is at an altitude too great for airplanes to reach. For practical purposes, the authorities estimate the greatest visible distance to be 300 miles from Chicago.

This beacon, dedicated to Colonel Charles A. Lindbergh by its donor and designer, the late Colonel Elmer Sperry, inventor of the gyroscope, is defined as a monumental product of modern electric light engineering science.

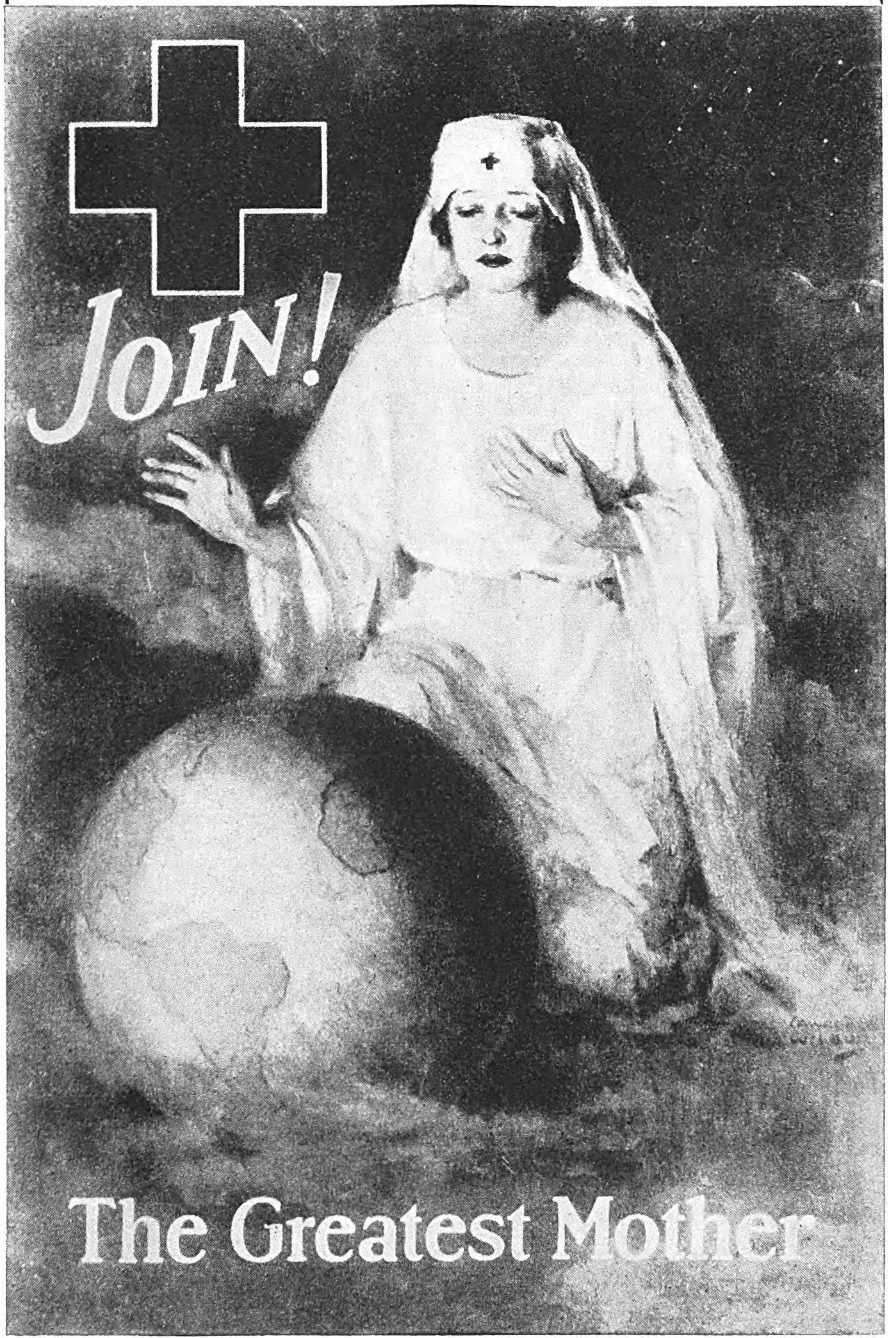
ASBESTOS INFLAMMATION OF THE LUNGS

WHILE the asbestos industry is more than 2000 years old, it has only within the past few years taken a prominent place among the great industries. With the development of the industry, physicians have begun to notice cases of extensive fibrous changes in the lungs due to the inhaling of the asbestos particles and inflammation of the lungs set up by the particles. When the material is taken into the lungs, it can be found in the tissues in the form of black particles. Similar particles are to be found in the sputum of the patient and indicate to the physician the source of the disorder. Drs. K. M. Lynch and W. A. Smith have described several cases in which these asbestosis bodies were seen in the sputum when the sputum was studied under the microscope. By the use of proper stain methods, they are given prominence. Thus there is provided for the scientific physician who is confronted with such a case a certain method of diagnosis.—*M. F.*

ELECTRICAL CONDUCTIVITY AT LOW TEMPERATURES

THE property of super-conductivity—that is, the disappearance of electrical resistance at very low temperatures—which has been discerned for lead, mercury, tin, iridium, and thallium, has been found by German investigators to apply to the carbides and nitrides of heavy metals. Thus the critical temperatures under which the resistance disappears is 9.3 degrees absolute for tantalum carbide. It appears possible

(*Please turn to page* 402)

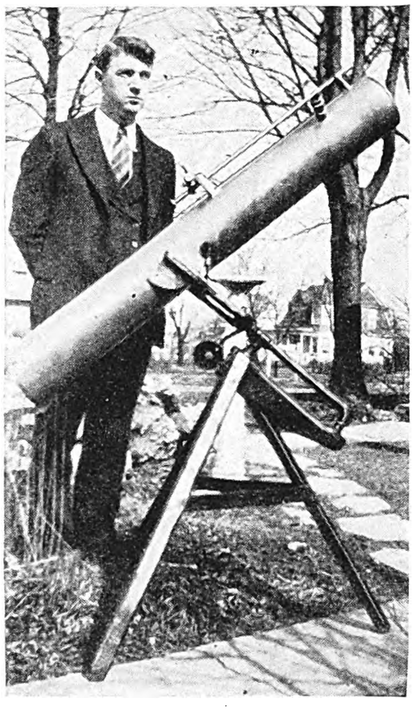


THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

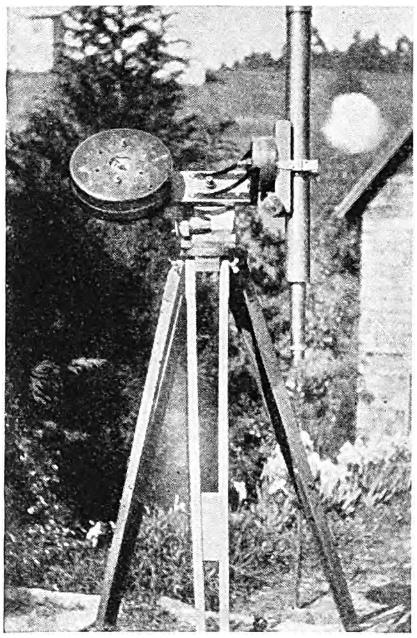
NOW that cold weather is peeking round the corner, amateurs soon will be ready to hibernate in cellar workshops, taking with them two disks of plate glass, some abrasive, and some pitch, to see what kind of a telescope can be knocked out of these "makings." This month, then, we reproduce, by way of inspiration, a number of descriptions of jobs already done by amateurs who found that the practical working instructions in the SCIENTIFIC AMERICAN book "Amateur Telescope Making" actually did instruct.

A. E. PARKE, 6453 Oliphant Avenue, Chicago, sends in a snapshot and says. "This is our first telescope which our boys and myself have just finished, a six-inch reflector which has turned out very satisfactorily. The craters on the moon and the moons of Jupiter are very distinct with a half-inch eyepiece. We have not yet had a chance at the other planets. The figuring of the mirror developed with very little trouble, and we have a total absence of color or distortion. Our mounting is made of pipe fittings on a wooden tripod and works very well. We have learned much in making this one and hope to have a still larger one."



A. E. Parke and his telescope

FRANKLIN B. WRIGHT, 155 Bret Harte Place, Berkeley, California, says: "While gazing at the Milky Way in the high Sierras I resolved to have a good portable instrument next time. The result is shown in the enclosed snapshot. It consists of a 60 millimeter (2⅜ inch) Bausch and Lomb objective costing 30 dollars, about nine dollars' worth of brass tubing and about six dollars' worth of wood, bolts and springs and other odds and ends for the mountings and tripod. Since I have no machine tools the mounting is designed to be made with nothing but ordinary tools which everybody has around the home. The bulky-looking counterweight consists of two old Chevrolet brake drums bolted together. It is adjustable in a wooden slot underneath."



Franklin B. Wright's refractor

E. LLOYD McCARTHY, 10 Powers Street, Canton, New York, a college student, sends in a photograph which shows that times have not changed since days we fondly recall; for the picture gives evidence that Sophomore McCarthy demolished a bridge in order to get a suitable pedestal for his telescope. Here is what he writes:

"The telescope has a six-inch mirror of 46-inch focal length; a one-inch prism; and a half-inch eyepiece. The mirror was polished on a lap of honeycomb foundation after failure with tempered rosin.

"That cast-iron base once did duty holding up a bridge railing. The bearings and axes are pipe fittings; the counterweight was made by casting a calculated amount of lead on a length of pipe. Two semicircular pieces of eight-inch strap iron grip the tube at its center of gravity.

"I have had some good 'shots' at four of Jupiter's moons as well as its belts; our own moon; and terrestrial objects. The other day I lectured about my telescope to one of the physics classes at St. Lawrence University, where I am a sophomore. Judging from the questions and comments afterward, about half of the class want to build telescopes of their own."

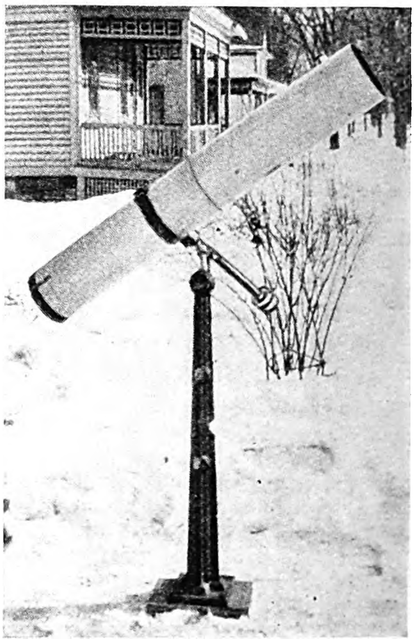
TURN now to page 71 of "Amateur Telescope Making" (the second, or 1928, edition) and you will see a telescope made by H. O. Bergstrom. Since then this enthusiast, who is a locomotive engineer at North Platte, Nebraska (P. O. Box 491), has turned out another—two more in fact, but one of the pictures he sends is out of focus so we can't reproduce it.

"Though it's a long time since you have heard from this 'T. N.' my enthusiasm in the work hasn't waned a bit," this Casey Jones (we'd like to ride behind him) writes. "I'm enclosing two photos. One of them is another six-inch reflector; the other is the eight-inch glass shown in the July 1928 number of SCIENTIFIC AMERICAN, with the mounting reconstructed. The equatorials for both these telescopes have a special 'North Platte type' quick-setting slow motion control, a real luxury for the amateur. The mount for the six-inch glass is made from an old cistern-pump stand and two Ford front wheel hubs. The other mount is made up of 'pump-stand' 1½ inch pipe fittings and two Ford transmission drums. The little 'star' standing by the six-inch glass is Marjorie Castell, aged four.

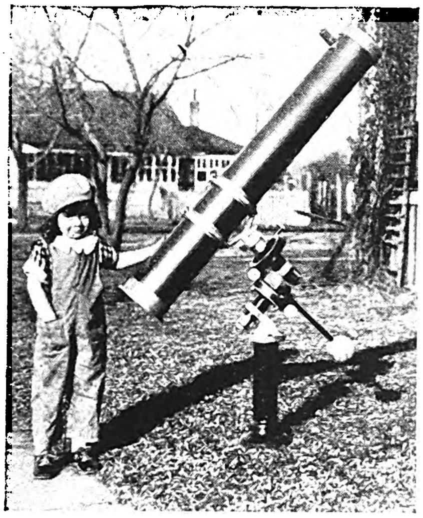
"I'm still at work on an eight-inch Cassegrain but on account of having very little leisure time the progress is slow.

"I have received quite a number of requests for a description of my earlier telescope, since it was published in the SCIENTIFIC AMERICAN. A few requests are still straggling in. Requests were received, among others, from Canada, Cuba, Australia and Java."

WRITES Paul W. Spain, 226 Seventh Avenue, North, Nashville, Tennessee: "Well, I finally got it finished. It is rather



McCarthy's "bridge type" mount

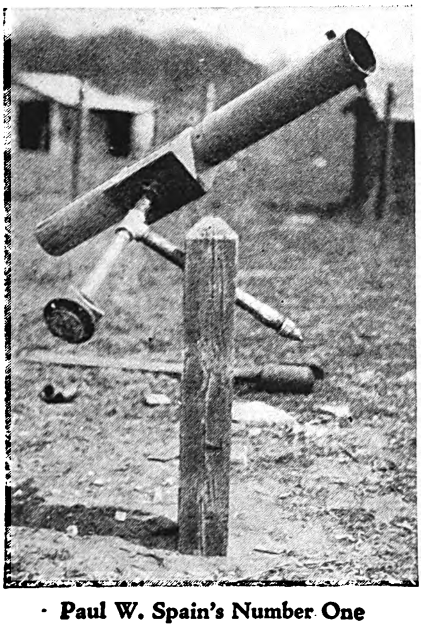


Engineman Bergstrom's telescope

crudely done, but I think it will do for a starter. The Foucault shadows were very well defined, however. I used a frosted 40-watt light in testing, and found that it gives a much better light. I was successful in my silvering the first time, probably due to beginner's luck. The tube is an old stove pipe found in a nearby junk pile.

"I am now planning a ten-inch reflector, with setting circles. The labor is certainly well repaid that is put into a telescope."

THE descriptions given above pertain to typical telescopes made by the average amateur bitten by the bug. We have on hand for publication a number of others, and these bread-and-butter jobs will be sprinkled in, as it were, with a variety of more out-of-the-ordinary things. For example there is a water-clock drive (and it actually works, too) by the old-timer Harold Lower; a telescope made in Australia; a 16-inch reflector mounted on giant sized pipe fittings; the new "milk pail" mounting discovered in Detroit; a circus telescope (Chrysanthemum our cynical office cat says they all are, but she doesn't know); a 12-inch Cassegrainian by Porter which is so smooth looking you'd want to take it to bed with you; also a 21-inch Cassegrainian by England's leading amateur, J. H. Hindle.



· Paul W. Spain's Number One

Jolt

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with this history of Man's struggle
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DO you smile at the people who thought the earth was flat? Are you contemptuous when you read how—when Galileo proved that light bodies fall as fast as heavy ones—people shrugged and called his experiments foolish?

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H. G. Wells, James Harvey Robinson, Richard Swann Lull—The New York Times and Tribune, the Philadelphia Ledger, etc., etc., have praised this book. Harry Elmer Barnes says, "It may work a greater revolution in human thinking than Darwinian evolutionary doctrines and their popularization. If there ever was a book which intellectual liberals should conspire to give the widest possible circulation, it is this one."

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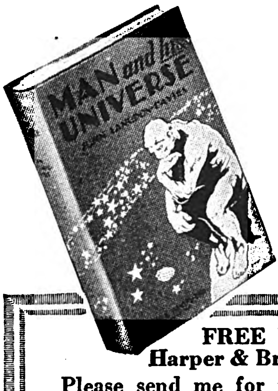

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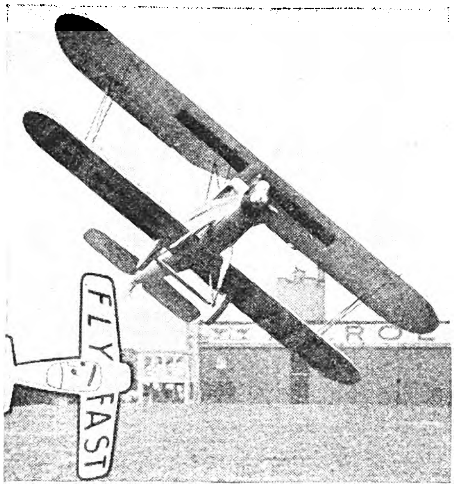

ONE OF 200 ILLUSTRATIONS

A Chandelle: The diagram represents a highly valuable way of showing how controls look when plane reaches position indicated. Black bar is the rudder. Black spot with line is the stick. Throttle is at top.

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 399)

that compounds exist in which the critical temperatures are still higher. At present this matter is entirely of scientific interest, since it does not seem to fall within the horizon of practical utilization as yet.—*A. E. B.*

FINGER NAILS IN TUBERCULOSIS

SHERLOCK HOLMES and other observant detectives remarked frequently on their ability to judge the character of the individual by his finger nails. A white line across all the nails is usually an indication that the person has been quite sick for some time.

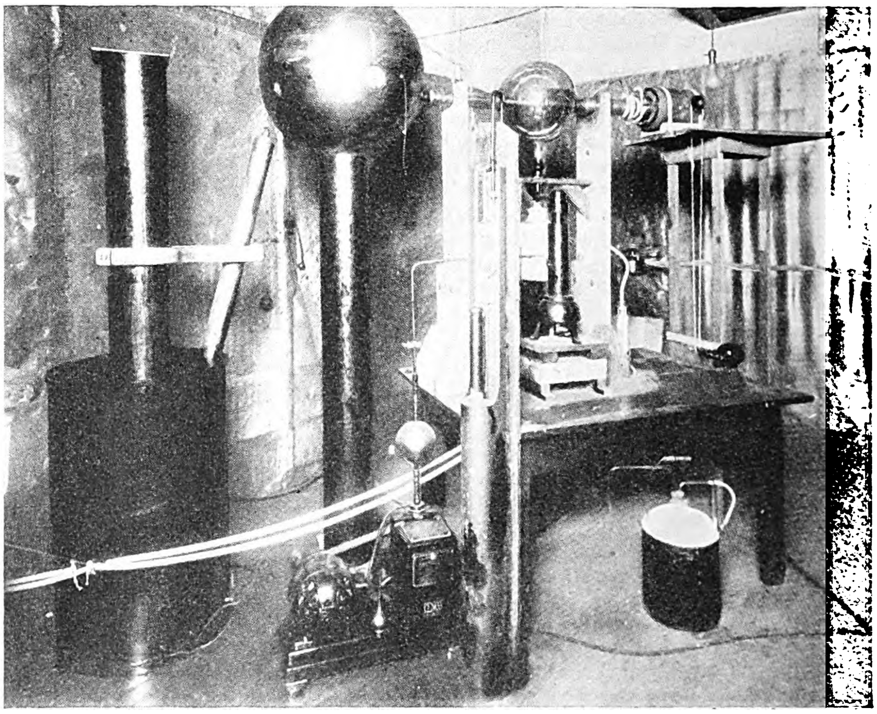
Dr. A. G. Hahn of the Trudeau Sanatorium made a special investigation of patients in that institution, and found that every one of fifty patients with active tuberculosis had pitting of the finger nails. This condition occurred in only three out of fifty patients with inactive tuberculosis, and was not found in any person who was normal. The pitting or depression appeared in the visible part of the nail about six weeks after the onset of the severe symptoms of the disease. The pits were found more often in the nails of the index and ring fingers and do not appear uniformly on the toe nails. Once the pits have appeared they naturally grow forward with the finger nail and are removed during manicuring.

More than 300 years before the Christian era, the school of Hippocrates mentioned the fact that downward curving of the nails was present in tuberculosis. Doctor Hahn found that normal people did not show such curving, 30 percent of the ex-patients had the condition, and 76 percent of the patients with active tuberculosis had downward curving nails.—*M. F.*

MAKES WELDS AIR-TIGHT BY ELECTROPLATING

AN interesting application of electrochemistry to a problem in steel welding is recounted by J. B. Calva in a recent issue of *Chemical and Metallurgical Engineering.* In building a tubular evaporator, the tubes were welded to the headers by the electric process, but on testing it was found that while the joints were mechanically strong, they were not air-tight, because of the presence of many minute capillary tubes produced by the electric arc.

Since this particular evaporator was intended to operate under a vacuum, it was necessary to make these welds air-tight. Caulking the joints proved vain. The next experiment was to induce the clogging of the capillaries with rust by promoting oxidation in their walls with a solution of ammonium chloride. This treatment also failed. Finally, a permanent remedy was applied. Around each of the welds, and concentric with the tubes, rings made of round structural iron, ¼ of an inch in diameter, were placed. These rings were held in place and insulated by means of small pieces of rubber which were compressed between the iron rings and the projecting ends of the tubes. The rings were then interconnected by means of copper wire and a water-tight wooden cover was



Recent experiments by Prof. J. S. Long of Lehigh University may procure for linseed-oil paint the same quick-drying properties as modern lacquers. The work has been conducted with the huge cathode-ray machine illustrated above. The rays from this tube were focused on samples of linseed oil for various periods and it was found that paint made from oil that had been "bombarded by electrons" for 10 minutes dried in half the time required for ordinary paint. The photograph shows the cathode-ray machine adapted for further experiments on the so-called drying oils. It is placed in a special room, the walls of which are completely covered with sheet lead to prevent the escape of the cathode rays

bolted to the flange. A piece of copper wire connected to the rings was made to pass through a rubber stopper which fitted a hole in the wooden cover.

An electrolyte made up of ferrous chloride, calcium chloride, and water was then poured into the tubes and in such an amount as entirely to keep immersed in it all the iron rings and welds. The electrolyte was kept as hot as possible by means of a steam coil.

The electric welding machine was then adapted for electroplating work by inserting in the magnetic field of the generator a slide-wire resistance. This was done in order to reduce the voltage at the terminals of the generator so as to limit the current to a density of 15 to 20 amperes per square decimeter, calculated on the effective surface of the iron rings.

The positive terminal of the generator was then connected to the copper wire coming from the iron rings and the negative terminal to the evaporator. After 24 hours of electro-deposition of iron on the welds, the evaporator was tested and the maximum expected vacuum was obtained. —*A. E. B.*

USE FLUE GAS TO PREVENT DUST EXPLOSION HAZARD

So many forms of dust are highly explosive that methods of preventing this hazard have long engaged the attention of chemists in the United States Bureau of Agriculture. One of the expedients they have developed is the use of an inert gas as the atmosphere to surround grinding operations and others that are apt to produce dangerous dust.

Such installations have been made at two hard-rubber grinding plants, a cork grinding mill, and a pyrethrum-flower grinding plant. A number of sulfur-grinding mills have adopted this method of preventing explosions, and a feed-grinding plant in the middle west is now installing one of the largest inert-gas systems in the country. The use of inert gas to provide protection in one of the large starch plants is being considered, and experiments are under way to develop methods of properly cleaning and conditioning the gas for such use. Fire extinguishers filled with inert gas under pressure, instead of chemicals, are now being produced and are finding a ready market in this country.

Methods of cleaning and conditioning flue gas to render it satisfactory for use as a preventive of dust explosion and fires are now being developed.—*A. E. B.*

SPRAY PAPER MULCHES TO AID CROPS

The use of mulch paper for covering the fields between furrows in order to help the soil retain moisture and to prevent the growth of weeds has been described previously in these columns. An interesting variation of this new idea is being tried out in Germany. Instead of covering certain crops with paper sheets, as is customary in America, a paper coating is sprayed on the fields.

The action of paper coverings results in many cases in a greatly increased production of certain crops, because the soil temperature is increased, weeds suffocated, pests destroyed, and the soil bacteria activated. The paper spray is said to be cheap, cannot be removed by the wind, and is not dissolved by rain. Its most obvious advantage over the use of paper in sheet form is its ease of application. What the effect on the growing plant will be has not yet been determined.—*A. E. B.*

PNEUMONIA FROM INHALING GASOLINE

Experimenting, boylike, with a rubber tube and the gasoline tank of an automobile, an eight-year-old lad got an unexpected dry cleaning of his lungs, which resulted in pneumonia, when his companion blew on the other end of the tube. The case was recently reported to the American Medical Association.

When the other end of the tube was blown into, the gasoline was forced into the boy's mouth. He choked and had a severe strangling spell, from which he recovered, but pneumonia developed. For four weeks he could taste gasoline and it could be smelled on his breath.

Gasoline is rapidly absorbed by the lung tissue, the report stated. The pneumonia that follows this absorption is not typical. The fever is not high and the rapid breathing continues for a long period. The inflammation of the lungs does not remain in one spot, but wanders about, suggesting that the gasoline fumes also wander about in the lung tissue, setting up inflammation in other spots.—*Science Service.*

TIMING A FLASH OF FLAME

The factors that contribute to the propagation of explosions in gaseous mixtures are being studied by the United States Bureau of Mines. This is part of the Bureau's investigation of the mechanism of mine explosions. No matter how long the column of an explosive gas mixture may be, the speed of the flame, when initiated, is accelerated rapidly until it reaches a maximum and constant velocity. The term "detonation" is applied to this type of explosion. So fast does the flame front travel that it sometimes reaches the high value of 10 times the velocity of sound, or over two miles a second.—*A. E. B.*

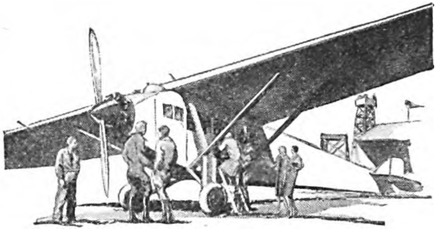
NEW PRODUCT PRESERVES AND IMPROVES GLUE

When the organic chemist begins to juggle atoms, tacking one here and another there on some molecule with a mouth-filling name, no one, including himself, knows what kind of a substance is going to result or what use it may prove to have. Thus, during the past year, chemists of the Dow Chemical Company, Midland, Michigan, have developed, from the laboratory stage to actual commercial production, a new product known as orthophenylphenol. Now what is this substance good for?

Well, being a relative of carbolic acid, one might suspect that the newcomer would be useful as a germicide, but we'll give you 999 guesses as to where it has found application. Answer: In making glue!

The problem of glue preservation, both from the standpoint of preventing mold and that of eliminating putrefaction, has been of extreme importance to both glue manufacturers and glue users. The sodium

"how can I get into Aviation?



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Bill for first operation performed under ether in 1842

IF YOU read "The story of Anesthesia" by Dr. John H. Evans in the November issue of HYGEIA, the Health Magazine, you may pause at the tale about the above bill and say, "Them was the good old days". But that first rude experiment is a far cry from the perfected science of anesthesia as surgeons administer it today. At some time in your own life, either because of an operation on yourself, a member of your family or a friend, you will be personally interested in some kind of anesthesia. Read Dr. Evans' story of ether and laughing gas in the "good old days". Let him tell you about the wonderful development of perfected anesthetics in "these still better days". Let him put you right regarding the various kinds of anesthesia.

"PHYSICAL ILLITERACY" what is it?

Do you get your exercise listening to the base-ball reports over the radio or sitting in the bleachers watching a football game? This form of exercise is so common to all Americans that it has been given a name—"Physical Illiteracy". Dr. J. E. Rogers points out the grave danger of physical illiteracy upon your individual health, the health of your family, community and country. Read this article in the November HYGEIA.

OTHER VITAL HEALTH ARTICLES in the November HYGEIA

"Perception" by Dr. William J. Mayo; *"April Blue"*, a child's health story; *"How to Protect Your Children from Tuberculosis"*—these are only a few of the additional health attractions treated in the November HYGEIA. The articles in HYGEIA are written by health authorities in a charming, non-technical style, pleasing to the layman, who can be sure that the variety of health topics presented are scientifically true. HYGEIA is for every member of the family. Take advantage of this special introductory offer to get acquainted with HYGEIA. The regular subscription price is $3.00 a year, but new subscribers are offered the special get-acquainted-price of $1.00 for six months.

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salt of this phenol is water-soluble in all proportions and, regardless of its high phenol coefficient, is reported by bacteriological laboratories as being non-toxic to humans. The quantities necessary to use are exceptionally small; 0.5 percent of sodium orthophenylphenate by dry weight has proved in all tests a complete control against both mold and putrefaction.

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"GALAGUM"

GALAGUM is the name given to a mixture of modified polysaccharides recently introduced and described in *Industrial and Engineering Chemistry*. It is a white powder, tasteless and odorless, and acid in reaction. It can also be obtained in a neutral modification. Galagum, when boiled in water, forms colloidal solutions of different viscosities, depending on concentration. A 1 percent solution forms a syrupy solution, a 5 percent solution forms a paste or jelly.

Neutral Galagum is edible and is used in making bakers' and flavoring emulsions. In the cosmetic industry viscous aqueous solutions are much used in lotions and hair preparations. These are produced by dissolving 1 to 4 parts of Galagum in 100 parts of boiling water.

In the baking industries it has been found that neutral Galagum replaces part of the eggs ordinarily used. In the manufacture of ice cream, neutral Galagum decreases the amount of gelatin required. Certain cheeses which are made with various protective colloids to give them smoothness and body may likewise be made with neutral Galagum.

Technically, Galagum possesses interesting properties in that it may be used for giving a heavier body to water paints, sizes, glue, and many other aqueous solutions. —*A. E. B.*

RESPONSIBILITY FOR TYPHOID FEVER

TYPHOID fever is carried principally by contaminated food and water and by carriers of the disease whose excretions get into food and water. From time to time brief epidemics have occurred in this country due to the fact that sewage has gotten into the water supply. An epidemic occurred in Salem, Ohio, several years ago, when there were several hundreds of cases. Small epidemics have also occurred in factories where the drinking water became contaminated by sewage.

In Lyons, France, recently the court held the water company responsible for the illness and death of various citizens who had become infected with typhoid fever from contaminated water. Moreover, the court declared Mr. Mercier, director of the water works, to be guilty of involuntary homicide as a result of his imprudence, negligence, and infraction of the regulations. They sentenced him to one year in prison, with suspension of execution, and they fined him 500 francs. Some of the people who developed typhoid fever were awarded damages ranging from 20,000 to 100,000 francs.

The epidemic originated from two wells which were contaminated by the water of a sewer. In its decision, the court maintained that it is the duty of the water distributing company to guard the purity of the water that it distributes. The monthly analyses made by the company were inadequate, and the company should not have ignored the dangers associated with the proximity of a sewer to the water supply.—*M. F.*

VARIATIONS IN SUSCEPTIBILITY TO DISEASE

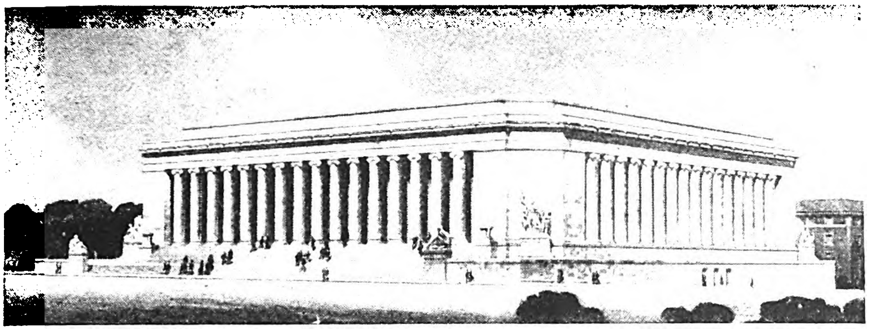
IT has long been known that different races vary in their susceptibility to various disease. Centuries of infection with syphilis have made the Chinese relatively insusceptible to that disorder. Jewish people suffer less than other groups from alcoholism and tuberculosis, whereas they suffer particularly with diabetes and with a disease of the arteries known as thromboangiitis obliterans. The races of Africa and the South Sea Islands have been free for many years from such conditions as measles, but come down with serious epidemics from the disease when it is introduced among them. For some unexplained reason scarlet fever is rare in the tropics; although cases have repeatedly gone into India, South America, and the Philippines, the result is only a local epidemic largely confined to newly arrived foreigners and with few cases developing among the local population. Several investigators have attempted to find out the reason for this immunity, and the most recent evidence indicates that this is due to some hereditary factor.

For instance, the Chinese are relatively free from scarlet fever as compared with the Japanese. Of 11,000 healthy Japanese tested, 37.3 percent were found positive to the Dick test, which was about the same percentage as reported by Zingher for New York City. On the other hand, only 19.4 of 3500 Chinese were found to be Dick positive. For a period of six years, the annual scarlet fever mortality among the Japanese was 361 per 100,000, as contrasted with 8 per 100,000 for the Chinese. —*M. F.*

HYBRID PLANT YIELDS PAPER AND OIL

BROTEX, a newly developed plant which threatens to replace hemp and to supply a suitable raw material for the manufacture of paper, is attracting considerable attention among British chemists. The new plant is being grown in America, France, Germany, Kenya, and Canada, as well as in the British Isles, and its possibilities on a wide range of soils are interesting great numbers of scientists and agriculturists.

Experimental work which has been already carried out indicates that it is a sufficiently hardy plant to be grown successfully to yield a six months' fiber crop in many parts of England and in other countries. In its six months and later stages the plant produces fiber which can be used for sacking, cordage, ropes, and the products in which coarse hemp is usually employed. For paper-making it affords a very quick-growing material. Its seed can



The new home of the Mellon Institute as it will appear when finished

be used for cattle food in the form of oil cake having 15 percent edible oil.

The plant, which is a hybrid biennial, was produced after many years of experiment by Mr. Leonard Browning. No extravagant claims have been made for it, and the closest scientific research is still being carried on.—*A. E. B.*

NEW HOME TO BE BUILT FOR MELLON INSTITUTE

ONE of the most interesting places in the world to anyone interested in chemistry is the Mellon Institute in Pittsburgh, Pennsylvania, and one of the most interesting of all chemists is its director, Dr. E. R. Weidlein. The fascination of the great laboratory and its director are both due, in part, to the fact that their work keeps them about two jumps ahead of the innumerable applications of chemical engineering to industry, for the Mellon Institute is the scene of hundreds of scientific conquests that later find their way to the public in the form of improved products.

Manufacturers, groups of manufacturers in similar fields, and even trade associations establish fellowships at the Institute, making it possible for some highly trained chemist or engineer to concentrate on the particular technical problems that they are most anxious to have solved. At the present time there are 63 industrial fellowships, relating either directly or indirectly to almost any business that can be named. Now Director Weidlein announces that a monumental new home for Mellon Institute, illustrated herewith, will be started this fall.

When the present home of the institute was completed, in 1915, it was felt that the industrial fellowships procedure created by Robert Kennedy Duncan had passed from the experimental to the practical stage. The building, which was given to the Institute by Andrew W. and Richard B. Mellon, incorporated the best laboratory constructional features of that period. It was thought then that it would provide adequate space for growth for many years; but for practically 10 years the institute has had a waiting list of companies, often almost as long as the roster of companies whose problems were being investigated.

In addition to providing a greatly increased number of laboratories, the new building will give more commodious quarters for general departments. The present library contains 11,000 volumes; the new library is planned to accommodate 250,000 volumes. The present Department of Research in Pure Chemistry will be expanded and facilities for pure research in other branches of science will be provided. Much more elaborate chemical engineering laboratories are to be available in the new building, and also the fellowships in each specific field of industrial research are to be grouped in suites of rooms so that they can best make use of general apparatus adapted to their needs. Certain rooms will be equipped for specialized phases of experimental technique, such as electrochemistry, spectroscopy, low-temperature studies, radiations, high-pressure experimentation, and so forth. Other special features to be included are a large lecture hall, a dining hall, an industrial fellowship museum, and an underground garage. For the past five years, members of the institute's executive staff have been visiting laboratories in America and Europe to obtain information on new features in design and equipment.

The new laboratory structure will be of that type of classical Greek architecture known as Ionic. It is to be seven stories high, with monolithic columns along all four sides. The proportions will be approximately 300 by 400 feet. The main entrance, which is located on the third floor, is reached by steps extending along the entire front of the building. The laboratories are to face on interior courts. The design of the new building is to be such that additional laboratory suites can be constructed in the interior courts without marring the beauty of the general appearance and without interfering in any way with the original laboratory units.—*A. E. B.*

BASEBALL PITCHER'S ELBOW

WHEN a baseball pitcher winds up to pitch a ball, the arm and forearm should be held in extension and the throwing of the ball should be from the shoulder. Sometimes, during the wind-up, a pitcher will hold his arm slightly flexed; then as he prepares to throw the ball, by suddenly and forcibly contracting the muscles in the back of the arm and rotating the forearm and hand inward and downward to give speed to the ball, he extends his forearm rapidly. In the maneuver the head of the large bone of the forearm is brought backward suddenly and with great force against the large bone of the upper arm. As a result, a small piece of cartilage and bone from the head of the radius, the large bone of the forearm, may be chipped off, will remain about the joint, and be constantly irritating and troublesome with every movement.

The average velocity of a baseball after it leaves the pitcher's hand is about 90 feet a second. This will give some indication of the force involved in the production of this injury.

Dr. F. J. Kirby has reported two cases

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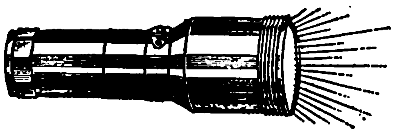

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The clear and simple treatment makes the book invaluable to social workers, physicians, parents, educators; first in developing a saner attitude toward the whole subject; second as a tested method in throwing light on sexual maladjustments as affecting personal relations.

The Scientific American says: "Almost to a certainty this book will upset a number of fondly cherished beliefs. It is a thoroughly scientific record of scientific work in sociology, performed by a noted scientific authority. The discoveries recorded were based on actual data secretly obtained." For free examination, use the coupon now. Price $3.50.

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of this character which came to his attention. In both, unfortunately, it was necessary to open the joint and to remove the small piece of bone in order to relieve the patient from constant difficulty in movement. Just as soon as the loose portion of the bone is removed and the operation wound heals, the patient is likely to recover fully.—*M. F.*

400 TONS OF BOTTLES A DAY

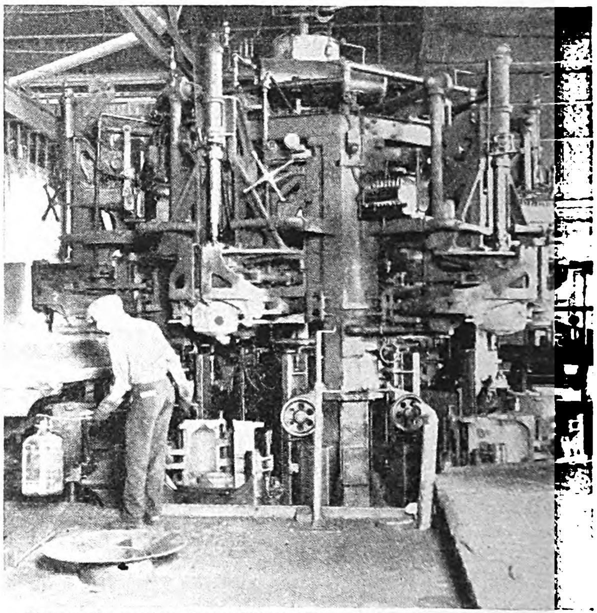
GLASS bottles! How often they play their unobtrusive rôles in little dramas of modern life: The message floating at sea in a stoppered bottle; the tiny vial of serum rushed to save a life; the "pop" bottles at the ball park and the road stands; the daily milk bottles; the bottles that gleam in the chemists' laboratory, on the barber's shelf, in the drug store, the grocer's, the stationer's. It is hard to realize how completely our comfortable modern life would be disorganized if glass bottles were suddenly taken away from us.

Until comparatively recently, all glass bottles were blown by hand or, rather, by mouth. A "gob" of molten glass was balled around the end of a blow pipe, by a skilful glass blower, and the bottle blown by lung power into a mold which gave it the desired shape. The demand for more and cheaper bottles has spurred the glass technologist and the mechanical engineer to convert the age-old process to a highly refined machine operation, until today, we find at Alton, Illinois, a single factory which produces 300 tons of machine-blown bottles per day. The bottles produced here by the Owens-Illinois Glass Company include over 3200 different styles and sizes.

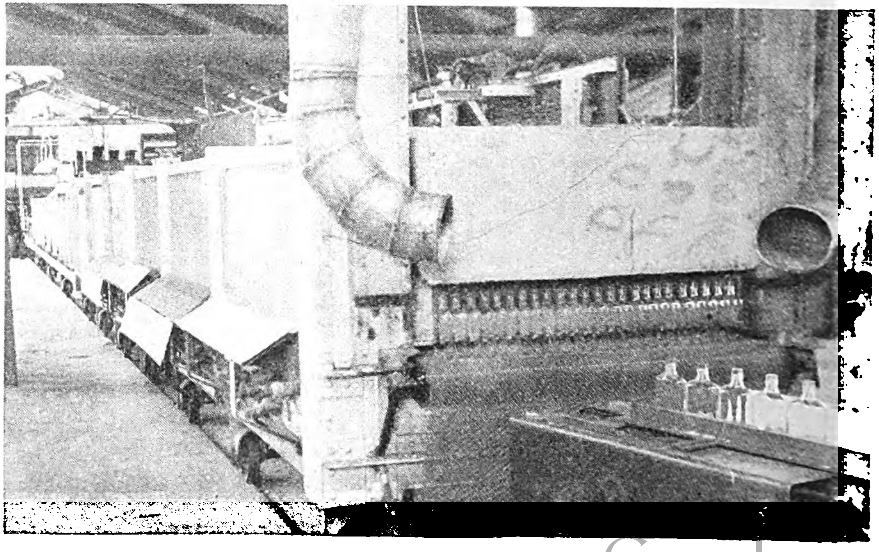
The molten glass fed to bottle machines must be exactly right in composition. Expert chemists control every step in its manufacture. In addition, finished bottles are inspected with instruments so delicate that the internal strains set up in the glass by holding a lighted match near the bottle can be readily discerned.

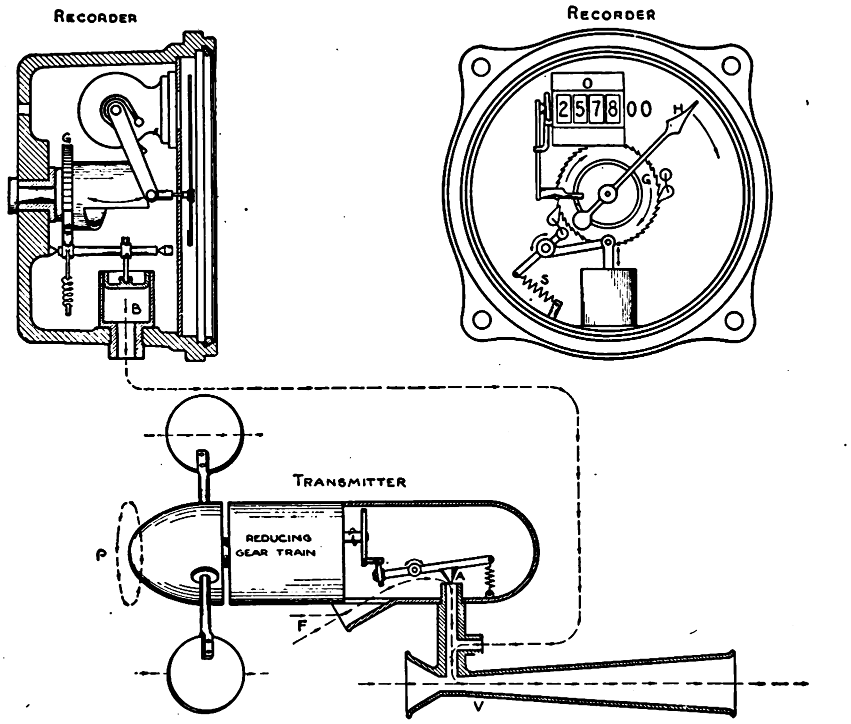
In the research laboratory of the company there is a collection of instruments not frequently found in an industrial laboratory. Among them is a specially constructed precision interferometer which is used in detecting sub-microscopic cracks in glass. An Abbe-Fizeau interferometer, regularly applied to the determination of the coefficient of expansion of glass, has been specially modified to adapt it to the determination of the softening point and heat conductivity of glass in addition to its regular function. The study of the structure of complex silicates is aided by means of an X-ray reflection apparatus. A precision Ruprecht

Right: Largest bottle blowing machine in the world. It is a six-head, vacuum-feed type, standing 20 feet high and weighing 120 tons. The revolving pot of melted glass is just to the left of the attendant who is removing a five-gallon carboy from its mold. *Below:* The feed end of an electrically heated lehr, in which the bottles are annealed



Photographs courtesy Owens-Illinois Glass Company





This new air log indicates airplane miles traveled

balance is used to determine slight losses in weight due to the solubility of glass, whole bottles being used in the experiments.

Machine-blown bottles furnish a striking and dramatic example of the mechanization of an ancient industry, made possible by the combined genius of scientists and engineers.—*A. E. B.*

USE OF ELECTRICITY DOUBLED

PER CAPITA use of electric power in the United States has more than doubled in the last ten years, according to statistics based on the 1930 census, says F. E. Bonner, executive secretary of the Federal Power Commission.

The figures show that for the entire country, the per capita use increased from 391 kilowatt-hours in 1920 to 800 kilowatt-hours in 1930.

THE AIR LOG

THERE is nothing more interesting on board ship than to lean over the taffrail and watch the log do its endless work of recording distance. The corresponding aircraft instrument, the air log, is less frequently employed. Its greatest value lies in long flights as an aid to navigation. It is also very useful for such records as fuel and oil consumption, mileage between overhauls, and other data of interest to the transport operator. The air log or air distance recorder as now built by the Pioneer Instrument Company, is an ingenious and interesting mechanism.

It consists of two parts—the transmitter and the recorder. In a biplane, the transmitter is mounted on one of the outer interplane struts, while on a monoplane it is mounted three feet or more ahead of the leading edge of the wing, so as to be free to some extent of the air-flow disturbance caused by the wing. The recorder is mounted on the pilot's instrument board. The two units are connected by a small copper tube. The basic principles of the recorder are clearly illustrated by the accompanying drawings.

The flow of air through the venturi tube V causes a suction at its throat or narrowest section, where the air must flow with its greatest velocity. This suction is carried through the copper tube to the piston B in the recorder, and pulls down the piston B against the action of the spring S.

The flow of air, as the plane moves forward, also rotates the flat disk propeller P, in the direction shown by the circle and arrows. The pitch of the propeller and the ratio of the gear train in the transmitter are such that the valve A is opened once every mile. This allows air to flow in at F and breaks the suction in the line. Once the suction is broken, the spring S pulls the piston B up to the top of its stroke, the position shown in the drawing. Simultaneously this causes the pawl to move the gear G one tooth, carrying the hand H on the recorder dial one unit forward. Valve A is then closed and the piston is once again sucked to the bottom of the cylinder ready to repeat the action at the end of the next mile.

The gear G has 100 teeth so that the hand makes one complete revolution for every 100 miles traveled. The gear also rotates a spiral cam causing the counter arm to move and indicate another hundred miles while the hand H continues on the next revolution. Total mileage flown is obtained by adding those shown by the counter and the hand. The mileage for a given trip is obtained by noting readings at the start and end of the trip.—*A. K.*

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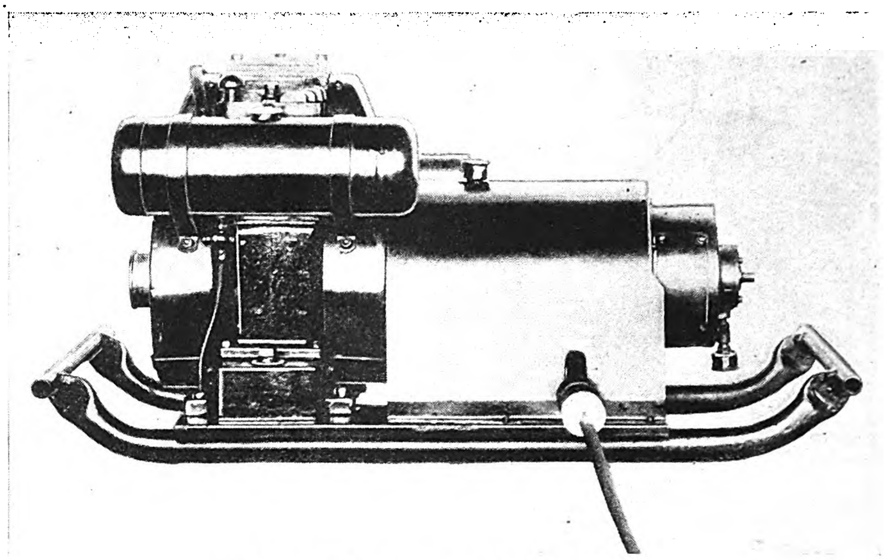

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This portable plant has been designed to meet the needs of construction and repair crews for a convenient and portable source of power. It is ideal for use in the field where power is required for drills, chisels, saws, and similar tools.

CURRENT BULLETIN BRIEFS

SHORT REVIEWS OF BULLETINS AND PAPERS ON SCIENTIFIC AND ALLIED SUBJECTS, AND WHERE TO GET THEM

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO, REPORT FOR 1929 is an important treatise on co-operative municipal-ownership power enterprises. Practically the whole province of Ontario is being supplied with Niagara Falls power at cost. There are excellent maps and a wealth of data. *Hydro-Electric Power Commission of Ontario, Toronto, Canada.—$2.00.*

◆

GEOLOGY AND WATER RESOURCES OF THE KAU DISTRICT, HAWAII (U. S. Geological Survey Water Supply Paper 616) is a misleading title, for the pamphlet is mainly descriptive of the geology of Mt. Kilauea where Dr. T. A. Jaggar maintains the United States Volcano Observatory. *Superintendent of Documents, Washington, D. C.—85 cents (money order).*

◆

BOOKLIST BOOKS 1929, A SELECTION, gives the most important list of the new books giving brief notes as to their value together with the number of pages and the prices. It is accompanied by a complete index. *American Library Association, Chicago.—65 cents.*

◆

AERONAUTICS TRADE DIRECTORY (Aeronautics Bulletin No. 3, Aeronautics Branch, U. S. Department of Commerce) is a most valuable booklet dealing with commodities and activities. It gives a complete list of manufacturers of airplanes, accessories, airport designers and constructors, engine manufacturers, hangar builders, and all the thousand and one items that go into this industry. It also gives a complete list of air-transport operators and aeronautical engineers. *U. S. Department of Commerce, Aeronautics Branch, Washington, D. C.—Gratis.*

◆

NATIONAL PHYSICAL LABORATORY REPORT FOR 1929 is a 300-page book giving a description of a year's research at Great Britain's "bureau of standards." It deals with heat, radiology, sound, optics, electricity, measurement, and general research. *His Majesty's Stationery Office. London, England.—Eleven Shillings.*

◆

THE ATMOSPHERE AND THE SUN (Smithsonian Miscellaneous Collection, Vol. 82, No. 7 by H. Helm Clayton) gives further scientific evidence of weather cycles, their causes and interpretation, with a particular view to long-range weather forecasting. *Smithsonian Institution, Washington, D. C.—25 cents.*

◆

EARLY PUEBLO RUINS IN SOUTHWESTERN COLORADO (Bulletin No. 96, Bureau of American Ethnology, Smithsonian Institution) by F. H. H. Roberts, Jr., is a 180 page account of archeological work done in 1928, with a brief history of early American cultures. Illustrated. *Superintendent of Documents, Washington, D. C.—75 cents.—Money order.*

AUTOMATIC ARC WELDING BY THE ELECTRONIC TORNADO PROCESS is a monograph on an accepted method for manufacturing pipe, tanks, boilers, and similar equipment when the production is sufficiently large to justify the cost of equipment. *The Lincoln Electric Company, Cleveland, Ohio.—Gratis.*

HINTS ON COYOTE AND WOLF TRAPPING (Leaflet No. 59, U. S. Department of Agriculture), *Superintendent of Documents, Washington, D. C.—5 cents, coin.*

MODERN METHODS IN REPAIR SHOPS is a large and beautifully illustrated monograph of 120 pages dealing with cranes, turn tables, car washers, and other devices useful in car shops, roundhouses and terminals. Free to interested parties. *Address Whiting Corporation, Harvey, Illinois.*

THE SURFACE WATERS OF MICHIGAN (Engineering Research Bulletin No. 16, Department of Engineering Research, University of Michigan) by Robert L. McNamee, outlines the hydrology and qualitative characteristics and purification of water for public use. Accompanied by an excellent series of maps. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—$1.50.*

THE INDUSTRIAL MUSEUM OF NEW YORK describes an exhibit of early astronomical and mathematical instruments. It also describes the David Eugene Smith collection and contains a monograph on the Astrolabe by Jekuthiel Ginsburg, A.M., and on (Sun) Dialing by J. Ernest G. Yalden. *Museum of the Peaceful Arts, Daily News Building, East 42nd St., New York City.—Gratis.*

THE HIGH SCHOOL SCIENCE LIBRARY FOR 1929-30 by Hanor A. Webb gives the titles of the very newest books in the field of science on the junior and senior high school level. *Address Hanor A. Webb, George Peabody College for Teachers, Nashville, Tennessee.—10 cents.*

CONSERVING VISION IN INDUSTRY (Publication No. 68) contains several interesting signed papers. *The National Society for the Prevention of Blindness, 370 Seventh Ave., New York City.—25 cents.*

FORMATION AND PROPERTIES OF BOILER SCALE (Engineering Research Bulletin No. 15, Department of Engineering Research, University of Michigan) by Everett P. Partridge, is an elaborate discussion of the subject, accompanied by a full bibliography. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—$1.00.*

SAFETY CODE FOR BRAKES AND BRAKE TESTING (Miscellaneous Publication No. 107, Bureau of Standards, Department of Commerce) gives valuable results which have been approved by the American Standards Association. *Superintendent of Documents, Washington, D. C.—5 cents, coin.*

SPICES AND CONDIMENTS (Leaflet No. 15, Field Museum of Natural History, Department of Botany) by James B. McNair, Assistant Curator of Economic Botany, is a valuable pamphlet fully illustrated and gives much out-of-the-way information. *Field Museum of Natural History, Chicago, Illinois.—25 cents.*

THE RUN OF THE TWENTIETH CENTURY, by Edward Hungerford, is one of the most illuminating publications on railroad service we have ever seen. It is accompanied by excellent diagrams and illustration. *New York Central Lines, 466 Lexington Avenue, New York City.—50 cents.*

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING gives valuable information as to retirement and pensions. *Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, New York City.—Gratis.*

ARTIC, THE REFRIGERANT (Technical Paper No. 274) is a small treatise on the physical properties and performance data of Artic. Of value to anyone interested in refrigeration. *The Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y.—Gratis.*

OUR POINT OF VIEW

(*Continued from page* 349)

of our Navy as a matter of course; actually it is the result of generations of systematic effort. The naval routine which trains American lads to become able seamen and capable petty officers, and develops midshipmen into captains and admirals is exacting. The naval exercises which gradually convert an aggregation of ships into a fighting fleet instantly responsive to the will of its commander, are arduous and unending.

The peace-time preparation of the fleet is carried on at sea or isolated anchorages, with none of the glamor of battle or the stimulus of war; it would become plain drudgery except for the animating spirit of the Navy that has been handed down from Paul Jones.

Pay the Navy personnel a visit on their annual day at home. Your interest will stimulate their future endeavors, and we believe you will come away a better American and more conscious of your obligations as a good citizen. The Navy selected Theodore Roosevelt's birthday for their annual day at home because that stalwart American devoted himself to increasing the efficiency of the fleet. Whether you are able to visit the Navy or not, remember his famous maxim, "Speak softly, but carry a big stick."

Great Britain Taken to Task by League of Nations THE Mandates Commission of the League of Nations is apparently taking its duties seriously, for it recently criticized the British Government severely for its failure to foresee and prevent the recent conflicts between Jews and Arabs in Palestine. Mr. Henderson, British Foreign Secretary, made a tart rejoinder and asserted that the Mandates Commission itself did not foresee these outbreaks although kept fully informed of

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conditions in Palestine. The exchange of notes will probably close the incident, for the League can scarcely be expected to take punitive steps against Great Britain.

Cynics have hitherto regarded "mandates" as a euphemism for "colonies" but the action of the League officials in the Palestine riots opens interesting future possibilities. And if the League dares to rebuke Great Britain, who with some justice prides herself on her ability as a colonial administrator, it will probably not hesitate to intervene in other instances.

The lot of present day Colonial Ministers is not easy, but if, in addition to answering the petitions of backward peoples clamoring for self-determination, they can be summoned to Geneva to give an account of their stewardship, additional troubles are in store for them.

There has been considerable discussion in England concerning the extent of her liability under the Covenant to use her Navy to enforce a decree of the League. Whose Navy *can* the League call upon to enforce a reform of a British mandate?

This incident, almost trivial in itself, illustrates the helplessness of a League of Nations; if the League authorities had the power to enforce their decisions, the world would be in the grip of a despotism just as real as the Roman Empire; without the power to enforce its decrees against a first rate state, the League can never be more than a common international scold.

Pilsudski and Poland PARLIAMENTARY government has received another setback in Europe. This time Poland chose to trust in its famous Marshal who turned back the Bolsheviks before Warsaw in 1920, rather than in a noisy, factious parliament.

There is nothing in the tragic history of a brave but politically unstable people to indicate that a parliamentary system will preserve Poland from internal disorders or external foes. Her first partition was made possible by factional jealousies and a constitution better adapted to protect Poles from their rulers than Poland from three land-hungry Emperors, possessed of well-equipped armies and endowed with power to use them at will. Poles, having to choose between an inefficient government under representative forms, and a Dictatorship which promises a strong but efficient government, have, like Italy, Jugoslavia, and Rumania, chosen the Dictator.

South American Revolutions THE exile of former President Irigoyen from Argentina is the climax and, we hope, the end of a series of revolutionary outbursts in South America.

Almost simultaneously the governments of Peru and Argentina were overthrown by successful revolts; the government of Bolivia had suffered a similar fate a few months earlier. Whatever may be the causes of these outbreaks, it is apparent that many South Americans still prefer to determine their elections with bullets.

We can not be indifferent to the customs of our Spanish-American neighbors. Peru, in particular, has been on peculiarly friendly relations with our country, and her recently deposed President Leguia was proud to proclaim his friendship for the United States. American mediation was instrumental in restoring one of Peru's lost provinces to her and in reducing the friction between Chile and Peru.

An American Naval Mission has been assisting the Peruvian Government to increase the efficiency of her Navy, and American capitalists have invested large sums to develop the mineral wealth of that small but richly endowed state.

As President Leguia became President by a military usurpation and retained power by military coercion, it will be easy for caustic critics to point the moral, but as during his long tenure Leguia gave his country domestic tranquillity and effected a settlement of the long-standing dispute with Chile, we hope his triumphant opponents will allow him an honorable exile and spare their new régime the needless stain of placing Peru's former President before a firing squad. As our State Department was willing to be considered his friend while he was in power, it should not hesitate to go to his assistance in his distress.

Argentina's deposed President, Irigoyen, prided himself on defying the United States, so in a negative way our relations with Argentina should improve by his deposition. Argentina has more trade with Great Britain than with the United States and many of her important industries are owned by English capitalists. There is a British-Argentine trade association actively engaged in fostering trade between the two countries. This association is preparing an exposition of British goods, to be held in Buenos Aires next year, and the British Government has shown its interest in the success of the exposition by agreeing to send the Prince of Wales as its representative.

England buys much of Argentina's meat and wool and sells manufactured goods to that country. One of the reasons urged against a British Empire preferential tariff is the large Argentine trade that would be adversely affected if Argentina were left outside the British tariff wall.

Mexico

AGAINST the revolutions in South America should be placed the orderly opening by President Rubio of the 34th Mexican Congress. He predicted that Mexico had definitely entered upon an era of peaceful reconstruction. Americans, although not so optimistic as President Rubio, will wish their southern neighbor well. No other country has so large an interest in Mexico's stability and prosperity; and our long forbearance should, by now, have convinced Mexico's rulers that we have no sinister designs on her territory and only wish to see her peaceful and prosperous.

Both Cuba and Panama have shown restlessness under their present rulers, and but for their treaty relations with us, would, undoubtedly, have gone the way of Peru and Argentina. The editor of a paper in Panama regrets that their relations with the United States prevent Panamanians from indulging in revolutions, that are open to all other Spanish-American countries; he extols the freedom of action open to a dictator to achieve reforms unhampered by a laggard legislature; and has nothing but pity for an executive who is under the mortifying necessity of soliciting the ballots of his fellow-countrymen. When we feel superior about our electoral customs, we should remember that many other peoples have little faith in ballots.

FOOTBALL

(*Continued from page 372*)

one-sided to give the new plan a fair trial.

As to the first of the foregoing points brought out in favor of the system, the losing team never had the ball in its possession during the last 20 plays. Concerning the second point, there can be no doubt of the value of the plan—the stop-watch is entirely unnecessary, and all that is required of the official timer is that he be able to count up to 40.

From the spectator-interest standpoint, this test game seemed to prove there was *less* interest shown, which, of course, may have been due to the uneven score. However, using the period-by-play system, in place of the interval elapsed, there is more of a tendency on the part of the players to waste time between plays. When this occurs the number of plays per minute is decreased, and spectator interest tends to wane. In the Brown-Boston University game, the number of plays in both the third and fourth quarters was reduced from 40 to 35 because of approaching darkness.

The data for the eight games studied indicates that the average number of plays per quarter consistently increased slightly in each succeeding quarter, which is as might have been anticipated. As soon as the losing side sees the end of the game is coming nearer, they invariably speed up their game; they lose little time in giving signals and in shifting formations. Thus the average number of plays in the first quarter was 40.3, 41.3 for the second, 41.5 for the third, and 42.9 in the last. The actual time the ball was in motion in the first quarter averaged 2 minutes 55 seconds, and 3 minutes 19 seconds in the last.

A complete chart of the 1929 Army-Notre Dame game at the Yankee Stadium in New York City last November appears on page 371. This chart shows in detail the plays made by each team as the game progressed. The legend, giving the symbols used, is located in the upper left hand corner.

In this very interesting and exciting game not a single forward pass was completed. However, Notre Dame intercepted three of the Army's passes, one of which ended in Elder's famous run and touchdown—the kind of a run that sinks and stays in the mind of the average football fan for years.

Applying Coach Glenn Warner's system of scoring—which awards a point for every first down made and eliminates the try-for-point after a touchdown—the score in this game would have been 12 to 5 in favor of Notre Dame. The Southbenders made six first downs and the West Pointers five. The difference in scores under the Warner method would have been seven, which was the same margin by which Notre Dame won using the orthodox method of scoring.

The two vertical black bars at the right-hand side of the chart represent the time the ball was actually in motion, and the time elapsed from the initial kick-off to the end of the game. The bars emphasize graphically the large difference between the playing time and the elapsed time; it will be observed that the latter is about 10 times the former, which visually explains the statement that you pay about twenty-five dollars per hour to watch football.

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COMMERCIAL PROPERTY NEWS

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BETTER MAILING CONTAINER SOUGHT

SAFER and lighter packing for parcel-post shipments in the international mails would help to increase American export trade in liquid preparations, according to a statement just made public by the Department of Commerce, prepared by Thomas E. Lyon, Assistant Chief of the Department's Transportation Division.

A method of packaging by a manufacturer of pharmaceutical goods is described in the statement, which follows in full text:

During the year 1929 the United States exported medicinal and pharmaceutical preparations to the total value of 21,282,000 dollars. More than one-half of this sum, or 11,655,000 dollars, composed medicinal preparations for internal use, which usually are shipped in bottles and distributed in small units. This last figure could be considerably augmented by other liquid preparations, such as hair tonics, toilet preparations, and so forth, which are usually sold in similar packages. While a considerable part of this trade is shipped by freight, American exporters have felt that it could be increased if parcel-post shipping conditions were improved. Heretofore it has been necessary in making parcel-post shipments to fill packages with sufficient absorbent material to take up any leakage caused by breakage; the absorbent material, as a rule, exceeded the actual weight of the commodity shipped, and thereby increased parcel-post charges.

A well known manufacturer of pharmaceutical goods recently carried on a considerable series of experiments with a view to improving his parcel-post package and has succeeded in developing an economical package which meets the requirements of the Post Office Department. He has furnished the Bureau of Foreign and Domestic Commerce with a description of this package, as follows:

At first a number of experiments were made with various forms of absorbent material packed around the bottles, the outer container being either waterproof or lined with a waterproof material. None of these produced a satisfactory package, however, and finally this idea was discarded and the work directed toward finding some sort of container or case which would adequately protect each bottle.

Obviously a case was required which would be light, very strong, waterproof, and not too expensive, and inside of this case must be placed a sufficient amount of some absorbent material to take care of the loss of the entire contents of the bottle, if necessary.

The form of protection finally adopted for each bottle was a five-ply fiber-board round mailing case, paraffin-sprayed both inside and out, and with a metal screw cap. The fiber-board of which it is made tests 295 pounds on a standard Mullen tester.

A feature of this case is the fact that the threads which engage the screw cap when the case is closed are formed in the fiber board itself during the process of manufacture, instead of being made of metal and fastened to the top of the tube. Such a method of construction insures an extremely tight closure when the cap is screwed down, for then the top of the fiber tube is pressed very closely against the inside of the metal cap, and, being of softer material than the cap, gives just enough to produce the same effect as if a washer were used. This case was found to be absolutely water-tight under tests conducted over a considerable period of time and with the package in various positions.

The absorbent materials ordinarily used, such as bran, sawdust, and so forth, were all unsatisfactory, and the material finally adopted was crêpe wadding. In using this material it was found that no corrugated liners, pads, or disks were necessary.

In assembling the packages for shipment, sheets of crêpe wadding were first procured of such a size that they were about six inches longer than the bottles, and wide enough to produce an overlap of at least two inches and cause the bottles to fit snugly in the cases. Each bottle was then placed in the middle of a sheet, the material was rolled around it, the two ends were tucked in, the wrapped package slid into the case, and the metal top screwed down tightly. The 12 individual cases were then placed in the corrugated box, and the box sealed with sealing glue under pressure in the customary manner.

The complete box, holding one dozen eight-ounce bottles, weighed 17 pounds 15 ounces. The standard export case, containing six dozen of these same bottles, weighs 120 pounds, or 20 pounds per dozen. In spite of the additional protection given the individual bottles by this method of packing, the total weight per dozen has been reduced over 10 percent.

"U. S." ENDORSEMENT IS FALSELY CLAIMED

FALSELY asserting that their respective products had received endorsement of the United States Government, a beverage manufacturer and a correspondence school signed stipulations with the Federal Trade Commission agreeing to cease the practice. The beverage company also misrepresented the qualities of its product.

Details of stipulations are as follows:

(1.) Statements which do not truthfully describe the properties and powers or the curative and therapeutic effects to be derived from use of a certain beverage will no longer be inserted in the advertisements of a corporation manufacturing such beverages.

The company will also cease representations which imply that the beverage has been approved by the United States Government, and will discontinue assertions to the effect that the preparation is used in government and other hospitals and in sanitariums and is prescribed by physicians and dieticians, unless and until such averments are substantiated by fact.

(2.) Representations tending to confuse the public into the belief that its home study courses of instruction in aviation have the approval of, or are rated, inspected, or graded by the United States Government or have the official endorsement of authorities in aviation, when such is not the fact, will be discontinued by a corporation conducting a correspondence school.

GOLF TAX NOT APPLICABLE TO MINIATURE COURSES

SO-CALLED "miniature golf" has no intrinsic relationship, though there are points of similarity, to the recognized game of golf, according to a ruling of the Supreme Court of the District of Columbia.

A license for the operation of the miniature game, therefore, Chief Justice Wheat of the court ruled, may not be exacted under the provision of the District of Columbia licensing act providing for the payment of a license fee of $5 a day for a golf course or kindred game.

The court directed the issuance of a mandamus against Wade H. Coombs, superintendent of licenses, requiring him to grant a license to the operator of a "miniature golf course" under another provision of the licensing act providing for the fee of $100 annually.

The name, Chief Justice Wheat stated, had nothing to do with making the game kindred to golf, pointing out that sometimes a game of dice is known as "African golf."

TRADEMARKS IN FOREIGN LANDS

THE influence of the common-law theory of property rights in trademarks, writes James L. Brown, Chief of the Patent and Trademark Section, Division of Commercial Laws, Department of Commerce, in a recent issue of the *United States Daily*, is noticeable to some extent in many countries where the common law does not generally prevail.

A recent case in one of the Slavonic countries called to mind the recognition given to certain industrial property rights regarded as inherent by the common law and not so recognized in countries where the civil law forms the basis for jurisprudence. A similar instance in Panama brought to light the fact that the theory of exclusive property right in the first user of a trademark limited to an extent the generally understood meaning of the term "first user." With the expansion of international trade, many of the countries not having the common law system of jurisprudence have given recognition to the intangible property right in trademarks by virtue of prior use.

The American exporter is often confused, if not misled, by the expression of the term "prior user" when considering the rights in trademarks, labels, or other means by which he identifies his products shipped abroad. Considering this expression from a general viewpoint, it would seem that he who first adopts and uses a mark in connection with his goods would generally be considered as a prior user and within the expression of the laws of most foreign countries that a prior user is entitled to the registration and exclusive use of a trademark.

It must be understood that provisions in foreign trademark laws protecting the rights of a prior user are intended to cover only prior use within that particular country and, although one has adopted and is the prior user of a trademark in his home country, the property right acquired thereby is not extensive to other countries where the rule of prior user prevails. It is often because of this misunderstanding regarding such provisions in foreign laws that foreign dealers are able to acquire the right to register a trademark and thereby its exclusive use.

In this connection, however, the laws are not uniform and the right acquired by prior user in many of these countries is recognized only for a limited period of time; that is, the prior user may have a registration by another or subsequent user set aside within a given period of time after the registration has been effected. This period of time in which to oppose a registration by a subsequent user varies from 30 days to three years.

While the American exporter should give particular attention to the protection of his marks in the countries where the first applicant of a trademark is entitled to its exclusive use, he should not be unmindful of the necessity of giving earnest consideration to the question of the protection of his mark in the countries where the prior user will prevail. In practically all countries of that group in which the prior user of a mark is entitled to the registration and the exclusive use thereof, it is also advisable to obtain registration since this is prima facie evidence of ownership and may be required in any action for infringement that may be brought later.

Despite the attention that has been given by the American exporter to the intangible right in industrial property in foreign countries, whether it be in the nature of obtaining patents for inventions and useful discoveries; copyright and literary and artistic works; or registration of trademarks, trade names, labels, and containers; there is a steady increase in the tendency abroad to profit by the good will established through advertising and other media by simulating American products and their means of identification.

PUBLICATION TITLES DENIED REGISTRATION

FIRST Assistant Commissioner Kinnan has held that the Fawcett Publications, Inc., of Robbinsdale, Minnesota, is not entitled to register either the words *Modern Mechanics* or the words *Modern Mechanics and Inventions* as trademarks for magazines in view of the prior use by Popular Mechanics Company, of Chicago, Illinois, of the term *Popular Mechanics* as a trademark for a magazine.

The ground of the decision is that the goods are the same and the marks as applied thereto are confusingly similar.

In the decision, after stating that the opposer had used its mark for over a quarter of a century prior to the adoption of the mark by the applicant, had established a large circulation and spent considerable sums of money in advertising, and that if there is a doubt it must be resolved against the newcomer, the First Assistant Commissioner said:

"It is believed this case is controlled by the decision in the case of New Metropolitan Fiction, Inc. v. Dell Pub. Co. 364 O. G. 778, 57 App. D. C. 244. In this case application was made for the registration of the words *Modern Marriage* as a title for a monthly magazine. The opposer proved priority of adoption and use of its registered marks *Marriage* and *Marriage Stories*, (quoting from the decision). The court further referred to the holdings in the cases of Vogue Co. v. Brentano's, 261 Fed. 420, in which the trademark *Vogue* as the name of a magazine was held to be infringed by the use of *La Vogue Parisienne* as the name of another publication, and Art Metal Const. Co. v. Textile Pub. Co., 54 App. D. C. 75, in which the name *The Office Economist* was held confusingly similar to the name *Dry Goods Economist* when used upon similar publications.

"It is clear enough, and the testimony supports the conclusion, that confusion will result from the use of these two names upon the respective magazines."

INVENTOR NEED NOT UNDERSTAND REACTION

IN a recent appeal from the decision of the examiner finally rejecting claims 1 to 5, inclusive, and claims 8, 9, and 10 on a patent recently issued, Shannon Smith, patentee, emerged victorious. Claims 1 and 3 are illustrative of the subject-matter on appeal:

1. A composition of matter for cutting back bituminous material of the character described, said composition including a mixture of quicklime and Glauber's salt in the proportions of substantially nine parts of quicklime to one part of Glauber's salt.

3. A composition of matter for cutting back bituminous material of the character described, said composition comprising light oil and a mixture of quicklime and Glauber's salt in the proportions of substantially nine parts of quicklime to one part of Glauber's salt.

The references relied upon by the examiner are:

Amies (Br), 9929, of 1909; Erwin, 1409088, Mar. 7, 1922; Amies, 951471, Mar. 8, 1910.

Each of the appealed claims is comparatively specific, drawn to a composition of matter for cutting back bituminous material and including a mixture of quicklime and Glauber's salt. Some of the claims include additionally specific proportions of these ingredients and a light oil.

This specific composition of matter for the stated purpose is not disclosed in either of the cited patents. The nearest approach to a disclosure of such composition is found in the Erwin patent, but this patent is indefinite as to the character of the lime employed and fails to disclose the use of Glauber's salt.

The contention of the examiner to the effect that sodium sulfate, broadly considered, referred to in the references, is the same as Glauber's salt, has no basis in fact, Glauber's salt being a specific form of sodium sulfate.

As the applicant's composition is specifically new and as it possesses advantages in the particular use to which it is employed over the compositions disclosed by the references, no reason is apparent why the appealed claim should not be allowed.

With reference to the examiner's contention in his supplemental statement to the effect that the explanation contained in the affidavit of James F. Carle that there is a reaction between the quicklime and Glauber's salt, wherein the quicklime takes up the water of crystalization of the said salt, thereby absorbing a portion of the heat evolved by the slaking of the quicklime to such a degree that the light oils of the bituminous materials are not evaporated, is inconsistent with the specification and claims, which make no mention of such a reaction, it may be stated that such contention is without basis in fact. The claims on appeal are wholly consistent with the original disclosures and the original claims. They are perfectly definite as to the character of the composition and its use upon the bituminous material. They are addressed to one skilled in the art and to practice the invention it is only necessary to employ the described composition in the described manner. An inventor is not required to understand the chemical reactions which take place in a composition, a disclosure of the composition and how it is employed constituting a full compliance with the law (section 4888 R. S.).

The decision of the examiner is reversed.

PAPER TRADE MEN QUIT UNFAIR COMPETITIVE METHODS

WITHDRAWALS of unfair competitive practices in the paper trade are reported by the Federal Trade Commission in two stipulation proceedings, one with a publisher of a monthly magazine devoted to the interests of the paper and pulp trade, the other with a company dealing in paper products.

Details of these particular cases are as follows:

(1.) The publisher of a monthly periodical devoted to the interests of the paper and pulp trade will no longer republish or reproduce printed material published by his competitors when such purported reproduction is not complete, unless he prints along with such information notice to the effect that it is not complete.

(2.) Use of the word "mills" in advertising will be discontinued by a corporation selling and distributing paper products so as not to deceive buyers into the belief that the company owns or operates a mill in which the products sold by it are made, according to a stipulation agreement between the company and the Federal Trade Commission.

BOOKS SELECTED BY THE EDITORS

THE PERSON OF EVOLUTION—*By W. D. Lightall, LL.D.*

THIS is not a book on evolution as the word generally is used, but on philosophy. Science does not attempt to go behind appearances, while philosophy does. Within the past five years a growing group of the world's ablest, most profound men of science—Compton, Millikan, Russell, Wheeler, Whitehead, Eddington, Smuts, Haldane, Needham, and others in high circles—have invaded the domain of philosophy and, though they differ somewhat in their interpretation, their thought centers around what might be called a scientific "religion" of "emergent evolution." Of this new trend, which rationalizes the more common emotional, revealed type of religion, the book under review is a splendid summary of 216 pages.

The central idea is, that the whole Universe, whether "inert" or living, is evolving toward a definite goal, imbued with a reasoning, directive, purposive power or "Outer Consciousness," the "Person of Evolution." Of this superpersonality or composite reasoning being, all lesser individuals, including ourselves, are extensions. This in turn explains our inherited memories, instinctive fears, the so-called instincts of animals; our conscience and altruism; and immortality.

This whole new trend toward a spiritual interpretation of the world is opposed to the materialistic interpretation by which all events are simply the mathematical resultants of causes, without intervention of purpose; likewise it favors the vitalistic concepts of life which, however, seem to most men of science to border on mysticism. The author concludes that "religion and science are not in two compartments, as nearly all the leading theologians and nearly all the leading present men of science say they are." —$2.20 postpaid—*A. G. I.*

WE have been asked a number of times what the italicized initials mean that appear at the end of some of the book reviews. These are the initials of the reviewing editor.

***A. G. I.*—Albert G. Ingalls, Science**

***A. A. H.*—Albert A. Hopkins, Fine Arts**

***F. D. McH.*—Fred D. McHugh, Engineering**

***A. P. P.*—A. P. Peck, Radio, Television**

Where no initials appear the review is by L. S. Treadwell who has responsibility for this department and to whom should be directed any questions that you may care to ask concerning books or other subjects upon which you desire information: Our staff cannot always answer your queries (no small collection of men can possibly envision all knowledge) but it is seldom that we are unable to give some tangible reference.

WAVE MECHANICS—*By A. Sommerfeld, Prof. Physics, Munich*

THE rapid succession of published papers on the theory of the atom and on atomic phenomena generally makes it almost impossible for the ordinary physicist to realise the present position of his subject. Professor Sommerfeld has brilliantly performed the task of surveying all the recent important developments and has also treated a number of the older facts in a new way. The achievements of de Broglie, Heisenberg, Schrödinger and Dirac are clearly set out, and it is shown how the weaknesses inherent in the Bohr atom have in many cases been successfully overcome. The work is almost wholly written in higher mathematics.—$6.40 postpaid—*A. G. I.*

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THIS seventh edition of an English work covers the entire subject most thoroughly in 162 pages, with a final chapter on small commercial and household refrigerating plants. It is a history of refrigeration as well as a text book of current practice and is a reference of international comprehensiveness.—$10.25 postpaid.

INDUCTION COILS—*By F. E. Austin*

THERE has been real need for a work on this subject because of its application to automobiles, telephony, wireless telegraphy, and X-ray diagnosis. This little volume so trenchantly and completely presented will be welcomed by those who have been unable to uncover this information in other sources. Specific instructions for building large and small coils to operate wireless outfits are also included. A most complete and satisfactory presentation.—$1.15 postpaid.

ABC OF GLIDING AND SAILFLYING—*By Victor W. Pagé*

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THE CONQUEST OF LIFE—*By Theodore Koppanyi*

THE subject of this 256-page book is biology—anatomy, embryology, evolution, heredity, physiology—but it is not at all like a textbook, rather is it designed for pleasant, though serious reading. The author has chosen some of the "pleasant spots" of this big broad science and dwelt on them at considerable length and with more than considerable interest. The chapter on the endocrine glands and the one entitled "Masculine and Feminine" are especially notable.—$2.15 postpaid—*A. G. I.*

THE GREEN LEAF—*By D. T. MacDougal, Carnegie Institution*

THE "major activities of plants in sunlight" (sub-title of the book) have been kept too largely in the dark and many of us therefore think of plants as dull inanimate things. But Dr. MacDougal's new book—which, by the way, concerns mainly what goes on in the insides of plants, an aspect we seldom hear of—shows that they are almost as human and interesting as monkeys. The "visit to the green-leaf mills," in which we actually crawl into a manhole in a 100,000-times magnified leaf and climb around the interior, reveals what a lively chemical laboratory a leaf is. Other inquisitions on trees bring to light whole factories full of hustle and bustle and machinery, of which most of us are not aware, perhaps because, unlike animals, trees do not roar or bark. The author's life work has been devoted to research on these silent manufacturing centers and the book represents information at first hand from a noted man of

FROM RECENT PUBLICATIONS

science. In addition it is full of interest; for example, such things as that a healthy tree manufactures lumber at the rate of one broomstick a day.—$2.15 postpaid.—*A. G. I.*

THE MOUND BUILDERS—*By H. C. Shetrone, Dir. Ohio State Arch. and Hist. Soc.*

FOR a long period of years there has been no up-to-date, all-around treatise on the mound builders, but at last one has been published and it is a rarely good one. Dr. Shetrone, than whom no scientific authority is better fitted to write on this subject, has made a splendid round-up of the whole field. The book has two parts, 165 pages being devoted to the various cultural phases of the mound builders, while in the remainder of the 500 pages the known mounds, of which there are myriads, are taken up systematically region by region, state by state, from Gulf to Canada and Atlantic to the West, and dealt with in detail. Finally, the intriguing question "Who were the mounders?" is discussed scientifically. The style is wholly non-technical and replete with interest, while the handsome, rather large volume (6½ by 9½) is printed in good type on fine, heavy, filled paper, has 299 illustrations, and is attractively bound. This book doubtless will be *the* standard work both for reading and reference during many years to come.—$7.70 postpaid.—*A. G. I.*

THE SECRETARY'S GUIDE—*By C. O. Sylvester Nawson*

NO more useful little book has come to our desk in a long time. It covers thoroughly, in most condensed form, the correct modern usage for spelling, compounding, capitalization, punctuation, abbreviations, figures and numerals, sizes and styles of type, use of italic, spacing, proofreading, correspondence, and diction. It goes at once on our reference shelf and we predict it will be used frequently as its general utility is much greater than the name indicates.—$2.15 postpaid.

THE ENLARGEMENT OF PERSONALITY—*By J. H. Denison*

THIS is not a psychological treatise in the sense we generally understand that term, but a common sense discussion of the facts of consciousness which are a matter of common experience and of historic record and a suggested interpretation of them. If a man is given a new and different idea of what he is, that idea in many instances will so recondition his reactions that his behavior and character will be materially altered. The process and proof are carefully developed by the author.—$3.20 postpaid.

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NEW WAYS TO MAKE MONEY—*By Roger W. Babson*

"TO help young people in selecting a vocation which has a great future"—to quote the author. Incidentally we might add that the adult might well give it careful reading for the keen insight into industry and business which with swift, decisive, almost curt sentences outlines the various opportunities in a wide variety of lines of effort. There have been other good books on "Choosing a Profession" and so on, but none to our mind quite so inclusive yet almost statistical in its briefness, as is this text.—$2.65 postpaid.

ROUGH AND TUMBLE ON OLD CLIPPER SHIPS—*By Captain Bob Ramsay*

THIS rousing, hearty story by an old shell-back is vivid with life, character study and tales of feats of the fast clipper ship in strange seas and foreign ports. It relates adventures of shark fighting, mutiny, and stern discipline, material ranging from deep sea diving to navigation on the Great Lakes. Primarily, however, the real rough adventure which attended the heyday of navigation is the keynote. A real tale by a real sailor.—$3.20 postpaid.

THE WILD GRIZZLIES OF ALASKA—*By John M. Holzworth*

THREE years collecting material for the U. S. Biological Survey enabled the author to study the grizzly and big brown bear as well as mountain sheep and caribou. An experienced scientific observer with all the enthusiasm of the tenderfoot writes in conversational style of most adventurous experiences, many of which give an entirely different idea of these wild beasts from that generally understood by most of us. 95 beautiful photogravure illustrations.—$5.20 postpaid.

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AN accomplished Turkish girl of distinguished ancestry gives an intimate picture of the daily life of an official family during the period of the struggle for freedom from the tyranny of the times and of war. All the hopelessness of oppression, the hopefulness of brighter days ahead, the swaying back and forth of the fortunes of war and despotism are depicted with an extremely facile pen, to make a story that is truly unique in subject matter and viewpoint.—$3.20 postpaid.

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AN accurate description of some of the worst plagues that have afflicted the world and the way man found out about them and conquered. Also an appreciation of many of the valiant men and women who have been responsible for some of the most dramatic events in human history—a story abounding in pathos and heroism. The author is an expert in public health, so he brings to the subject sound knowledge and fervent enthusiasm.—$3.65 postpaid.

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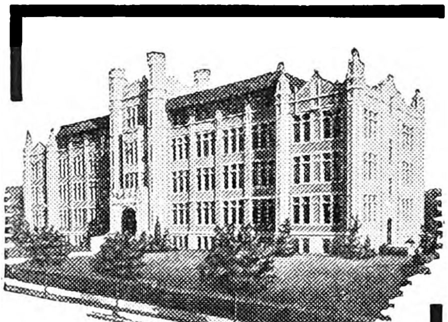

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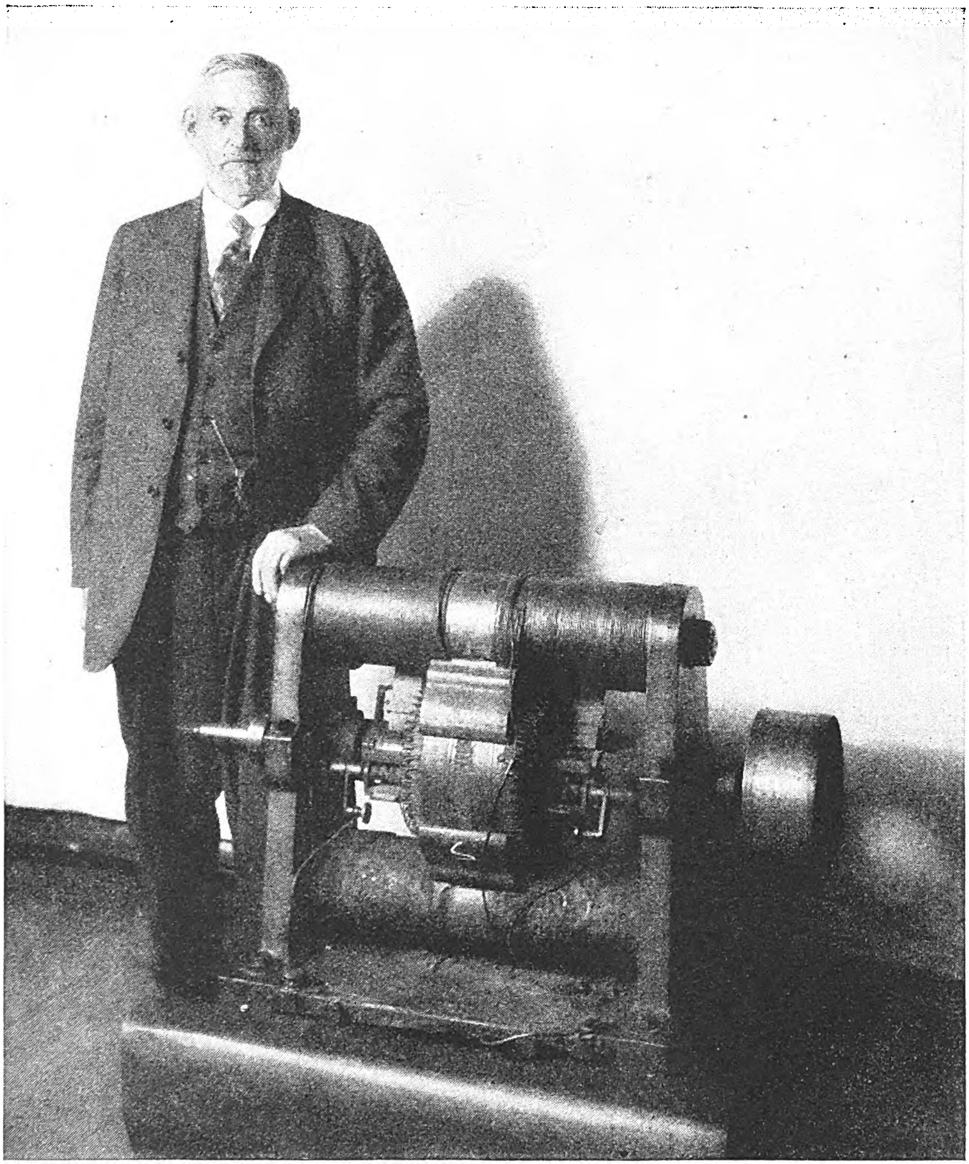
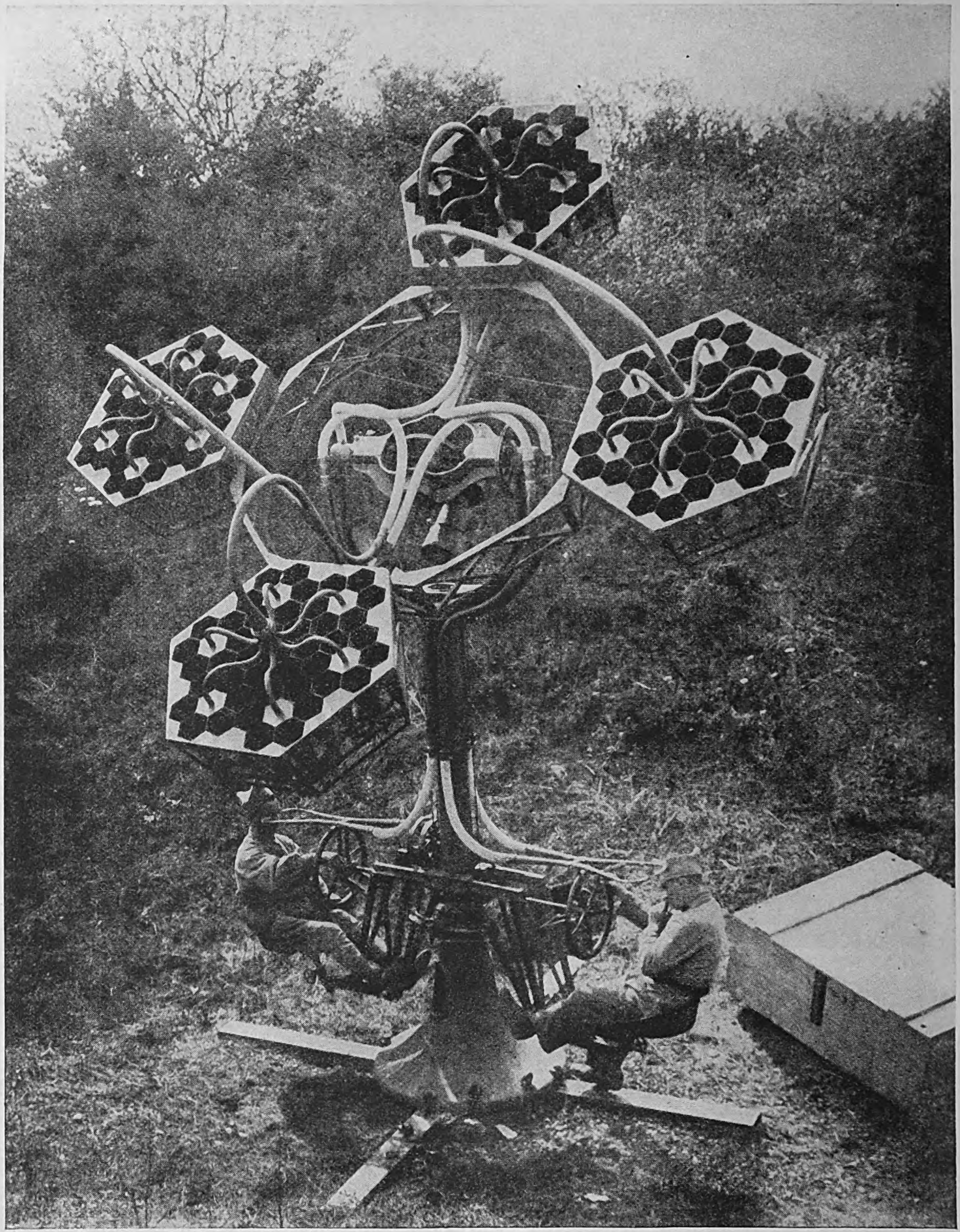


Photo by Troy

TWO SURVIVING PIONEERS

THE first dynamo built in America, like the surviving one of the two Cornell professors who built it in 1875, still is in perfect working order at Ithaca, New York, where it furnishes power to the students' shop in the physical laboratories of that institution. "In 1875" says the physicist Edward L. Nichols in the *Cornell Alumni News,* "Gramme brought out in Paris his form of dynamo machine, and no sooner had the description of it reached this country than Anthony and Moler (Professor W. A. Anthony and Professor G. S. Moler—the latter appears in the picture, which is recent—Ed.) undertook to build one. Long before the first imported dynamo reached America this machine was successfully completed and in operation. With it, before the close of the year, arc lamps were installed on the Cornell campus and were put into regular service, and thus it came about that inhabitants of remote farms among the hills of central New York saw the arc light shine out nights, years before the introduction of this means of illumination in Paris, Berlin, New York, or any of the great cities of the world." Professor Moler told a member of the SCIENTIFIC AMERICAN staff that he and Professor Anthony were forced to wind all the wire with home made insulation. Insulated wire was not available in 1875. The wiring of the outdoor lighting system was underground and the cables were made by drawing copper wire through gas piping and pumping tallow into the pipes, a method which nevertheless proved very satisfactory.



Courtesy *Illustrated London News*

NEW "EARS" FOR FRENCH ANTI-AIRCRAFT GUNNERS

TO keep pace with the great strides made by military aviation since the war—that has been the problem of the anti-aircraft sections of the artillery of all nations. The efforts of the French to do this are symbolized by this new device, by means of which ground crews listen to the approach of an enemy plane, "focus" upon it, and determine its position and altitude. While no details have been released concerning this apparatus, which was tested in recent French aerial maneuvers, it is said to register the sound of planes 20 miles distant. Although aero-detectors have been demonstrated before, this one is interesting because of its novel construction.

Plowing in North China. A man is often a more economical draft animal than a mule

A 4000-YEAR FOOD EXPERIMENT

By **WILLIAM H. ADOLPH, Ph. D.**

Associate Professor of Chemistry, University of Nebraska.
Recently appointed Professor of Chemistry, Yenching University, Peking.

THE average Chinese lives on but a few cents a day. This is not a myth, nor is it a sign of poverty; it is a simple statement of an economic accomplishment of which China may justly feel proud. We in spendthrift America should at least stop and honestly study China's sane solution of her food problem.

The brief experience of the Occident becomes ridiculously insignificant when compared to the 4000 year experiment which the Orient has conducted on the feeding of large numbers of people. In present day laboratory studies the scientist measures the nutritive value of a diet by feeding tests upon a small colony of perhaps ten or a dozen caged animals. The experiment is brought magnificently to a close after 30 or 40 days, during which the white rats for example have grown or failed to grow on the diet in question, and the conclusions are pronounced with due finality; only recently has it been realized that laboratory feeding experiments must often extend over not only several days, but over several generations before satisfactory conclusions can be drawn.

But here in eastern Asia is a colony of 400,000,000 people who in response to various environmental factors, and possibly racial factors, have adjusted and readjusted their food habits until the present *status quo* was reached! And this condition of established food habits would seem to have remained unchanged for the last thousand years or more.

We, with our new civilization, are still undergoing adjustment to new environmental and economic influences and have not yet reached a state of stable equilibrium. In laboratory experiments, a nutritional equilibrium such as the Chinese would seem to have attained is exactly what the biochemist seeks. The thoughtful nutrition chemist loaded with the faddist lore of the Occident can not but sit as a humble observer before this long term experiment and its accumulated mass of evidence. The Chinese would seem to have sensed certain fundamental principles of food supply long before they were discovered by the up-start West.

The Author

CHINA from ancient days has been an agricultural country, and it is still essentially agricultural. Certainly less than 10 percent of the population are found in the large cities and even these are mainly engaged in trade or industry involving agricultural products. The encroachments of the new industrialism may soon begin to alter this state of affairs, but so far there has been little measurable change. The majority of the people eat what they raise. China continues to feed herself largely in terms of a hand-to-mouth operation. The very thoughts of the people, and the language background, are agricultural. A man's wealth in China is expressed not in dollar marks, but in acres of land. An institution in America may possess an endowment of so many million dollars; in China it is endowed with so much land.

The race for the almighty dollar becomes in China the struggle for land, and this in time produces population pressure. The American and European can calculate the amount of money needed to feed and clothe each member of his household per year. The Chinese glibly reckons this factor in terms of land area, or *mow*. In Shantung, it requires three *mow* to support one man; or, poorer land would be rated as four-*mow* land.

This situation means that practically every available plot of land is under cultivation. Farms may be little more than a single furrow or two hanging on the mountain slope. It is significant that

TABLE I

Composition of the Chinese Dietary
(in percentages by weight)

	China North	*United States*
Cereals and beans	65	25
Vegetables and fruits	27	20
Butter; fats; sugar	1	14
Meat and fish	4	18
Eggs	1	5
Milk and cheese	0	15
Other foods	2	3

the size of a family is commonly expressed as consisting of so many "mouths," much as industrial Europe and America refer to so many "hands." The primary aim of each household is to work that bit of land intensively enough to keep the family alive for another half year, or until the next harvest. Ambitions in the big majority of homes do not proceed very far beyond this sphere. This tremendous pressure for a livelihood is not a condition of recent years, but history shows that in very early times there were laws in China regulating the conservation and distribution of food. Our science of national food economics, urged upon us by the World War, is hardly a 20th Century discovery!

A Chinese highway eighteen inches in width effects a saving in land area available for cultivation, which means food for more mouths

TABLE 1 shows the character of the middle class Chinese diet compared with that for the United States. It is a cereal diet. While these figures are for north China, they are in general true for south China also, except that in the northern third of China the cereal is largely wheat, used as wheat bread, while in the southern two thirds of the country the cereal employed is rice. The common assertion that the Chinese live on rice is therefore only two thirds true. The division into north and south China, that is, a wheat-eating region and a rice-eating region, is a well-recognized one. Habits of life, climate, and agricultural conditions in these two areas also differ greatly. North China has a dry climate; south China is wet. Data now being accumulated for south China, while as yet incomplete, indicate that the only real difference between the dietary of the two areas is in the replacing of wheat by rice. The same fundamental laws of food economics hold throughout the country.

The important place occupied by legumes (this means the soy bean) in China deserves more than passing mention. Of all the varieties of beans, it is nothing short of remarkable that the Chinese farmer-dietitian, thousands of years ago, chose to develop and retain in his agricultural repertoire just that one variety which contained the highest percentage of protein, and also the highest percentage of fat. The soy bean was the one vegetable product which could in any sense replace meat in his dietary. But the soy bean and its wonders is another story.

It is evident that China is not addicted to the meat eating evil. Table 2 shows that the daily food intake represents a total of about 2800 calories. But of this amount, 87 percent is derived from cereals and beans, while only five percent of the calories is supplied by meat and fish. And these data do not represent the farmer class, but are those of the middle class Chinese. Meat is relatively more expensive in China than in America and Europe. The peasant farmer consumes practically no meat at all, except for an occasional indulgence at the time of the Lunar New Year. It is probable that the Chinese approach as near to being a truly vegetarian people as is to be found anywhere on the earth's surface.

Figure 1 is a "dollar diagram" indicating the manner in which the average Chinese family divides its expenditure for food. The Chinese housewife very evidently spends her food dollar in a different manner than do we. It is to be noted that eggs are used only in small quantities; milk and dairy products are conspicuous by their absence.

Meat and cereals are important because of their protein content. Protein of course is the all-important nutritive factor of all foods. The nutrition chemist of a generation ago devoted his energies to determining the total number of grams of protein consumed by the individual per day. It was not then known that the kind of protein was as important as its quantity. We now know that the amount of protein is only part of the story. One hundred grams per day (about 35 ounces) is regarded as the protein requirement for the average adult in the Occident, weighing 70 kilograms (154 pounds). In America we actually consume far more than this amount; the Chinese consumes somewhat less. But when, in addition to this, it is remembered that a vegetarian diet is a much bulkier diet than the meat-containing diet of the Occident, and that the degree to which this protein is utilized in the alimentary canal may be reduced by the very bulk of the food to 50 or 60 percent of its original value, one realizes that the Chinese receives in reality an extremely small amount of protein nutrient daily. In fact, the actual intake for a man of 60 kilogram weight on rice diets may be only 35 or 40 grams (about 14 ounces) per day. This low protein diet again represents a habit of long standing. Have the Chinese indeed accommodated themselves to a lowered protein intake? And if it should be proved that they have done so successfully, perchance the figure for protein requirement which we have established will need revision.

DIETARY surveys show that 91 percent of the protein consumed is of vegetable origin, while nine percent proves to be of animal origin. In America about 80 percent of the protein consumed per day is from animal sources. Much has been written on the relative merit of animal and vegetable protein, of the meat *versus* the vegetarian diet. It is commonly suggested that the aggressive peoples of the world consume large quantities of meat. Table 3, taken from Robertson's "Principles of Bio-chemistry," expresses quantitatively the meat eating habits of the nations. The figure for China has been added to this table by the author and is based on

TABLE II

Composition of the Chinese Dietary

Intake of protein, total energy value, and so on, per man per day (Figures are for North China).

Total food	1188.0 grams
Total protein	86.4 "
Total fat	34.1 "
Total carbohydrate	537.0 "
Total energy value	2794.0 calories
Weight of average man	60.0 kilos

observations in Chinese homes and on such trade reports as were available. One wonders whether it is possible to explain certain of the racial characteristics of the Chinese in terms of this low per capita consumption of meat.

That a vegetarian diet rather than a meat diet holds sway in China can be traced to economic factors. The food-consuming animal is a mechanism which transforms food energy into heat or work or even into other forms of food, as into meat for example, which can again be used as food; the animal body, in short, is a converter. Studies in this country during recent years have shown the relationship pictured in Figure 2, which indicates that the transformation by cattle of food cereal into milk or into meat is always attended by considerable loss, a "transformer loss." China in her unconscious way has realized this. At least she has realized that the cereal grains are most economically employed directly as human food.

AND yet this knowledge is not solely unconscious knowledge, for the peasant farmer will tell you that he can obtain a greater return per acre by growing peanuts and extracting the peanut oil than by pasturing a cow in this same field and manufacturing butter or cream—which is merely another variety of oil—from the milk. In fact he knows this so well that for the past thousand years or so he has not even regarded it as worth while to perform the experiment. Just here, incidentally, lies the economic stimulus for our own vegetable oil industry. And we of the West have just come to the stage of measuring these things and have discovered that they are quantitatively true. Do we wonder that China eats little meat and that there is practically no dairy industry!

And the Chinese use of pork is equally startling. Only recently has it been demonstrated by modern science that an acre of ground in the form of pasturage produces two pounds of pork for every pound of beef or mutton. So when meat is used in China, it is pork. The laws of economics have dictated far more of the actions of the Oriental than we realize. A man instead of a horse pulls a ricksha because a man is a machine weighing only 60 kilograms and its cost of maintenance is less than that of a horse which is, say, a 600 kilogram machine.

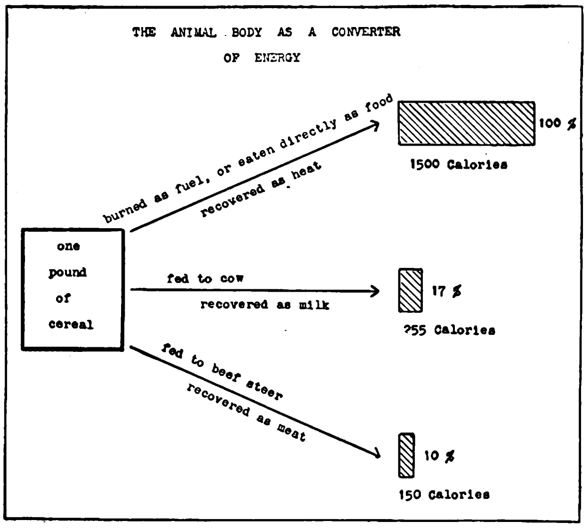


Figure 2

In times of special stress affecting the food supply, such as may be brought about by famine, the farmer tends to dispose first of his draft animal, a luxury. Even when there is no famine at all, it often becomes more economical to hitch a man to a plow than to use a mule. The one-wheeled cart, which requires only a narrow, 18-inch-wide path for its operation and thereby saves more tillable land to the fields on each side of the road, is but another instance of the manner in which economic laws hold the commanding position.

Blind experiment, that guiding angel of the Orient, was kind. It taught the Chinese the importance of vitamins, or at least the importance of vitamin-containing foods. Today, recognizing the importance of vitamins and similar food essentials, we wonder that China not only survived but flourished on a straitened food supply. But China has long been making use of green vegetables, spinach, cabbage, and so on, and fruit. And we of the Occident, having just discovered vitamins, are now busy haranguing our housewives and urging greens in the diet—and often with ill success. Wheat protein and rice protein are now known to be incomplete proteins, but recent American patents suggest that wheat protein should be supplemented with soy bean flour. Effective combinations like this were in fact *discovered* by the allied food experts during the World War and were served to the soldiers at the front in the form of "war bread." China, on the other hand, has for centuries been making use of similar combinations of protein food materials. In addition to this, infants deprived of the nourishing protein of cow's milk are insured the growth-promoting essentials by being breast-fed till three or four years old.

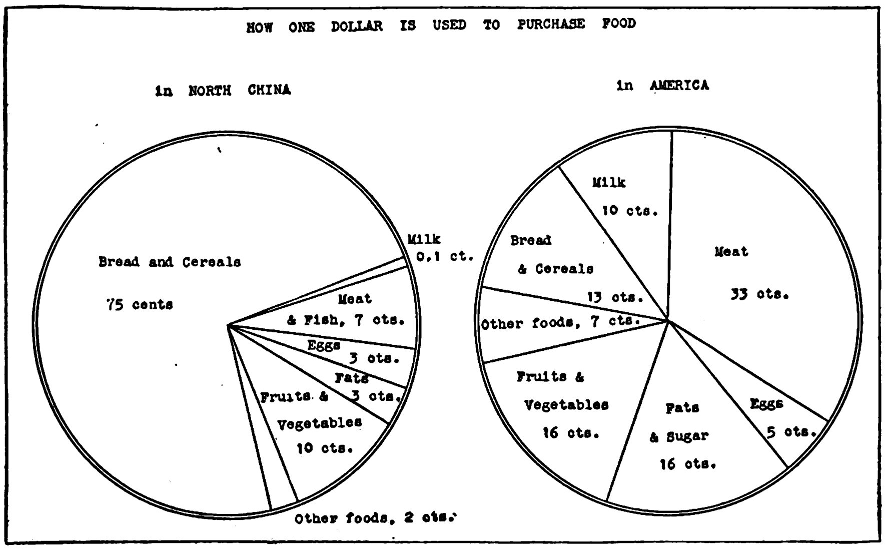


Figure 1

THE great bulk of the Chinese vegetarian diet is often looked upon by us with suspicion. It is such a considerable factor that the Chinese student coming to America finds it difficult to adjust to the smaller bulk of our more concentrated mixed dietary. He asserts that a period of a month or more is required till the digestive system accommodates itself to our small bulk meal. During this period of accommodation of course he finishes each meal with appetite still unsatisfied, and goes hypothetically hungry. We of the West formerly asserted that our type of diet was more concentrated and hence more efficient. But our own dietitians now urge roughage—and more roughage. The Chinese diet however, means a freedom from the multitudinous intestinal disturbances which affect the Occident. Laxative pills are not every-day essentials, and druggists in China must look elsewhere for means of livelihood.

Does the Chinese metabolize on a more efficient plane? Much interest has developed during the past few years in the basal metabolism of the peoples of eastern Asia. A few years ago an experiment at Teachers College, New York, upon a few Chinese women students indicated a much lower basal metabolic rate than would have been expected in the case of American women

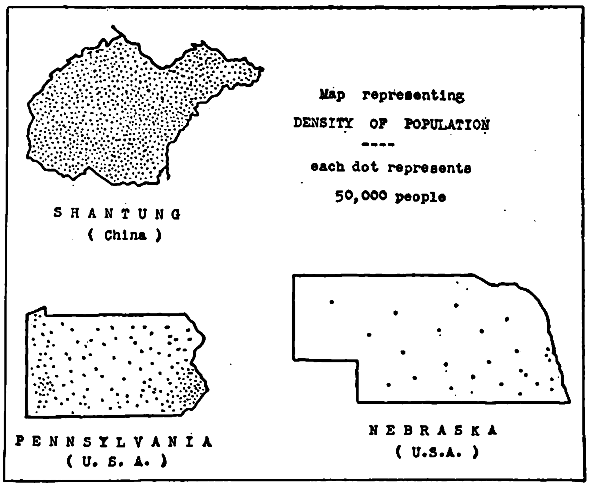


Figure 3

students. The basal metabolic rate, about which our physicians are beginning to talk in such familiar terms, is nothing but a measure of the energy required just to keep the human engine alive at rest without doing work except that involved in breathing and the other essential functions. Does this lower figure mean, the physiologists all asked themselves, that the Chinese human mechanism is a more efficient machine than that of the European and American? Does it mean, asked the nutrition chemist, that the Chinese people need less food to keep them alive than their American neighbors of equivalent weight?

More exhaustive data is now being obtained; portable metabolism outfits have been sent by the Carnegie Nutrition Laboratory of Boston to different parts of the world to settle this point as it applies to the different races. It may be suggested that the lower figure for basal metabolism is the normal for the human race, and that the rush of the Western civilization has merely produced a higher metabolic rate in the Occident, while the philosophic Orient has avoided this abnormal high tension effect. Or the low metabolic rate for China, if confirmed, may merely indicate that the Chinese can truly live longer on a lower ration than is required by the European.

TABLE III

Meat Consumption of the Principal Countries of the World

(grams per capita per day)

United States	149
Great Britain	130
France	92
Belgium and Holland	86
Austria-Hungary	79
Spain	61
Russia	59
Italy	29
Japan	25
China (North)	15

Are metabolic traits inherited or environmental? The dietary and metabolic habits of a race presumably either are inherited or are the result of the reactions of environment. The very fact that Chinese leaving China and Occidentals domiciling in China find that certain physiological reactions are temporarily altered would point strongly to environment as the influential factor. North China and south China each represent different types of climate and diet, and when the southern Chinese migrates to north China and adopts north China food, his sons begin to approach in height and weight the higher standards of the northern part of the country.

Environmental factors often do not reveal themselves in a single generation. The Japanese who settled in the United States a generation ago are now developing a larger physique approaching western standards. Cantonese from south China who emigrated to Hawaii are now, after several generations, attaining greater physical height than they did in south China. The blood pressure of Americans moving to China approaches the lower Chinese standard, while Chinese coming to America tend to approach the higher American norm, while the basal metabolism itself of the Westerner moving to south China is apparently lower than it would be at home.

MANY different races now compose the white population of the United States, yet we generally agree that the same physiological standards hold for all of them; at least there have not been discovered among them distinct racial reactions of a purely physiological character. The so-called racial characteristic as distinguished from the environmental factor would therefore seem ultimately to disappear in the realm of food and metabolism.

While it may be a distinct accomplishment to have been able over long periods to feed a nation on a minimum food intake, this habit of merely maintaining an existence has provided no insurance against interruptions in the regular food supply. The tables and figures reproduced in these pages indicate that the Chinese people live constantly on the fringe of starvation. There is absolutely no margin or reserve. A famine in China is primarily a violent disturbance of the delicately balanced economic *status quo*—so violent that the common people find it difficult or impossible to buy food. Drought, floods, grasshopper pests, revolution, are disturbing agents. And they are usually augmented by ill-developed means of communication, such that the areas with excess food supplies can not automatically unload their surplus unconsciously, as is done in America, on the regions where the demand is high and the supply low. One crop failure in a district brings about enormous suffering; two crop failures result in famine and starvation; and three successive crop failures in the same district produce havoc and devastation.

MOREOVER, human beings in China do not always die of starvation to the extent that they die from disease caused by a weakened physical condition. Food intake and health are closely related and famine studies show how a very slight lowering of the quality and quantity of food intake produces immediate disaster.

China, while receiving credit for a finely balanced solution of her food supply problem, is at the same time face to face with the fact that the prosperity of the nation demands not mere maintenance, but an optimum metabolism expressed in terms of improved growth and vigor. It is hardly to be doubted that in this modern age, with its new demands, China will rise to a solution of these newer problems with all the thorough-going capacity which she has displayed in the past.

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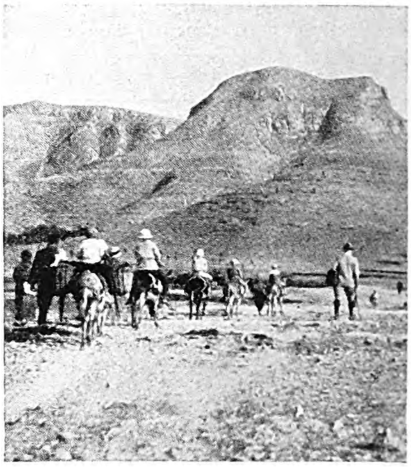
¶ *When Professor Goddard's exploring rocket soars 50 or 60 miles aloft what scientific instruments will it carry? What will be their purpose and what the practical value of their findings? Next month this will be explained clearly and simply.*—The Editor.



One effect of population pressure: a deforested mountain in North China. Population pressure results in the unconscious discovery of some valuable methods, such as hogs as the most efficient source of meat, but the deforestation that also occurs is not one of these

OUR POINT OF VIEW

SPEND FOR PROSPERITY

UNTIL a few months ago, there was, among industrial and business men and all people of the thinking class, a feeling of optimism regarding the economic depression, an optimism not of the Pollyanna sort but rather of a constructive nature. Many splendid plans were advanced as possible means of stimulating business recovery but nothing much has been done toward adopting any of them. And now, even the thinking optimists, as well as the Pollyannas, have turned lugubrious pessimists.

What is the matter with the American people?—that "race" which is famed for and vaunts its ingenuity, industriousness, and ability to the world. They are not unaccustomed to slumps; they've had them before. Where is that comeback, that fight, that will-to-win, bear-for-punishment spirit? Are they, to whom the world looks for a certain amount of guidance and, unfortunately, with envy and hate sometimes, because they *have* possessed a progressive spirit and an acquisitive instinct—are they to be cowed, to admit defeat and wait for someone else to start the world back toward normal conditions? Usually only the mongrel dog slinks away, whining, with his tail between his legs.

The country is not in such a bad state, after all. September disbursements of dividends to shareholders were nearly 76 millions of dollars more than for September, 1929. There was a large increase in the number of dividends omitted and reduced, but the total disbursements were 475,094,394 dollars compared with 399,391,264 dollars in September, 1929. This can mean only one thing: that while many businesses have suffered losses, many others profited far more than they did before the slump. There may be drawn from this the conclusion that if some can prosper, others can at least make a new start and grow. But somehow it hasn't seemed to work that way.

Long-established and vital industries that have withstood for months the laments of the pessimists, have at last succumbed and inaugurated programs for retrenchment that are sure to have a devastating effect, not only because they will withdraw many millions from circulation but also because they will further lower the morale of all those who hear of them. And the distressing part of it all is that our greatest customers, the American workingman and the small-salaried office man, are always the first to feel each new blow. They are discharged in hordes without the slightest prospect of obtaining other employment. Their purchasing power is lowered, business suffers further, and old man "vicious circle" is at work again! And even the man with a job becomes frightened at the possibility of losing his source of income and hoards his money "against a rainy day"—more money out of circulation!

DANIEL GUGGENHEIM

IT is our sad duty to record the death of Mr. Daniel Guggenheim, capitalist, philanthropist, and patron of aviation, on September 28 at the age of 74. Known chiefly to the country at large as the donor of the Daniel Guggenheim Fund for the Promotion of Aeronautics and vaguely as a "copper king"—vaguely, because while his power was tremendous, it was quiet—his interests spread over the world like a far-flung empire.

Mr. Guggenheim's business ability and progressiveness brought continual success to his endeavors but as his power grew, so apparently did his humanity also grow. Identified with the early romance of American mining, expanding his interests to other fields, and ever persistent in his encouragement of scientific research in industry, he yet had time for art and music and flowers. He gave liberally yet quietly, dealt fairly with all, and was imbued with a public spirit that few could equal.

In the death of this valued citizen his friends have suffered an incalculable loss. But his greatness transcends the limits of ordinary personal friendship; in him was the warmth of a great soul, a warmth that radiated outward through contact with him and his philanthropies to touch thousands whose lives, expanded and made finer because of him, shall be his greatest memorial.

In a case such as this it is easier to diagnose than to prescribe. One thing is certain, however, and that is that the American people, collectively and individually, must start a veritable orgy of spending. They must stop hoarding for a while, stop being frightened, stop crying "hard times" and put money into circulation, thus creating a great demand for all sorts of things the manufacture of which will make the wheels hum again and bring a return of prosperity. Time enough, after that is accomplished, to save!

Along with others, we have given up hope for any real help from business itself, and now appeal to the individual. And if that individual is one of those who persistently passes the buck to the other fellow, who is always perfectly willing to "let George do it," we venture to say that if he doesn't cooperate this time, the other fellow, George, may get his job!

INTERNATIONAL AFFAIRS

The Deplorable Cut In Naval Personnel

WE are convinced that the recent announcement by the Navy Department of a contemplated reduction of 4800 enlisted men in the Navy will be a distinct disappointment to the American people, a large majority of whom are willing to be taxed for the support of the Navy. The unplausible attempt to connect this reduction with the provisions of the London Conference will not impose upon the general public, who were only recently told by the Administration itself that a large new building program would be necessary to bring our fleet up to the allowed treaty strength. Obviously, ships without men are useless, so the proposed cut means either that the Administration has no intention of building a treaty fleet or that it does not propose to man it after construction.

The accompanying statement that our fleet is to become a "training nucleus" will still further alarm our people who have been taught to believe that a large standing army is unnecessary because our fleet would be maintained as a sure and ready shield, behind which our skeletonized peace army could expand to war proportions. Now we are to have a skeletonized navy as well as a skeletonized army. The term "training nucleus" has a comely sound, but the American people have too long regarded their fleet as their first line of defense to be charmed by any new catchword, however beguiling.

We also fail to see the consistency of the Administration discharging 4800 sailormen in the present condition of unemployment, while at the same time it requests private employers to refrain

(*Please turn to page 486*)

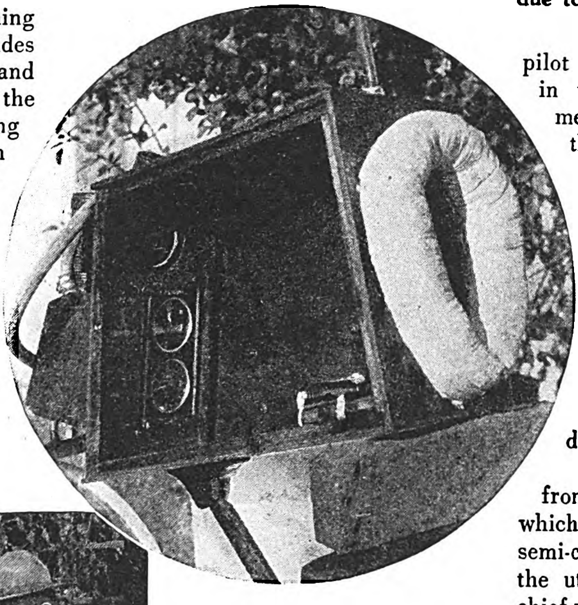
Captain Ocker and Major Mileau, flight surgeon, giving a test with the Barany chair. After a few turns in the chair with his eyes closed, the subject almost falls out of the chair due to effects of vertigo or dizziness

not due to any asymmetries in the legs or other parts of the locomotor organs of the body generally, such as right-handedness.

“One and the same person may walk or swim or drive both right spiral turns and left spiral turns in different experiments or sometimes in the same experiment. No apparent difference is observed in the direction of turning that is referable to difference in age, sex or right- or left-handedness. Spiraling is not a conscious phenomenon. Consciousness gets no direct repeat from the spiraling mechanism. A blindfolded person is conscious of swimming or driving a straight path when he is actually going in spirals. The spirals are smaller, however, when the attention is not intensely directed on the manner of making each step, but is occupied with counting the steps or thinking about something else than walking a perfectly straight path.

“Persons who lose their way in forests, snowstorms, and fogs go around in circles because, in these persons, the orientating senses are not functioning and then the spiral mechanism guides the path. Rabbits, foxes, antelopes, and other game, when hard-pressed in the chase, lose the power of orientating themselves through fear and then the spiral mechanism also leads them around in circles.”

This tendency to move in spirals is not lost in the air. It is rather further complicated by the addition of a third dimension with which the pilot must cope. Professor Schaeffer’s report and the experiences of many pilots while flying through fog lead to the belief that this spiral tendency may work in the third dimension and such a compound tendency may readily cause a plane to become tilted at almost any angle while the pilot still believes himself flying on an even keel. Under such a condition, while flying in fog, it would be quite possible for the plane to be tilted at a stalling angle without the pilot realizing it.



At right: Close-up of instrument box for use with Barany chair to show illusions caused by vertigo. _Below:_ Method of using instrument box with Barany chair. Slide removed in both cases to show instruments

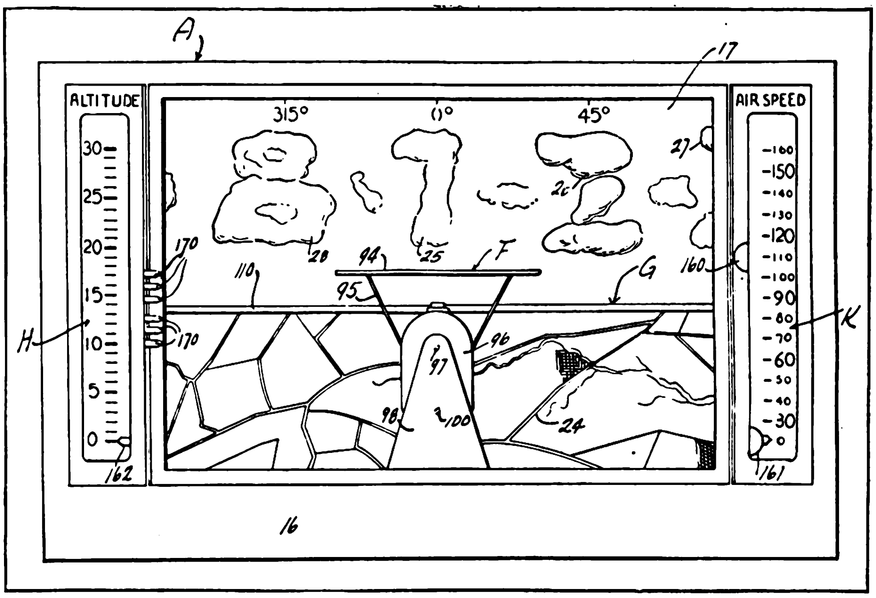
To correct this spiraling tendency and enable us not only to walk in a straight line but to maintain our equilibrium, Nature has endowed us with a number of senses, chief of which are the sense of sight, the vestibular sense, deep muscle sense, and the tactile sense. Tactile sense, or the sense of touch, is of considerable importance on the ground but in the air, with heavy clothing and within closed cabins, this sense is reduced to a minimum and plays only a minor and insignificant part and may be disregarded entirely so far as maintaining equilibrium or a straight course is concerned.

Deep muscle sense, often alluded to by pilots as “feel of the ship” or “seat sense,” includes sensations resulting from stimuli from the muscles, tendons, bones, joints, and internal organs. The pilot has been taught to lay great faith in this sense. There is no known method for accurately measuring this sense but the thoroughly trained pilot appears to develop it and interpret the stimuli to a much greater degree than others. Deep muscle sense is far from being infallible in maintaining equilibrium, however; many pilots have come out of fog to find themselves off their course, with a wing up or down, and even with the plane upside down.

The vestibular sense is derived from that portion of the inner ear which has to do with equilibrium—the semi-circular canals, the saccule and the utricle. These are considered the chief motion perception organs and have been the subject of many investigations as being of great importance in flying. One of the simple tests which have been devised to indicate the accuracy of the vestibular reactions can be made with the Barany chair, a revolving chair with control attachments.

The vestibular reactions are controlled by the semi-circular canals of the inner ear, which are at right angles to each other. By reason of their position, they are stimulated by changes of position of the individual and stimuli received by these organs are interpreted by the brain as sensations of motion. The stimulation of the canals and the reactions observed by rotation in the Barany chair are similar to those produced in actual flight, although the subject is not actually in a spiral dive or tail spin. When rotation stops, the sensation of vertigo, or dizziness, results. If the subject in the chair is questioned after a few turns, it will be found that this sensation of dizziness is actually a sensation of rotation in the opposite direction to which he is being rotated. The individual has no control over these impulses.

Although it is known from actual experience in aviation and from experimental work that the erroneous impression derived from the repeated stimulation of the labyrinth of the inner ear is subject to decrease and duration, no normal person has been known to overcome this illusion entirely. The vestibular sense, then, is one of the senses which govern equilibrium, but without the sense of sight it not only is useless but is actually dangerous because of the illusions it creates. The sense of sight is important on the ground but is much more so in the air.



Flight integrator invented by Lieutenant Carl J. Crane and the author. At the left of painted landscape is the altimeter; at right, the air-speed indicator

THIS special sense is, of course, not infallible for there are such things as optical illusions—a mirage for example—but it is certainly the most reliable. Through sight alone are we able to take bearings on our position and calculate our approximate position in regard to a given point. So long as our sight is not impaired, we may reasonably expect to remain orientated.

Equilibrium in the air, then, depends first on the sense of sight, then on the vestibular sense, deep muscle sense, and last upon the tactile sense. In flying in fog, this sense of sight also fails as there is no fixed point outside of the plane, no horizon to aid in orientating the pilot. The solution of this problem is to have absolute confidence in the flight instruments. such as the bank-and-turn indicator, the inclinometer, and the rate-of-climb indicator. In this connection an interesting psychological problem arises.

Until very recently, all flying students were taught to disregard flight instruments and trust entirely to their "flying instinct" even in fog. As a result, pilots taking the blind flying training, flying by instruments under a covered cockpit, find it hard to disregard their instinct, which they are thoroughly convinced is a handicap without sight, and to trust their instruments implicitly. The older pilots at Kelly Field taking blind flight instruction learned less easily than the younger pilots or the flying students in whom the flying instinct theory had not been so deeply ingrained.

After the pilot has been convinced that he must disregard his instinct, instrument flying is principally a matter of co-ordination. He has been accustomed to moving his hands and feet in accordance with stimuli produced by a landscape at various positions relative to the nose of his plane. In instrument flying the stimuli are produced by various dials which must be read and interpreted before the controls can be manipulated properly. This mental process causes confusion at first but can be managed so that the average pilot can bring his plane out of spirals and spins and fly a triangular course of some distance with considerable accuracy after about 10 hours of training in the covered cockpit. Flying by instruments alone is more fatiguing than ordinary flying and also requires some practice in the covered cockpit when actual fog flying is not possible to "keep in training."

Several new instruments have been developed to lessen the strain on pilots who must fly by instruments alone, of which the Sperry company's directional gyroscope and artificial horizon are two. When a pilot wishes to make a turn of 90 or any certain number of degrees, the magnetic compass is unreliable because it spins when the plane is banked. The directional gyroscope does not spin and the pilot can tell immediately when the desired turn has been made. The artificial horizon shows the pilot the position of his plane relative to the horizon, indicating the angle the plane is banked and whether it is climbing or gliding.

THE flight integrator, invented by Lieut. Carl J. Crane and myself, is still in the experimental stage but gives promise of reducing fatigue and also decreasing vertigo caused by the rotation of the plane in a spin or power dive. It consists of a miniature plane silhouetted against a landscape painted on an endless belt. As the plane turns to the right, the background moves to the left, giving the pilot watching the miniature plane the illusion of turning similar to the impression he would receive were his vision not cut off by fog or the covered cockpit, as the case may be. Skidding or slipping is indicated by tipping of the miniature plane. A narrow white band stretched across the landscape rises above or falls below the horizon to indicate that the plane is gliding or climbing.

An altimeter reading vertically will be placed on one side of the integrator and an air-speed indicator at the other. Thus five instruments will be combined in one, making it unnecessary for the pilot to "chase all over the board" to figure out what the plane is doing, and the plane's movements will be shown directly, eliminating the mental process which is one of the chief causes of fatigue in blind flying. Vertigo is also minimized by the moving screen. When the plane stops turning, the screen stops moving and the pilot is able to orientate himself in a very short time.

The value of being able to fly in fog is readily apparent. It greatly increases military efficiency to be able to fly in all kinds of weather. As for the commercial field, it will increase safety and decrease the number of trips which must be cancelled because of bad weather, principally fog. Only one problem remains—that of landing in fog. When this is solved—and indications are that it will be, in the near future—the menace of fog which has long been aviation's most formidable enemy will be conquered.

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A railroad executive was intensely interested in the intricate details of railroad signalling systems as described in an article soon to be published. We warrant you will be, too.
—The Editor.

ELEVATED HIGHWAY TO SPEED TRAFFIC

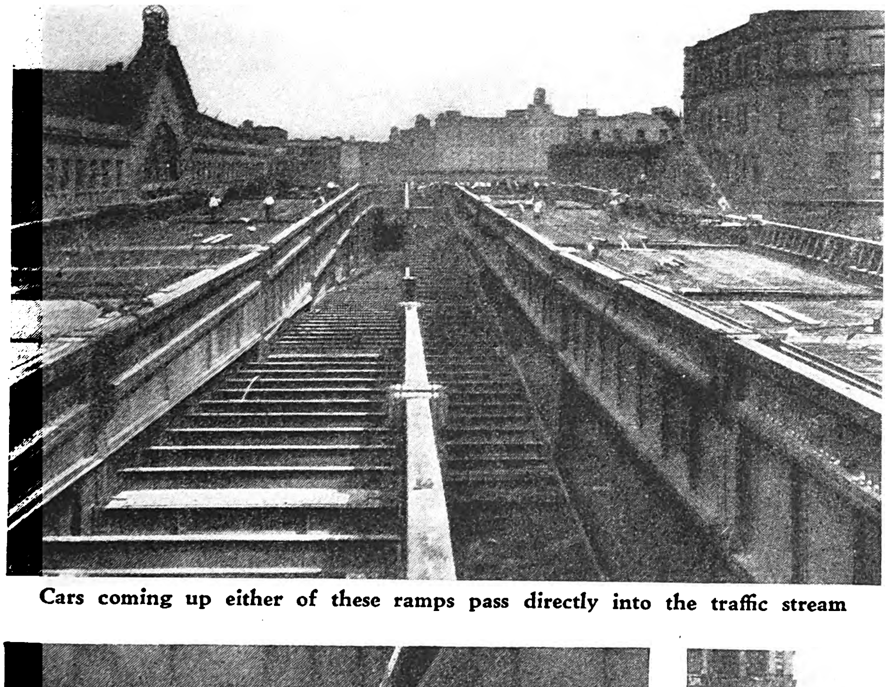
WHAT will be the finest, and perhaps the greatest, highway of its kind in the world, is now under construction in New York City. Built along the Hudson River waterfront, this highway, which may be listed as one of Borough President Miller's important achievements, begins at the Hudson Tunnels at Canal Street and will extend to Spuyten Duyvil, a distance of 14 miles. The lower section, up to 72nd Street, will be elevated 14 feet above the street level. From 72nd Street, it will be a beautiful boulevard covering the tracks of the New York Central Railroad completely.

Ramps will be provided at 23rd, 42nd, and 57th Streets, reaching the center of the elevated roadway so that no cross traffic will occur. This will permit a speed of 40 miles an hour, resulting in a traffic capacity of 5000 vehicles an hour. Approaches will be constructed at nine uptown points, beginning with one at 72nd Street. The roadway will be 60 feet wide to accommodate six lines of traffic and will have the most modern signal system for traffic control, fire and police protection. The architectural design will take care of the esthetic as well as the practical values of the structure.

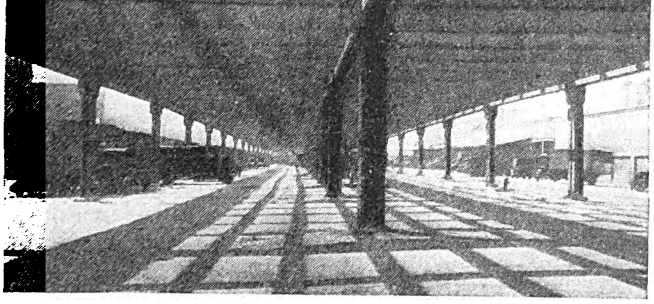
The first section between Canal and 22nd Streets is now nearing completion and may be opened for traffic before this article is printed. Construction of this section involved many difficulties, one of the worst of which was the building of concrete foundations for the 400 columns in waterfront land that was filled in years ago with all kinds of waste materials, soil, and stones.

This great structure will aid greatly in solving New York's north- and southbound, long-distance traffic problem. It is understood that the plan calls for double-decking some time in the future.

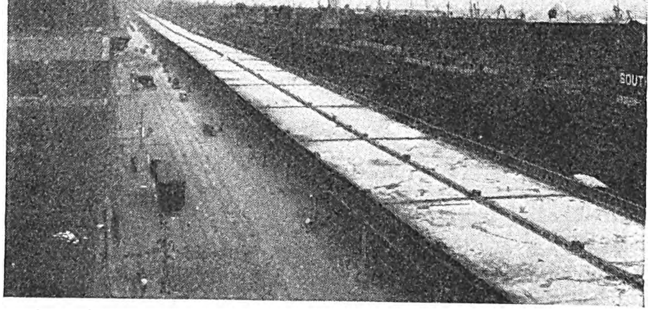
The entrance ramp of the elevated highway at busy Canal Street



Cars coming up either of these ramps pass directly into the traffic stream



Fourteen-foot clearance of the highway on a broad street



Nearing completion: lower section with paved roadway

X-RAY FINGERS FEEL OUT THE ATOMIC STRUCTURE OF MATTER

By **SIR WILLIAM BRAGG, F.R.S.**

Director of the Royal Institution of Great Britain and of the Davy-Faraday Research Laboratory.
Nobel Prize Winner. Author of "Concerning the Nature of Things"

MAN, having the power to forecast the result of overcoming difficulties and the wish to try to overcome them, has devised various ingenious methods to help him in his task. Taking first of all the difficulties that depend on the inadequacy of his vision he has invented the microscope which gives him the power of seeing details thousands of times too fine to be perceived by the naked eye. The spectacles that many of us use may be looked on as making a small step in this direction.

The power over the handling of materials has been enormously increased by the microscope. It has been the chief instrument in the study of metals and alloys, so that whole new branches of metallurgy and metal working have depended upon its use. It is fundamental to the study of the minutiae of fibers, so that textile industries depend on it more and more. It is, of course, the main weapon of the biologist and the bacteriologist upon whom so many sciences rely, such as agriculture, and all the economic development of plant life. In fact the microscope has immensely increased our powers of perceiving the small things and invisible conditions which must be treated sometimes as dangers, sometimes as objects of welcome usefulness. It has widened and enriched our world.

BUT there is a point which the microscope can not pass. With its aid we perceive what is very small, but not the "very very" small. There are regions of minuteness which it can not ever penetrate. The limit is set by a curious natural barrier; natural because it depends on the nature of light. If all the small things which mattered to us were contained within the barrier, there would be no need to try to surmount it, but this is not so. Wide as the fields are which the microscope has opened to us, far wider fields lie outside its range: fields which also contain events and things of first importance. There are details of the structure of the living cell, essential features in the composition of metals, cotton, silk, rubber, paint, bone, nerve, and a thousand other things which are hidden even from the microscope, and must always remain so hidden because the failure does not lie with the skill of the optician but with the incapacity of light itself.

Let us look a little more closely at this curious fact. The process of vision begins first with the emission of radiation from some source. Without illumination nothing can be seen. The nature of radiation is in many respects a mystery, but we know enough about it to understand that we may talk of it in many of its important aspects as waves in some medium which we call the ether. The eye is an organ designed to perceive these waves. If we turn our eyes towards the source of radiation they are filled with the sense of light. If the radiation falls on any object, it is turned aside and modified in various ways. When our eyes are directed towards the object, they take in the modified rays, and we have learned by long practice to know, from these modifications, the nature of the object that has made them. That is "seeing."

THE central point of the process is the act of scattering and modification. Now waves have a certain wavelength, and common experience of such waves as may be seen, for example, on the surface of the sea tells us that an object which is very much smaller than the length of the wave has no appreciable effect upon it. The wave rolls past a cork on the surface without showing appreciable traces of modification, but a rock or the side of a steamer may actually turn it back again. In just the same way there may be objects which are so small that they can not affect a ray of light, and such objects are forever invisible in the ordinary sense. The length of the light wave which our eyes can perceive lies within a short range on either side of a fifty-thousandth of an inch. An object of such small dimension can indeed affect a light wave, but the parts of the object do not produce obvious separate effects, so that we can not do much more by the aid of light than merely detect the object as a whole. We can see nothing of its details. There are smaller objects which we can not even perceive.

Now such details and objects can be of fundamental importance, as we have already seen. What shall we do now?

The X rays break down the barrier for us, and admit us to this immense field in which we want to be. They do so by virtue of their character as light waves, 10,000 times or so smaller than visible waves, but of exactly the same nature. They have all the necessary characters for modification by the "very very" small objects on which they may fall. We have only to ask, then, how they may be used and perceived, for our eyes fail entirely to detect them.

It happens that there are various ways in which they can be registered. One of the simplest and most convenient is by the process of photography. The plate or film which is made sensitive to light can, fortunately, also perceive the X rays, though our eyes have not this double power.

So far, so good. But we should not be able to go farther were it not that nature builds her structures on certain most interesting principles. Let us look into this matter also.

WE can take the atoms as the elements of all the substances that we use or handle in any way. We know that there are some 90 kinds of atoms of which a few vastly surpass the rest in numbers; oxygen, silicon, and aluminum heading the list. A piece of pure iron contains nothing, of course, but iron atoms; the point of great importance is that the atoms are not merely jumbled together anyhow, but are arranged very perfectly according to a simple pattern which is not very difficult to picture. Suppose a pile of cubical blocks to be made so that they lie in rows in three perpendicular directions. Think of the corners of these cubes as points in space. Put an atom of iron at each corner, or perhaps one should say, at each point where eight cubes meet. Place also an atom at the center of each cube and allow the cubes to vanish. There the iron structure is complete.

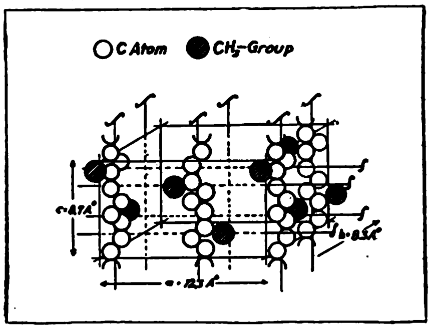
The structure of a piece of copper is even simpler. The atoms are arranged as in a pile of cannon balls, just as they are shown beside the guns in the old pictures. The structure of a diamond is rather more difficult to apprehend from a verbal description; it may, however, be grasped if it is remembered that each atom of carbon has four neighbors at equal distances from it and equidistant from each other. And so we go on to more and more complicated structures. The distances between the atoms are very small, we must remember; they vary about a mean of something like the forty-millionth of an inch. They are, of course, invisible, even in the microscope.

If a substance is such that all the atoms which compose it are arranged on one and the same pattern, so that the straight rows run through from side to side, the substance is a single crystal; crystalline character meaning, simply, perfect arrangement. Single crystals are, of course, common enough, such as jewels, salt, sugar, and a host of other kinds of substances, occurring, for example, in great frequency in the chemist's laboratory. But most substances, and especially those we handle every day, such as the metals, must be described as masses of small separate crystals. In fact a single crystal of a metal is rarely seen, and is a most curious object. A copper bar which is but one crystal throughout can be bent between finger and thumb like a piece of stiff clay. But in the very act of bending the complete uniformity disappears; the mass breaks up into small crystals. The bar loses its extreme plasticity and after a little handling becomes as stubborn as copper usually is.

THE fact is that in many kinds of crystal there are special directions in which planes can be drawn or conceived to be drawn, and the atoms on one side of such a plane can slide more or less easily over those on the other. They are called glide-planes. When the copper bar is one crystal throughout, it is easy to make this slipping occur. But when the bar is multi-crystalline, the planes of easy slipping are not the same for all the crystals, because the latter are oriented in different ways. However we try to deform the bar, there are always some crystals which resist being deformed in that particular way. And the various crystals back each other up according to some principle which we do not fully understand. Thus the properties of the bar depend upon its crystalline character.

The small crystals of which it is composed are often visible to the naked eye, and very often to the microscope. It is for this reason that the microscope has been of so much use to the metallurgist. But though the microscope can do and has done so much, it is only the X ray that can tell us the internal arrangement of the crystal, and it is only by becoming expert in the use of X rays that we can hope to unravel further the marvelous complexity of the relations between structure and properties.

If this is true of the simple metal, it is also true of the complex alloys, the properties of which are of such extreme importance in modern industry. We learn for example that iron, when treated sufficiently, changes the arrangement of its atoms to that already described as characteristic of copper. With this change its properties change also. If certain substances, carbon or manganese, for example, be added to the iron, the reverse change may be prevented, even when the temperature is once more brought back to normal. Thus the properties of iron in the second state may be retained and this is sometimes very desirable.



Courtesy of *India Rubber World* (New York)

The elementary unit of stretched rubber is found to consist of atom groups each about .00000087 millimeter in length, arranged as shown

More generally the properties of an alloy depend not only on its composition but also on the nature of the crystals which the components form, on the sizes, forms, and relative orientations and dispositions of the crystals. And this is true, to some degree at least, of all substances. In fact, when Nature builds up a substance she tries always to put the atoms together in regular order and according to a regular pattern. The crystal is always arrived at. Generally, however, the attempt to carry the structure of a single crystal through the whole of a visible mass is only partially successful and not obvious. The X rays often surprise us by showing that crystalline structure exists where we had not expected it; for example, in cotton, silk, stretched rubber, bone, and so on, and we may be quite sure that the crystalline tendency is part of the plan and contributes to the desired character of the structure.

IN conclusion, let us now consider briefly the method in which the X rays are employed to examine the crystalline structure of any body. To describe it with any fulness we should have to use the diffraction principle of physics and other principles as well. But a general understanding can be reached by readers through less accurate means. Let us remember that to make any object perceptible by the use of radiation we must allow the radiation to strike the object which then scatters and, it may be, modifies that which strikes it. The scattered rays are received by the eye or the photographic plate or some other suitable apparatus. They are registered and we use our brains to judge by the result the nature of the object.

The X rays are of short enough wavelength to be turned aside or scattered by the atoms, when longer light waves are not. A single atom can, however, do very little. What apparatus we possess can only be effective if immense numbers of atoms act together. Here is where the regularity of crystal arrangement comes in. The unit of pattern is repeated an enormous number of times even in a crystal just visible to the naked eye. Whatever one of these units does in the way of scattering, all the others do in regular order. The combined amount is perceptible, and so the crystalline character is detected.

Sometimes we have watched a flock of pigeons flying over the town roofs in the evening and have seen that, as they wheeled, the sun's rays have flashed back at the same moment from the under surfaces of all the wings. Then the flock has for an instant been a notable object in the sky. The analogy is very imperfect, as everyone will see who knows the laws of diffraction, but it may serve to illustrate the method in which the X rays are used. The rays are made to fall upon the crystal which is turned about in all ways. Then at certain moments the position of the crystal is such that all the component units act in unison and a reflected ray flashes out from the crystal of a magnitude that may be perceived.

OF course this is an indirect way of examining the structure. We do not perceive the individual atoms; we discover only their arrangements. But the knowledge so gained can be combined with other knowledge that we already possess and we have actually found ourselves able to decipher the patterns of Nature to an extent we did not dream of a few years ago. We have a new field of knowledge, a new branch of science which is in fact the physics and chemistry of the solid. Its exploration gives us unexpected but most welcome information about the fundamental design of solid materials, organic and inorganic, living and non-living. It promises to fill a wide and serious gap in our previous knowledge and to give results of the greatest interest and importance in relation to science generally and in particular to the use of science in industry.

●

In an early issue a more detailed article on the X-ray analysis of crystals, especially with regard to the study of engineering materials, will be published.—The Editor.

A FACT-FINDING FACTORY

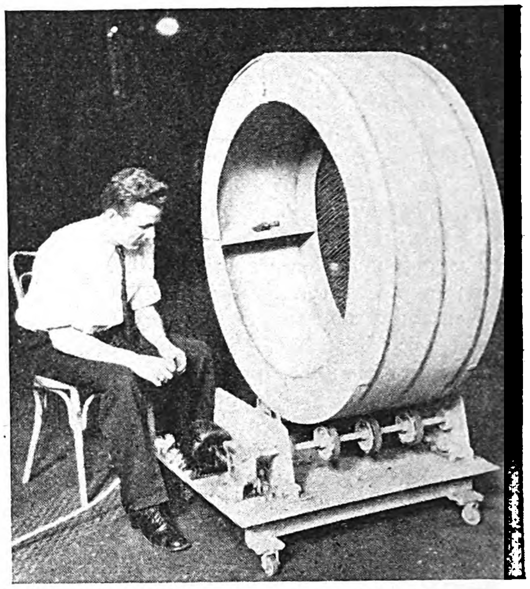
WE are frequently asked for information on testing laboratories that can be utilized for special problems by concerns and individuals who themselves do not have enough work of this kind to warrant the expense of maintaining their own laboratory. In response to the demand we present in this article the story of the availability and resources of a particular laboratory, as typical of the development along this line. Should you have problems of this kind we will be glad to give such information as we can.—*The Editor.*

THE purchasing problem is one which is always with us. It is easy to obtain prices for comparison, but unless prices are coupled with some indication of quality they do not guide efficient buying. Recognizing this fact, some of the larger industrial companies, railroads, and the government bureaus, have established laboratories for determination of the quality of materials purchased. The general public up to this time has had to be satisfied with makers' or sellers' guarantees or representations and word-of-mouth endorsements from users, in addition to such judgment and experience as are available. This problem is very much in the foreground at the present time, as witnessed by such movements as that of the Federation of Women's Clubs, the Consumer's Research, Inc., the various "institutes" maintained by publications, and so on, which endeavor to supply a service in recommending to members or subscribers the various appliances, devices, and supplies which after inspection and test can be recommended as satisfactory for purchase.

There is an observable movement also on the part of manufacturers of some classes of goods, principally in the engineering fields, to grade their own products and to issue such products under labels which the manufacturer guarantees will be affixed only to materials of a certain specified quality; for example, in recent advertising of pineapple products, a page advertisement was devoted to pointing out to the public the marks upon the cans which denote the various grades supplied. Some of the lumber manufacturers are guaranteeing the qualities of the gradings of lumber which they identify by branding the grade upon each piece of lumber.

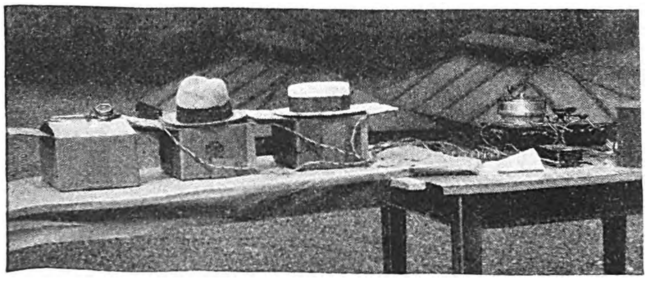
THE real difficulties in this situation are that first, testing is expensive; and second, that the expense of testing is justified only when the quantities at stake are large enough; for example, it would not pay the individual purchaser of an electric refrigerator to have tests made upon all the existing types for the purpose of discovering whether he is purchasing the most efficient device for home use. Such a procedure would cost tens of thousands of dollars while his expenditure for the refrigerator would perhaps be 500 dollars or less. But if the purchaser is buying many units, or if there are many purchasers who wish this information, then the testing can be combined so as to make it not only an economic possibility but a really profitable proposition.

Acting on this premise, the Association of Edison Illuminating Companies over 30 years ago pooled some of its testing problems, and Electrical Testing Laboratories is the outgrowth of this co-operative effort. The people behind the laboratories have been farseeing and have equipped the institution so that at the present time it is an organization open to the public in general where testing equipment and experts are available for investigations of many diverse problems and the equipment provided is very extensive and complete.

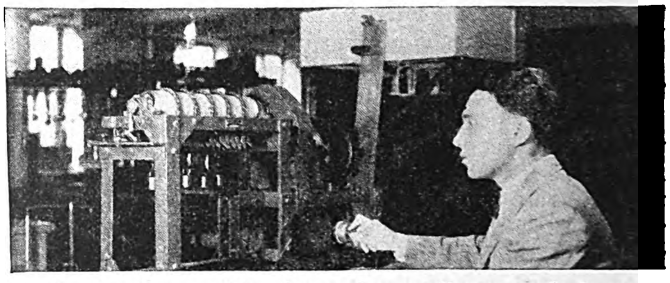


An electrically operated tumbling barrel ready to test the appliance plug on shelf

It is true that the bulk of the tests and investigations carried on at the laboratories are electrical in character but many of these involve problems outside the electrical field which demand collateral investigations. For example, the investigations of the quality of power cable bring in the study of the composition and properties of lead, copper, paper, and insulating oils, all of which are the component parts. In addition these components must be subjected to mechanical tests for strength, effect of distortion, and so forth, and electrically, tests must be made to determine the conductivity of copper and the electrical strength of the insulation. Studies must also be made of the effect of heat and cold, the heating effect and consequent deteriorating effect of time, heavy current, and so on, so that it is



A straw hat maker wanted his hat tested to find the heat inside as compared with that within a felt hat



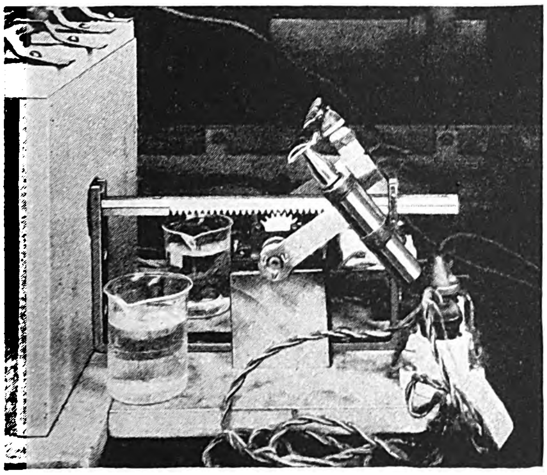
An abrasion machine for testing appliance cords is an example of machines designed to test to destruction necessary to provide very large and expensive equipment and even more important, a staff of experts who can bring to bear on the testing problems a wide variety of experience.

At the present time, these laboratories occupy several buildings situated at the corner of East End Avenue and 80th Street, New York City, comprising 66,000 square feet of floor area. There is a force of 325 people, 225 of whom are engaged in work at the main laboratories and 100 who are traveling or resident inspectors located at various factories from Boston, Massachusetts, to Oakland, California. Traveling inspectors visit practically every state.

THE magnitude of the work which is done can best be realized when it is explained that tests made by this laboratory in the past year covered the inspection and testing of over 300,000,000 incandescent lamps, 9,000,000 feet of power cable, over 1,000,000 porcelain enameled steel reflectors, design tests of all of the automobile headlamps in use in 20 of the eastern and central states, besides some 8000 miscellaneous tests for large purchasers, manufacturers, and consulting engineers covering many varieties of electrical apparatus, and appliances. Many thousands of electrical safety devices, such as rubber gloves, linemen's protectors, overshoes, leggings, insulated tools, and so forth, are regularly inspected and tested.

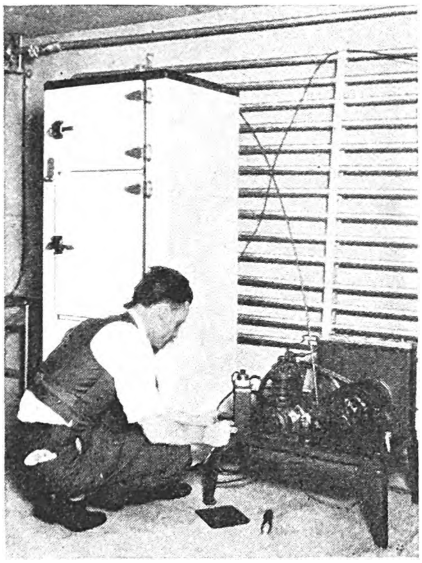
In the chemical department analyses have been made upon such diverse materials as steel, coal, paper, soaps, typewriter ribbons, pencils, insulating varnishes, oils, gasoline, boiler compounds, water, and fuel oils.

During the past year, a very interesting investigation has been carried on for the electric light and power companies which comprise the Association of Edison Illuminating Companies, on electrical appliances which are used in the homes served by these companies. Samples of all types of electric flatirons, simple and automatic, over 50 different models of electric ranges, 150 appliance plugs, 100 types of appliance cords, many percolators, electrical refrigerators, toasters, and so forth, are being tested, in many cases to destruction, to find out their serviceability, so that these power companies may be in a position to recommend to their customers appliances which give good efficient service for long periods with a minimum of repair and readjustment.



A machine that will substitute for a lot of shaves in determining the life of a safety razor

The photometric department performs many services. In addition to the measurement of incandescent lamps, it makes tests upon lighting fixtures, search-lights, flood-lights, and flashlights. Tests are also made by this department on the illumination of artificially lighted premises such as offices, banks, railroad terminals, and lighted streets. It is sometimes called upon for tests of artificial and natural lighting, in connection with damage suits, both personal and as the result of restriction of natural lighting. Many tests of this kind are also made in connection with the determination of the validity of patent claims.

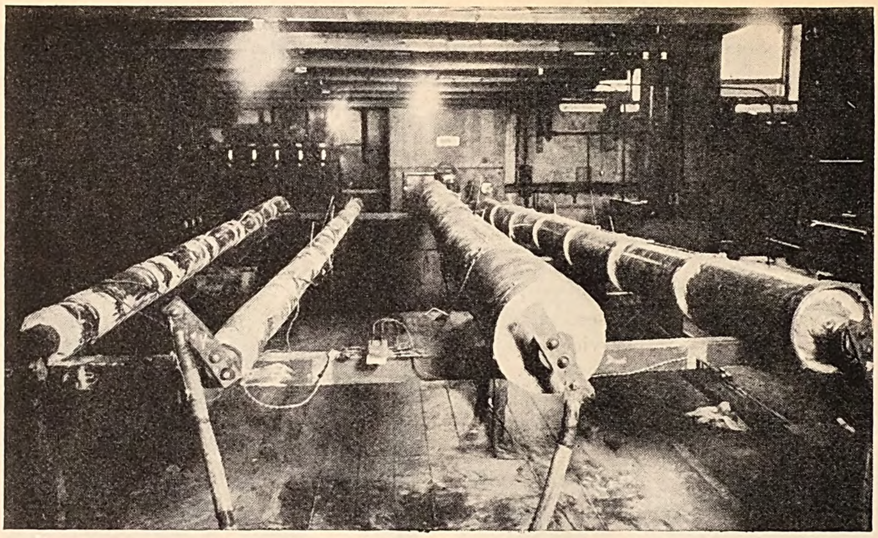


Testing an electrical refrigerator unit in a specially equipped room

Perhaps the most interesting examples of testing are those which may be termed "freak" investigations. For example, a dead goldfish was submitted by a hotel in New York with a request that a determination be made of the amount of copper sulfate in the body of the fish, it being thought by the client that the fish was poisoned by the absorption of copper sulfate from a copper tank in which a large number of fish were kept in the hotel lobby. A manufacturer of cigarettes submitted a number of brands of cigarettes to determine the heat of burning the cigarettes under normal smoking conditions in order to prove an assumed superiority of one brand. Three brands of golf balls were tested for relative resiliency. Samples of procelain-enameled iron were submitted for tests of deterioration of the enameling under acids which might be encountered when metal table tops are subjected to ordinary kitchen usage. A manufacturer of straw hats submitted his product for test in order to find the relative heat inside the straw hat as compared to the heat inside of felt hats, the hats being exposed to direct sunlight.

Filling rubber gloves with water as part of an electrical leakage test

IN this category also may be placed the tests made for investors who wish to know something about the value of an invention or process in which they are considering investment of capital. For example, a gasoline substitute was submitted, which upon analysis was found to be composed of a fair grade of gasoline with a small admixture of lubricating oil to give it color. A rechargeable dry battery was found to be simply a good dry cell of a standard type with a new label substituted. A storage battery compound, warranted to increase the capacity of any lead-sulfuric acid storage cell, was found to be made of corn starch which had no beneficial effect. A new type of airplane cloth reinforced with very light but strong steel wires designed to add materially to the strength of the material was subjected to mechanical tests. A so-called "electric therapeutic" device, which it was alleged had effected marvelous cures of rheumatism and sci-

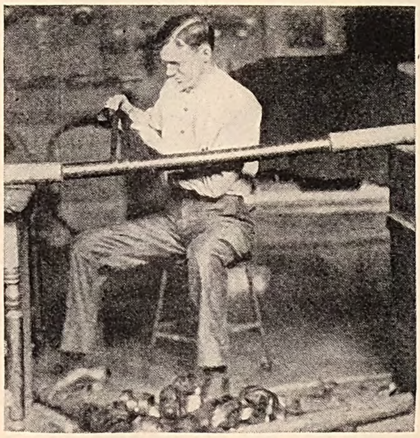


A view of part of the mechanical laboratory where tests for thermal conductivity, valuable to manufacturers, are being carried out on various steam-pipe coverings

atica, proved upon investigation to be a nickel-plated cylinder filled with sealing wax.

It is not only in exposing obvious frauds that these laboratories function. These constitute but a small though interesting fraction of the work of the laboratory. It functions often in connection with the development of processes which are brought to satisfactory and successful results. There may be cited in this class the Klaxon automobile horn which was designed by a client of the laboratories, working in a private shop and submitting from time to time the results of his labor for tests. Several manufacturers of insulating varnishes have used tests developed in the laboratories in connection with their own experiments in the blending of varnishes not only to increase the insulation resistance of their varnishes, but also to increase the length of time that the varnished cloth or paper made up with their compounds would remain pliant. A manufacturer of diffusing glassware, by continued experimentation, designed a form of translucent glass which transmits a considerably larger amount of the light falling upon it than was apparent in the first samples submitted.

DURING the World War, manufacturers of star shells for lighting battlefields at night, by constant test and experimentation of various mixtures, increased the illuminating power of such shells from 10,000 candlepower with a burning period of 30 seconds to over 100,000 candlepower with a burning period of a minute and a half, eliminating also a great deal of the flicker which was characteristic in the first samples. In all these cases, the tests were made for the manufacturers upon samples which they fabricated using the formulas which had been suggested or proved by repeated tests.

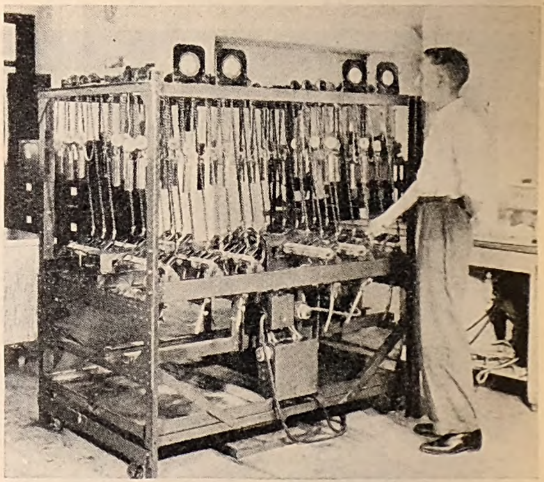


After a cable has been tested on over-load, insulation is inspected

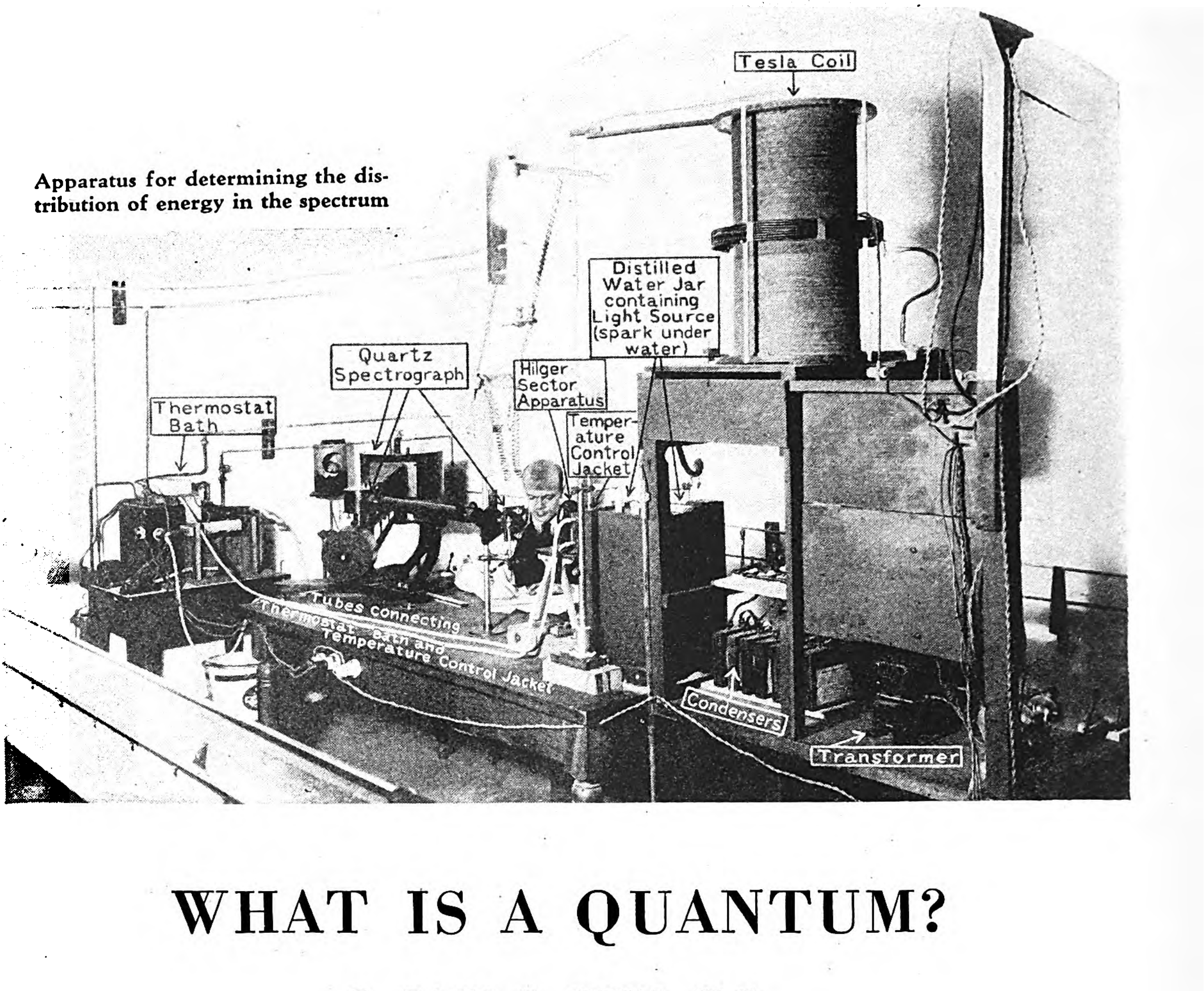
As was indicated previously, this institution is called upon from time to time for tests in connection with legal controversies. In such cases, the laboratory prefers to be retained if possible by both sides and to make the results of its tests available to both parties in the action. As examples of this type of service, there may be cited a test which was made to determine the electrical resistance of a pair of shoes which had been worn by a lineman who had been killed by an electric shock; the testing of a street lighting installation to determine the compliance to specifications of the street lighting equipment used by a power company; the measurement of natural light reaching the windows of a building; the measurement of the loss of light occasioned by changes in the construction of the Manhattan Elevated Railroad in New York as a basis for determining the compensation to be paid to owners of adjoining property. Very often in such cases the variation in natural lighting is so great as to make it impracticable to obtain complete measurements on the actual premises. In such cases, a few check measurements are made in actual position and a scale model is constructed which is artificially illuminated. An exhaustive study of the model is made, in this way eliminating all the variable features except those that are in question.

IT is to be expected that an organization of this kind is called upon from time to time to make tests for inventors whose hopes for success are greatly in excess of the merits of their inventions. In such cases, the attempt is made to dissuade them from spending money foolishly. In the 34 years of existence of this institution, there have been submitted perpetual motion machines, direct-current transformers, lighting appliances which are designed to multiply the total flux of the original lamp 100 times, electric generating machinery for producing more than 100 percent of the power put in, mechanical and electric water heaters of 200 to 300 percent efficiency. The problem in these cases, a diplomatic one, is to dissuade the inventor and at the same time to convince him that the laboratories are not the agent of the trusts which are engaged in keeping back improvements which might revolutionize industry and thereby destroy invested capital.

Many more instances of the variety and interest of the work might be given but the bare outline which is presented indicates the wide variety of effort which is characteristic of the testing problem, the diversity of the clientele which must be served, and the value of constant continuous research as an aid to betterment of conditions, the safeguarding of human life and property, and the encouragement of progress.



Electric appliance plugs get hard usage in service; this machine tests them more severely


Tesla Coil
Distilled Water Jar containing Light Source (spark under water)
Quartz Spectrograph
Hilger Sector Apparatus
Thermostat Bath
Temperature Control Jacket
Tubes connecting Thermostat Bath and Temperature Control Jacket
Condensers
Transformer

Apparatus for determining the distribution of energy in the spectrum

WHAT IS A QUANTUM?

By **PAUL R. HEYL, Ph.D.**

Physicist United States Bureau of Standards
Author of "The New Frontier of Physics"
Contributing Editor *Scientific American*

"DO you remember," said the visitor, "when I came here some time ago, asking you to tell me what an atom was?"

"Yes," said the scientist, "and I could not do it."[1]

"Perhaps you did better than you thought. Now I have another question to ask you."

"I hope it is something easier this time."

"Well, it isn't about Einstein. I only want to know what the quantum theory is all about. What is a quantum, anyway?"

"You do not seem to be getting any more moderate in your demands," said the scientist. "How much do you know about it, to begin with?"

"Very little. All I have gathered is that a quantum has something to do with energy, and that it is considered a very important thing nowadays."

"Then so far you have nothing to unlearn," said the scientist. "We may as well start at the beginning. The quantum theory is a good illustration of the fact that history is prone to repeat itself as well in scientific thought as elsewhere."

"How is that?" asked the visitor. "Is not science always progressive?"

"Yes, certainly; but some parts of it progress faster than others, principally because they had an earlier start. Our ideas regarding energy, for example, have recently undergone a change similar to that suffered by our concept of matter a great many years ago."

"In what way?"

"MATTER has been studied by man for thousands of years. It was at first supposed to be continuous in its structure, as indeed it appears to be; but our present idea is that it is really discontinuous in its structure, built up of atoms and molecules and actually consisting principally of empty interspaces. This concept grew up gradually, but we may perhaps take the work of Dalton at the opening of the 19th Century as marking a time when the atomic theory was rather generally accepted."

"Yes," said the visitor. "I have heard him called the father of the atomic theory."

"Still," continued the scientist, "there were men of scientific standing all through the 19th Century who clung to the older continuous theory. The last great disbeliever in atoms, Ernst Mach, died as lately as 1916."

"You surprise me!" said the visitor. "I did not know that the past projected so far into the present."

"Such are the facts of the case," replied the scientist. "This last opponent of the atomic theory lived to see the doctrine against which he so hopelessly fought conquer not only the domain of matter but also that of energy."

"Are there then atoms of energy?"

"Something very like it; only we call them quanta. Energy is a comparatively new concept, dating back only to the middle of the 19th Century. When it first took shape it was regarded as continuous."

"Of course," said the visitor. "I have always understood it that way. The continuous stream of light and heat from the sun illustrates that."

"How do you know that the stream of light from the sun is continuous?"

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[1] Heyl: *Scientific American*, July 1928.

“Why,” said the visitor, “there are no dark spaces perceptible—but then,” he added with a smile, “I suppose the same might be said of matter.”

“Exactly. The cases are parallel. For good reasons we believe in the existence of atoms, though no one has ever seen them; and also for sufficient reasons we have come to recognize the discontinuous nature of energy. History is repeating itself in scientific thought.”

“So that is what the quantum theory is all about!” said the visitor. “But how did this change in our ideas of energy come to pass?”

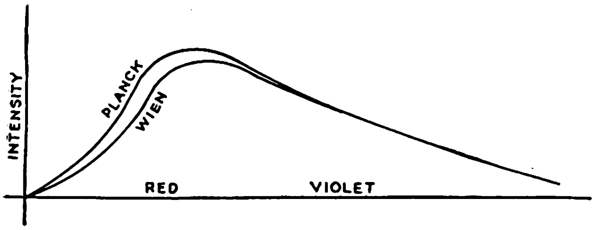
“Very much as the atomic theory of matter came to supersede the continuous theory. One was found to fit the facts of experiment better than the other. The historical parallel is perfect.”

“This is getting interesting,” said the visitor. “Tell me how it happened.”

“It began over 30 years ago, shortly after the discovery of the X rays. It was soon found that air or any other gas exposed to the passage of X rays became electrically conducting. Bring a charged electroscope near an X-ray tube in action, and the divergent gold leaves will collapse at once; the charge leaks away through the air, which under normal conditions is one of the best of insulators. It was found that this conducting property of the air was caused by the fact that some of its atoms were split up by the X rays into two parts, bearing opposite electrical charges, though the original atom was electrically neutral. This is called ionization of the gas. And the surprising thing was that so few of the atoms were ionized. Although the gas was swept through and through by successive waves of X rays, only about one atom in a million million was thus broken up.”

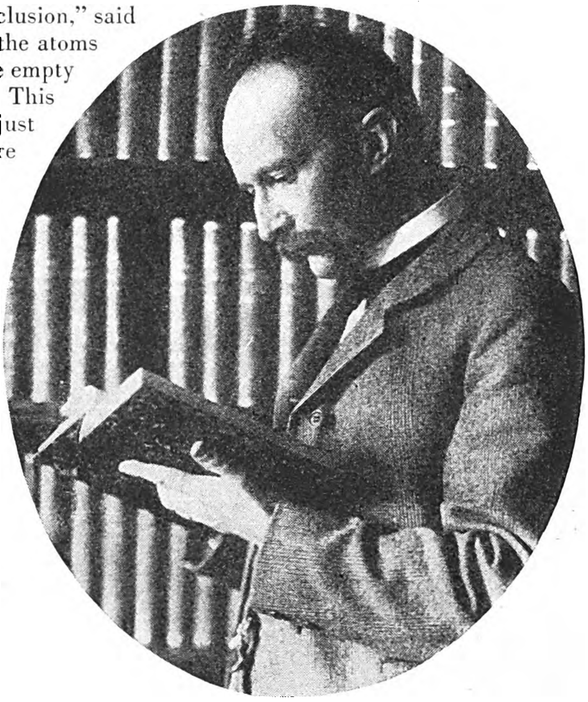
“I should say,” said the visitor, “that that net must have had a lot of big holes in it.”

“Exactly,” said the scientist, smiling. “Put into scientific language, that was just what J. J. Thomson thought about it. He was forced to the conclusion that the advancing wave of X rays was not uniform, but of a beady or lumpy structure, the energy of the wave being concentrated mostly in spots and spread out thinly elsewhere. His explanation was that only these intense spots of energy were equal to the task of splitting up an atom, and from the fact that so few atoms were ionized he reasoned that the wave front must be made up principally of thin places.”



Distribution of energy in the spectrum. The curve marked “Wien” represents the best that classical theory could do. The curve marked “Planck” is that given by the quantum theory, and fits much more closely the curve obtained by experimental work

“A perfectly natural conclusion,” said the visitor. “But where do the atoms of energy come in—and the empty spaces between them? This thick-and-thin structure is just as continuous as if it were uniform.”



A rare photograph of Max Planck, who has been called the Dalton of the 20th Century. His law of radiation (1901) asserts that “radiant energy” is emitted and absorbed in integral multiples of indivisible quanta of energy. For his contributions to science he was awarded the Nobel Physics Prize in 1918

“True enough,” answered the scientist. “The quantum theory carries things to the limit of *supposing* all the energy to be concentrated in the spots with the interspaces empty. This extreme the X-ray evidence that I have mentioned did not require, and it is a principle of scientific thought that we are never to assume more than is necessary to explain the facts. It required evidence of another sort to force us farther. This next step is due to Planck, who in 1900 suggested the modern form of the quantum theory.”

“On X-ray evidence?”

“No; the evidence was of a different nature. It had to do with light. Theory and experiment had, in a certain field, failed to agree. Planck brought them into agreement by supposing energy to be atomic in its structure.”

“Was the discrepancy between theory and experiment so serious as to require this radical step?”

“It would have been serious, no matter what its magnitude, provided that it was great enough to be sure of; but judge for yourself. What happens when a piece of iron is heated?”

“It becomes red hot.”

“And then—?”

“Yellow, and finally white hot.”

“But suppose I should tell you that it should not act that way; that on theoretical grounds it ought to show a blue color from the start, no matter how hot it was?”[2]

“I should consider that a very serious discordance. Was it really as bad as that?”

“Yes, the classical theory insisted on predicting rays more intense than those actually observed, and of the wrong color. To take an analogy from sound, the emission of light from a gradually heated body is something like what happens when we press down and hold down all the keys of an organ in succession, beginning at the lowest. To the lowest frequencies would be added successively those higher in the scale, until at last the whole range (or spectrum) would be present. But the classical theory demanded that the high frequencies should appear from the start, and always be more intense than the lower ones.”

“And Planck’s theory straightened out this discrepancy?”

“Perfectly. On the quantum theory we suppose that energy is made up of atoms or quanta. Less than one quantum can not be absorbed or emitted by a body, and all emission or absorption must be in multiples of this fundamental quantum.”

The visitor looked blank.

“It is something like our money system,” continued the scientist. “The smallest amount we can pay anybody is one cent, and any amount that changes hands must be a multiple of one cent. Now suppose your income was small, say one cent per hour, and that your creditors were pressing you. All you could do would be to pay out one cent now and then. This corresponds to the case of iron slightly heated. The influx of heat is not rapid, and the iron can emit only quanta of low frequencies—

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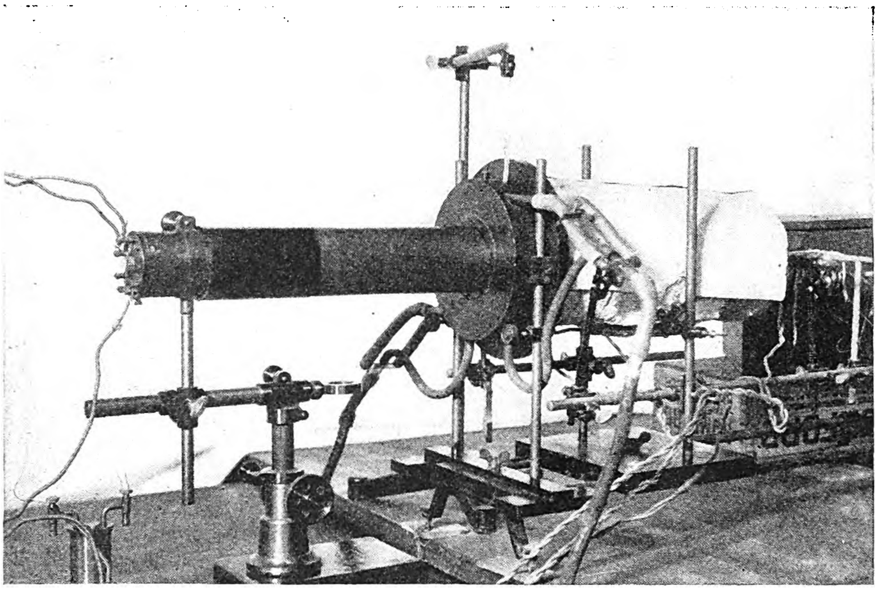
[2] A. H. Compton: *Physical Review Supplement*, July 1929, page 74.

coins of low value. If your income was more rapid you might be able to pay out nickels or even dimes occasionally along with the cents. So as the iron is more intensely heated it is able to emit quanta of higher frequencies along with the lower ones."

"Is there only one fundamental quantum?"

"No, matters are more complicated than that. It is like having several different kinds of currency circulating together; English, French, German, as well as our own. The smallest coins of each kind would be different in value, and not exact multiples of each other; and we would have a series of multiples of each kind in circulation together. There may be many quanta of different frequencies, and a radiating body may emit multiples of any of them."



Apparatus for determining the Stefan-Boltzman constant of radiation, which is connected with the distribution of radiant energy in the spectrum of hot bodies

"But nothing but exact multiples? No fractional quantities?"

"Apparently not."

"Why is that?"

"We do not know."

THE visitor was silent for some moments. Then he said:

"The only reason why I can not pay out or receive anything but exact multiples of one cent is because the mint in this country does not coin anything else. It is not a limitation on my part. In England I would not find the slightest difficulty in paying out multiples of a half penny, although that is not exactly equal to one cent."

The scientist nodded approvingly.

"I agree with you. This curious restriction to multiples of a quantum in exchanges of energy may be a limitation arising from something in the structure of the molecule, or it may be that Nature's mint coins nothing but even multiples of a quantum. I am inclined to the latter view. The fact that a molecule can actually emit almost any quantity of energy that can be imagined, provided that there is a fundamental quantum of which it is a multiple, suggests that the limitation is not in the molecule."

The visitor smiled.

"I have read that Sir John Herschel once compared atoms to manufactured articles, because of their close similarity. Now it seems that we must think of energy likewise. Nature coins quanta and multiples of quanta, and it is against the law to clip or debase the coinage."

"Yes," said the scientist. "A quantum seems to be indivisible."

"Just as it used to be thought the atom was."

"Your point is well taken," answered the scientist. "But up to the present we have no experimental evidence requiring us to assume the contrary."

"Well," said the visitor, "to return to my original question, what is a quantum? If we magnified a light wave sufficiently what would we see?"

"It is no more possible to magnify a light wave sufficiently to perceive its structure than to magnify matter enough to see the molecules; but if we could sufficiently enlarge an advancing front of a light wave it would probably appear as a lot of bright specks on a dark background."

"That rather suggests Newton's corpuscular theory of light."

"Quite so, except for the important difference that each quantum is vibrating with a certain definite frequency."

"And what is it that vibrates? What is a quantum?"

"Nobody knows. Some have thought it to be a little train of waves, something like a dart; others have pointed out that it is more probably a three-dimensional affair. We have no more idea of what a quantum is than we have of the nature of an atom; and, as you know, our concept of an atom is a good deal like a moving picture."

"Three dimensional?" said the visitor. "How big is a quantum?"

"That question has been asked by others. The answer seems to depend on the direction by which we approach the question. For instance, a quantum of light must enter the eye as a whole to excite vision. Less than a quantum will not do. And yet, from astronomical considerations, a quantum of starlight must have about the dimensions of a barrel."

"And all that has to get into the pupil of the eye? That is something like packing the genie into a bottle."

"We frequently encounter contradictions of this sort in the early stages of scientific thinking about any subject. It indicates usually that our ideas are as yet incomplete and fragmentary. We must attain a broader and more general concept, of which these contradictory pictures may be seen to be special cases."

"The philosophers of old," remarked the visitor, "used to say that Nature makes no jumps; but what with atoms and quanta it begins to look as if discontinuity was the first law of Nature."

"There is a curious consequence of this discontinuity," said the scientist, "which probably you have not heard of. Suppose that you took a pocket full of pennies and went to visit an orphan asylum, and on your arrival found that there were more children than pennies. Even allowing only one cent to each child some would have to go without. But perhaps you see what I am coming to," said the scientist, breaking off as the visitor began to smile.

"Not exactly," said the visitor. "But I can see that for 'children' we must read 'molecules' and for 'pennies', 'quanta of energy.' "

"EXACTLY," said the scientist. "We have a pretty good idea of the energy value of a quantum just as we have of the size and mass of a molecule, though we can not tell just what either looks like. And it works out in this way: the total heat energy in a body may consist of fewer quanta than the number of its molecules. This is possibly the case in red hot iron. It is a curious thought that in such a body there may be molecules here and there as devoid of energy as if the whole body were at absolute zero."

"Poverty and riches rub elbows among molecules as with men," said the visitor. "Very human little fellows, these."

"Perhaps," said the scientist, "the molecules of which we are made up might view the matter oppositely, and with more reason."

FEEDING THE CREW OF A BATTLESHIP

By **JOHN DONALD THOMPSON**

Chief Boatswain, U. S. S. *West Virginia*

THERE are, no doubt, many hungry people within the broad domain of Uncle Sam, but if so, certainly they are not to be found upon his fighting ships. Food, selected and inspected, the finest in the world, is most plentiful. Carefully guarded, refrigerated, cooked hygienically and served under supervision from the cleanest of dishes fresh from electrically operated dish-washing machines filled with distilled water, boiling hot, the food reaches the men in its most tempting condition.

One hundred and ninety turkeys; more than 2000 pounds for only one meal! It sounds like a great deal, but it is only for a holiday, the fourth of July or Christmas, dinner to which must be added all the other good things that go with such feasts. The men, the boys that man the fighting ships are, most likely, far from home, but otherwise the holiday meal is just as tempting and complete. Then, to this must be added the novel surroundings of life on board ship and an appetite whetted by regularity, salt air, and wholesome exercise. On the fourth of July, at noon, 2000 pounds of turkey disappear from the plates of the eager boys as if by magic; the well rounded out menu is reproduced on this page.

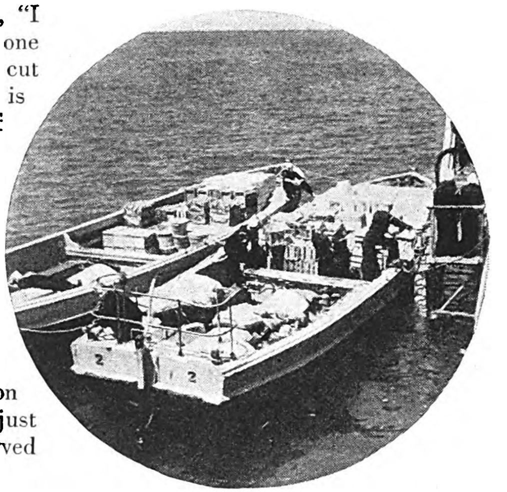
I passed by the metal-screened door of the butcher shop where the head butcher was carefully explaining to a lady visitor (and as many other visitors as could crowd into the doorway) his daily labor in providing the meat portion of the daily ration for 1300 men.

"Why," she exclaimed, "a ham will last us ever so long, even if we are all at home—and every one of us is a hearty eater!"

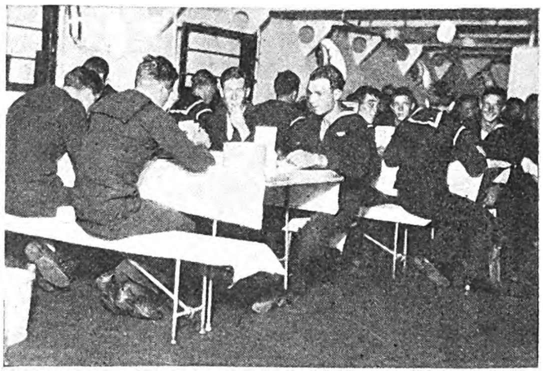
"Yes'm," he patiently explained, "I guess so, but 50 hams makes just one meal for us. It is boiled, then we cut it up and serve it out; none of it is ever left over. Lots of other stuff goes out from the issue room and the galley up forward. Beef? Oh yes, we use lots of beef. We cut up about 850 pounds of hind quarters into beef steak with this machine for one meal; then it is fried in the galley. Seven hundred and fifty pounds for veal cutlets and only 500 for stew. Six hundred pounds of halibut makes the noon meal on Friday; besides this, just about every sort of meat is served at various times."

Lots of times when I pass the butcher shop I look in through the large round port hole; usually they are all busy cutting up meat or cleaning and polishing up the shop.

WE have thousands upon thousands of visitors from every state in the union; no matter what port we may happen to be in. Many men are detailed as guides to show them about the ship and make them feel at home. Sometimes I act as a guide myself, though not so often now, and it seems that all visitors, especially women, invariably ask to be shown, the "dining hall, the kitchen, and the pantry." So we take them down below and show them the great deck spaces hundreds of feet long and from 30 to 50 or more feet wide; this, they are told is the "dining hall," or more simply, the mess deck. From here, they are shown into the large galley that is lined with huge oil-burning steel ranges and steam-jacketed kettles manned by a dozen white-clad cooks busily preparing the next meal, the savory odors of which invariably bring forth exclamations of delight. This, they are informed, is the kitchen. They leave this attractive place of activity, of pleasing odors, with many a backward glance and exclamations of wonder.



Boxes, bags, crates: two 59-foot motor launches at the gangway with provisions



All photographs by the author

Any doubt that our sailors are well fed will be dissipated by one glance at the menu at the left and at the healthy, happy faces in the illustration above. During such a holiday meal, 2000 pounds of turkey disappear from the plates of the sailors

INDEPENDENCE DAY

4th of July, 1930

•M•E•N•U•

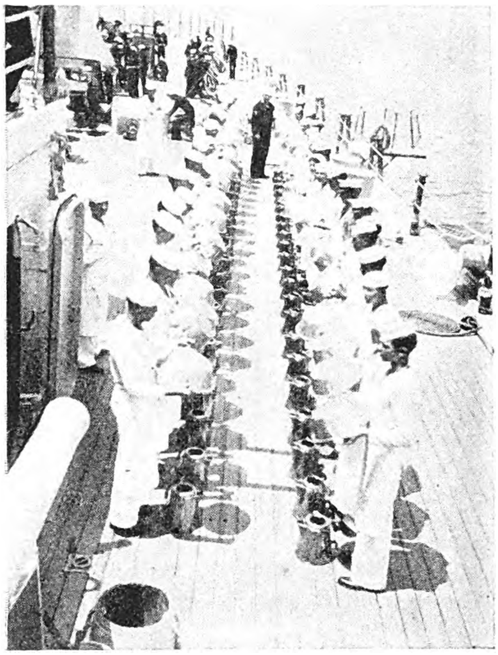
Sweet Pickles **Green Onions**
Queen Olives **Celery Hearts**
Pineapple Salad **Sweet Mayonnaise**
Cream of Celery Soup **French Croutons**
Roast Imperial Turkey
Celery Stuffing **Giblet Gravy**
Creole Potatoes **Buttered Squash** **Sweet Corn on Ear**
Sunshine Cake, frosted **Blackberry Pie**
Neapolitan Ice Cream
Cigarettes
Coffee

"Now," confided one attractive young matron, "I must see the pantry. They may cook in a galley, but there must be a pantry." So the party was shown into the compact and abundantly stocked issue room with its snow white tiled deck and glistening shelves, its rows of polished bins, barrels of pickles and vinegar, rows of sacks of sugar and beans, and the untold number of things that go to fill the pantry, or as we call it, the "issue room."

"And this," said the guide to the attractive young matron, "is the pantry."

After marching forward on one deck and aft on another without having seen anything resembling a dining table, the party is sure to ask where the tables are. They are then pointed out, neatly stowed in pairs on iron racks overhead between the beams. Each table is fitted with folding iron legs, as are the little benches that fold up and are stowed on top. When taken down and set up for use, they seat 10 men quite comfortably. One mess consists of 20 men using two tables and served by one mess cook, or a total of 21 men. The number of messes varies somewhat, but averages around 65.

The mess cook, who does no cooking at all, brings the food from the galley, the bake shop, and the issue room, and the dishes from the scullery. He also washes the knives and forks, besides cleaning up the deck and a considerable portion of the paint work in the immediate vicinity. Then once each week he has to take the tables up on deck and scrub them with sand and bleach them out in the sun.



On deck in bright sunlight, the daily inspection of shiny coffee pots and dish pans

If it so happens that a mess cook is good in bringing down "seconds" from the galley, the boys give him a lift now and then with the work and of course help in stowing the tables overhead. After a period of time, usually three months, the detail is relieved. Sometimes they stay for many months on this duty and seem to like it. When I was a mess cook, food was rather scarce and I was well pleased when I went back on deck.

The dishes are washed in a scullery where the far famed "scullery maid" would have found delight, for in their metal racks like eggs in a carton, the dishes for 1300 men are washed and stowed in from 14 to 19 minutes with an electrically operated dish washing machine having a crew of four men and one checker. After having been washed they are stacked, in their own racks, upon shelves, all ready for the next meal.

Visitors note with satisfaction the "spud coxswain" and his gang of a dozen or more men as they busily prepare vegetables in the vegetable-locker adjoining the galley. About one ton of spuds, or potatoes, are prepared each day. Two electrically driven peelers make quick work of about 20 sacks, then each one is gone over by hand for spots. If required, they are passed through the slicer for French fry, or go into the steam-jacketed kettles to make the well known mashed potatoes. Celery, lettuce, cabbage and, in fact, just about all vegetables are prepared only by the crate.

IN looking over the accounts I note that the boys have used in one half month, 10,000 pounds of cantaloupe besides 8000 pounds of watermelon and 1500 pounds of various berries. Eight hundred pounds of green onions must have been a lot of onions, but it went along with 10,000 pounds of green corn; 1500 of lettuce; 2000 of cabbage and a like amount of celery; 1400 of ripe tomatoes; and 1000 of bell peppers, and numerous other items that would appear small, being, as they are, under 1000 pounds. Fruit is served much more than is commonly believed —practically every day if possible. If fresh fruit is not available, the canned article is used.

In the preparation of vegetables, 20-gallon steep-tubs are used. In the cooking, either the 40- or the 60-gallon steam-jacketed kettles are used. The same kettles then come in handy when cooking macaroni, stew, beans, and numerous other standard articles of diet while the long row of steel, oil-burning ranges is principally used in the preparation of meat. One of the principal troubles encountered with meat is that it has to stand for some time after cooking before it is served; this has never tended to improve the quality of meat.

Having passed through the wide, white-tiled galley with its long rows of huge kettles and ranges, the visitor comes to the coffee pot. A shining copper urn of 120-gallon capacity, majestically it stands beside the galley door. Its eager daily visitors are legion, for be it known that "Jamoke" has ever played a most important rôle in the daily life, and it might be said, the night life, of both the old-time shellback as well as the sailors of the modern man-of-war.

COFFEE is served out to the crew at 5:30 each morning; then once again for breakfast and at noon. Tea or cocoa is usually served with the evening meal, but coffee drinking is general throughout the ship both day and night, especially by the men on watch. The daily inspection of coffee pots is a pretty sight. The mess cooks are lined up in formation in spotless white uniforms with aprons, each with his shining coffee pot and bright dish pan.

Once outside the galley, the door of the bake shop stands invitingly open, while from within issue tempting odors of newly baked bread mingled with that of spiced pies and delicious pastries. Inside this Aladdin's shop, huge electric bake ovens silently perform their tasks while the electrically driven dough mixer vies in slow rhythm with the lively tune of the cake mixer.

Stacked in neat array against the steel bulk-head, ready at hand, you observe many tons of flour and sugar besides the ample stock of ingredients that go to make up the bread and pastry shop of the ultra-modern man-of-war.

For the time being the visitor is apt to think that the navy is simply a place ingeniously equipped for the preparation of food, for hardly has he passed out of this novel bakery when he is confronted with another galley entirely different from anything seen before. This time the roaring ranges are presided

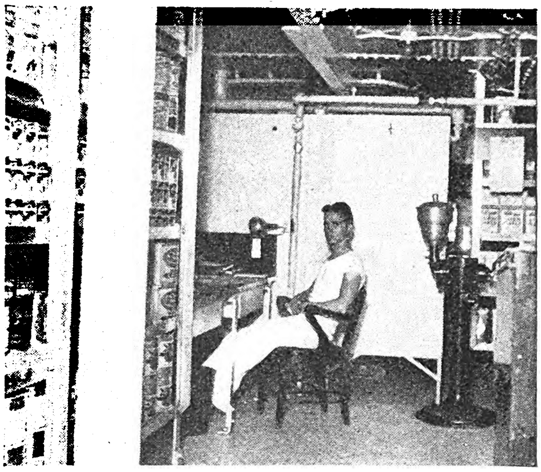
The dishes are stowed in metal racks like eggs in a crate. After being washed, they are stacked, in their racks, ready for the next meal

over by men of different races: Filipino cooks, Negro cooks, and sometimes a Japanese. This is the officers' galley where these mixed races deftly ply their art. From this galley, a sparkling gem of efficiency, go the very choicest foods in the world to the officers' mess.

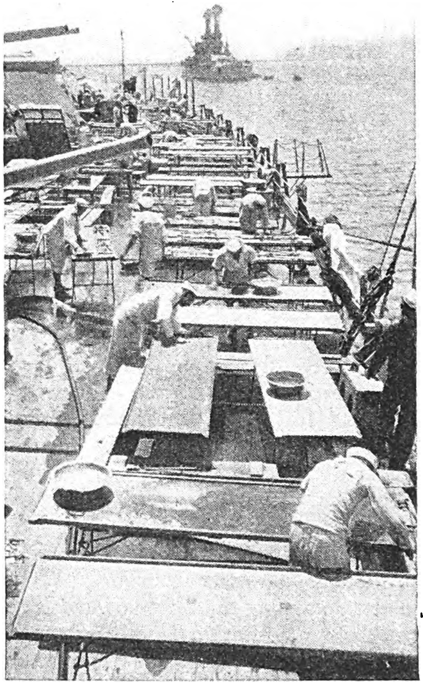
When necessary to provision ship, usually once each month, a day is set aside for that purpose. About 100 tons of provisions, consisting of both fresh and dry stores about equally divided, are taken on board that day. About 50 tons are tinned and sacked stores while the rest is all of the fresh or perishable variety. The meats are frozen and go into the refrigerator while most of the fruits go into the chill room with the eggs, the butter, and the cheese.

SOME of the articles loom rather large. Of beef there will be 20,000 pounds and of sugar a little more. Flour soars to 30,000 pounds while potatoes top the list and run between 40,000 and 50,000 pounds. Coffee keeps well above 1500 pounds; pork loins run about 4000 pounds while one ton and a half of hams skimp sadly by. Bologna and "franks" are slightly less and 1500 to 2000 pounds of chicken or turkey simply means one meal. Five thousand pounds of butter together with 3000 dozen eggs fried with 1500 pounds of bacon finishes a good many breakfasts to the fighters of the nation's first line of defense. Six thousand cans of milk are used each month in cooking and in coffee, while 600 pounds of yeast finds its way to the bake shop.

On one day each week a working party of some 25 men are engaged in bringing up provisions from the well-stocked store room to the commissary issue room. This issue room presents a most imposing appearance. It resembles a fully stocked grocery store minus any perishable articles except fruit and is presided over by a specialist in commissary work, who is a diplomat capable of keeping the crew contented and the captain satisfied—a task of no mean proportions. An army is said to travel on its stomach; a navy, then, might be said to sail on its stomach with the commissary steward as the chief pilot supported by his ample store rooms filled to capacity with practically every known article of food on the market, in the finest condition, ready to weather the storm.



The Issue Room and the desk from which all orders of food are issued. The ship's pantry



The mess tables are scrubbed with sand and bleached in the sun on deck

BILL OF FARE *for the* GENERAL MESS

Beginning June 30th, 1930

	BREAKFAST	DINNER	SUPPER
MONDAY	Cantaloupes, Corn-flakes, milk, sugar. Scrambled eggs, braised bacon. Lyonnaise potatoes. Vienna rolls. Bread, butter, coffee.	Vegetable soup. Crackers. Grilled beef steak, onion gravy. Mashed potatoes. Steamed peas. Shirred lettuce. Apricot pie. Bread and coffee.	American chop suey. Steamed rice. Boiled sweet potatoes. Tapioca-fruit-pudding. Bread, butter, tea.
TUESDAY	Cantaloupes. Boiled hominy grits, milk, sugar. Fried pork sausage, pan gravy. Creamed potatoes. Parkerhouse rolls. Bread, butter, coffee.	Cream of tomato soup. Saltines. Pot roast of beef, brown gravy. French fried potatoes. Boiled cabbage. Sliced tomatoes. Mincemeat pie. Bread and coffee.	Fried hamburger steaks. Worcester gravy. Boiled new potatoes. Macaroni-Italian. Beet-onion salad. Chocolate pudding. Bread, butter, tea.
WEDNESDAY	Oranges Baked pork and beans. Tomato catsup. Hot corn bread. Bread, butter, coffee.	Bean soup. Saltines. Fried pork chops. Country gravy. Mashed potatoes. Corn on cob. Boiled turnips. Shirred lettuce. Pumpkin pie. Bread and coffee.	Fried beef liver. Onion gravy. Boiled potatoes. Mashed summer squash. Green onions. Watermelon. Bread, butter, tea.

Every week a bill of fare is made out for each meal that is to be served; in the case of holidays a blank is left and a special printed menu is made out. These bills of fare are posted in all branches of the commissary department. Then the cooks, bakers, butchers, and the men in the issue room can make all preparations to furnish all the items listed, and in the exact quantities required.

The number of men to be fed each day varies; men are received and transferred; others go on leave or to the hospital, so that a definite number is never possible to count on for any great length of time. Yet there must be plenty of food without any additional allotment of money. Great care must be exercised or the ration, usually 50 cents per day, will not be sufficient. It is remarkable that such a bill of fare as that for the first three days of a week, reproduced in these columns, can be maintained at that price.

Imagine the great amount of fine detail work necessary to combine the numerous combinations of food in the large quantities required, in order that each man may sit down to his meals on the exact minute, three times each day during the year.

MORE ABOUT PLUTO

By **HENRY NORRIS RUSSELL, Ph. D.**
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

EVER since the discovery of the new planet Pluto it has been eagerly observed at many places. More than a hundred accurate observations of its place in the heavens have been secured, and from these a rich harvest of knowledge has been reaped. The numerous observations of March, April, and May improved our knowledge of the orbit so much that, figuring backward, its position in past years could be calculated and images of the planet, in some cases very faint, were thus identified on photographs taken at Uccle, Belgium, in 1927, at Yerkes in 1927 and 1921, and at Mount Wilson in 1919. With these available the observed arc of the planet was multiplied twenty fold.

The calculations of Crommelin in England, and of Bower and Whipple in California, based on this fuller material, agree closely and leave no doubt outstanding about the main characteristics of this most interesting object. First and foremost the claim of the newcomer to rank as a planet is decisively confirmed. Though the eccentricity and inclination are greater than for any of the eight principal planets which were previously known, they would pass as moderate among the asteroids and there can be no hesitation in assigning the new body to the ninth place among the sun's more important attendants. There is nothing cometary about it at all; its orbit is far too near a circle and it is eight or ten times as far away as the distance at which even the brightest comets fade out into complete invisibility.

THE early calculations which indicated a highly eccentric orbit turn out to have been upset by a small error—only three seconds of arc—in one of the earliest photographic observations, made with a telescope of comparatively short focus and a long exposure. How such a small departure from exactness may be enormously magnified by the process of calculating an orbit was explained last month. In the second place the orbit, now that we know it, is found to be so similar to that which Lowell predicted from his calculations 15 years ago that it is quite incredible that the agreement can be due to accident. Setting prediction and fact side by side we have the following table of characteristics.

	Predicted	Actual
Period	282 years	249.17
Eccentricity	0.202	0.254
Longitude of perihelion	205°	212°30′
Perihelion passage	1991.2	1989.16
Inclination	about 10°	17°9′
Longitude of node	not predicted	109°22′

Lowell saw in advance that the perturbations of the latitudes of Uranus and Neptune (from which alone the position of the orbit plane of the unknown planet could be calculated) were too small to give a reliable result and contented himself with the prophecy that the inclination, like the eccentricity, would be considerable. For the other four independent elements of the orbit, which are those which Lowell actually undertook to determine by his calculations, the agreement is good in all cases, the greatest discrepancy being in the period, which is notoriously difficult to determine by computations of this sort. In view of Lowell's explicit statement that since the perturbations were small the resulting elements of the orbit could at best be rather rough approximations, the actual accordance is all that could be demanded by a severe critic.

Even so, the table does not tell the whole story. Figure 1 shows the actual and the predicted orbits, the real positions of the planet at intervals from 1781 to 1989, and the positions resulting from Lowell's calculations. It appears at once that the predicted positions of the orbit and of the planet upon it were nearest right during the 19th Century and the early part of the 20th, while at earlier and later dates the errors rapidly increased. Now this (speaking broadly) is just the interval covered by the observations from which the influence of the planet's attraction could be determined and, therefore, the interval in which calculation could find the position of the planet itself with the least uncertainty.

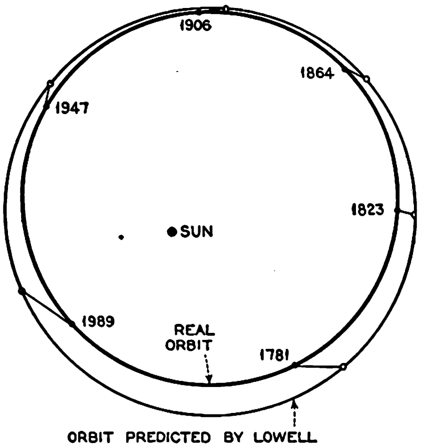


***Figure 1:* Actual and predicted orbits**

In the writer's judgment this test is conclusive. If someone should maintain that a calculation based on wholly insufficient data (and hence physically meaningless) might by some strange bit of luck result in predicting all four of the important elements of the orbit with the relatively small errors shown above, he would still have to account for the fact that the outstanding errors are so *adjusted* that their influences partly counteract one another and bring about the closest agreement of prediction and fact—just at the time when a genuine prediction, based on physically significant data, would have behaved in the same way!

IT may be remembered that substantially the same thing happened in the case of Neptune. Both Leverrier and Adams had assumed that the distance of the unknown planet agreed with Bode's "law," and had therefore taken it much too great. Their calculations made the orbit considerably eccentric (though it is really very nearly circular) but this spurious eccentricity brought the predicted orbit toward the sun in the region where the planet actually lay at the time, and went far to undo the error of two original assumptions. They still had the distance too great, however, and the predicted mass of Neptune was therefore considerably larger than the real value. There were some critics then who maintained that these discrepancies showed that the discovery of Neptune was only "a happy accident" but it has long been acknowledged that these critics were wrong, and the full credit for the great triumph of mathematical analysis has gone where it deserved to go.

History seems this time to have repeated itself closely, except in one tragic detail—Percival Lowell did not live to see his prediction thus fully confirmed. In only one particular was he seriously wrong—he overestimated the apparent brightness of the planet more than ten fold. Several causes probably contributed to this. Pluto is somewhat nearer to Uranus and Neptune than he supposed, hence a small mass would suffice to produce the observed perturbations. Within a year or two—perhaps sooner—someone will doubtless make the necessary calculations and determine the mass of the actual, rather than the predicted, planet. We may guess that it will turn out to be four or five times the earth's mass, instead of six. Even so, it is evident that the planet must be of high density and its surface of surprisingly low reflecting power. But speculation on these matters may well be postponed until observations with the greatest telescopes, under the best conditions of seeing, which will undoubtedly be made this winter, tell us more about the planet's actual diameter.

THE relations between the orbits and motions of the new planet and those of Uranus and Neptune are curious enough to deserve mention. According to Bower and Whipple the mean distance of Pluto from the sun is 39.60 astronomical units (we may note in passing that this is close to the distance predicted by Bode's "law," 38.8, for the next planet beyond Uranus, but we will be wiser if we attempt no explanation). This puts the new planet, on the average, about 900,000,000 miles farther from the sun than Neptune. But the eccentricity is so great that the distance at aphelion is 49.7 and at perihelion 29.55—which is less than the perihelion distance of Neptune (29.82). If the two orbits were in the same plane they would intersect and there would be a chance of a collision. But the high inclination of Pluto's orbit keeps him well out of danger.

Figure 2 shows the orbits, Pluto's being projected on the plane of Neptune's orbit and a little foreshortened, which apparently brings its perihelion farther in. At the points where they appear to cross, Pluto is high above Neptune. The orbits are nearest at point A where the distance is 2.6 astronomical units (240,000,000 miles). This looks considerable, but when compared—as it should be—with the distance from the sun, it turns out to be by far the closest approach among any of the principal planets—when the two planets are nearest their distance from one another is only one twelfth of the average distance from the sun, while at the next closest approach between the earth and Venus this fraction is about three tenths.

Such close approaches are, however, very rare. The period of Neptune is 164.77 years, that of Pluto according to latest calculations is 249.17. (The computers, however, point out that on account of the observational errors this value "is determinate to about a year" and we must not draw conclusions from the last two figures.)

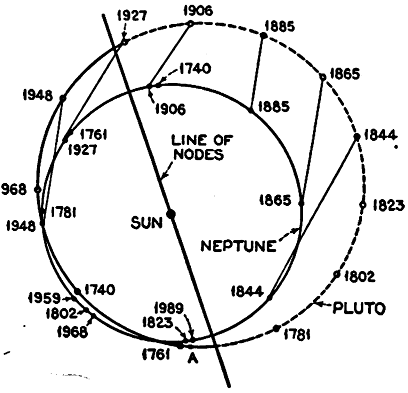


Figure 2: **Neptune's orbit coincides with the plane of the paper, that of Pluto being inclined 17° and intersecting that plane in the "line of nodes." The dotted part is below the paper, the full part above. Thus the orbits are not "grade crossings" and the danger of collision between the bodies vanishes**

Three revolutions of Neptune require 494.3 years. Two of Pluto take 498.3 years. The relative positions of the planets, therefore, almost repeat themselves at intervals of little less than 500 years. Just how they do it can be seen from Figure 2. The positions of Pluto are marked for 12 equidistant intervals, from one perihelion to the next, at intervals of 20.76 years, and also those of Neptune at the same dates. After eight intervals Neptune has completed a circuit of his orbit and advanced a little less than three degrees farther, which explains why the dots representing his positions are arranged in pairs. It appears from the figure that the two planets were nearest in 1892, and that at present Neptune is drawing more and more ahead of Pluto and increasing the distance between them. For more than two centuries the planets will get farther and farther apart, and it will be nearly 500 years before they are as close again as they were recently. "A stern chase is a long chase" and a simple calculation shows that, on the average, Neptune catches up with Pluto once in 486 years, during which interval one planet has made almost three revolutions and the other almost two.

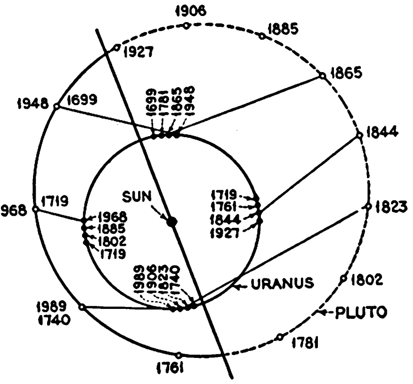


Figure 3: **Relative positions, 1699—1989**

At the recent conjunction, however, the distance of the two planets was 19 astronomical units—more than six times the minimum, and the perturbations, though greater than for centuries past or to come, must have been relatively small. When may we look for a really close conjunction?

A glance at the figure shows that Neptune passed the critical point of its orbit in 1824 and will do so again in 1989, while Pluto reached the corresponding point in 1763 and will do so again in 2012. On the latter occasion Pluto will still have 23 years to go when Neptune reaches the point of approach and, as Figure 2 shows, the planets will be a long way apart. Five centuries earlier Neptune came to the same spot in 1495 and Pluto in 1514, this time only 19 years behind. Working backward in this way we find the conjunctions closer and closer at each interval of five centuries, until in the year 976 B.C. the calculated times for the two planets agree within a few months. Still longer ago Neptune was behind Pluto and the conjunction less close.

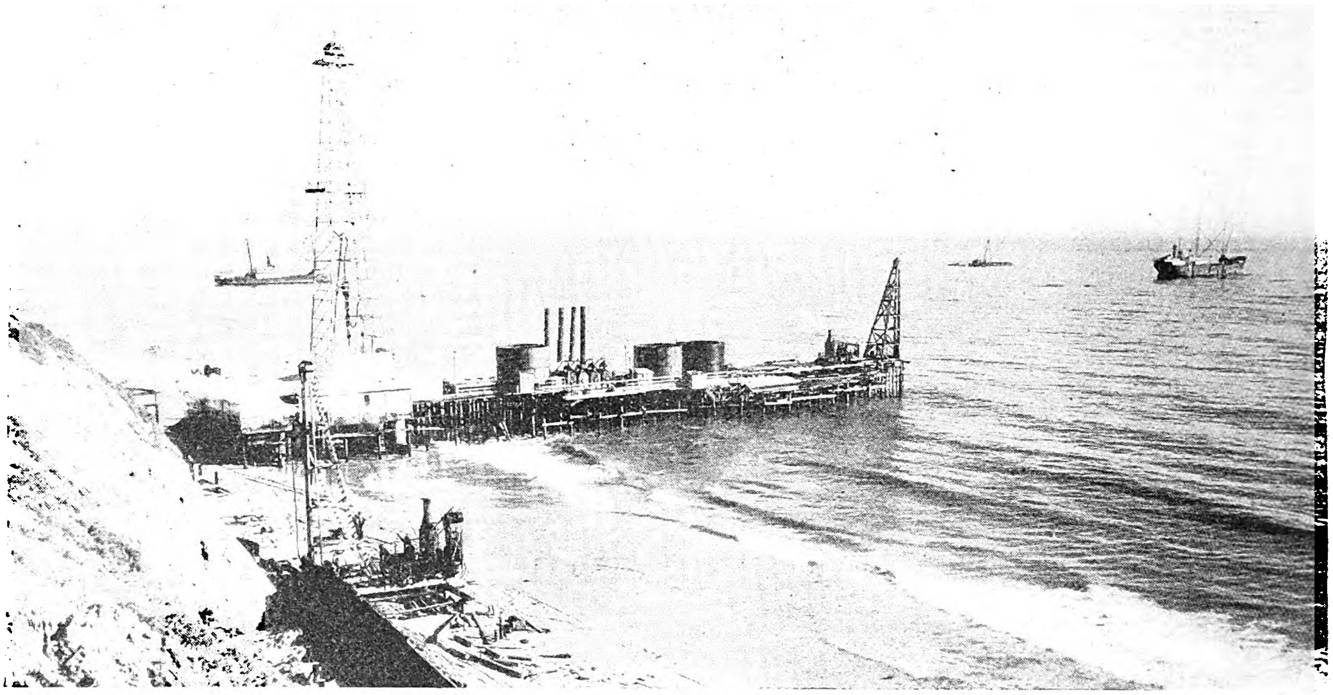
IN the future, the successive "returns" of this conjunction will be less and less favorable but, working forward from 1824 when Pluto was 61 years ahead of Neptune and remembering that the former loses four years in every 494, we find that another close conjunction will occur about the year 9238 A.D. Still others will follow at intervals of about 10,200 years.

These figures, however, are liable to alteration if the true period of Pluto turns out to differ somewhat from that here assumed. If, for example, it were one year longer Pluto would fall behind by six years instead of four in three revolutions of Neptune and the dates of close conjunction would be 11 A.D. and 6765 A.D.; while if Pluto's period should be one year shorter the dates would be near 4000 B.C. and 17,000 A.D. and the interval between close conjunctions fully 20,000 years.

In any case it is clear that no conjunctions of the sort will occur until the span of recorded human history is doubled.

When they do happen the planets are close together for half a century or more, as appears again from a study of the figure. Though the orbital velocity of Pluto is on the average considerably less than that of Neptune, it increases so much at perihelion that for a short time the planet of longer period is actually moving faster and the two bodies

(Please turn to page 487)



Completed derrick on one of the two permits, built as described in the text. The landing wharf, with the steamer *Mahukona* and the tender *Daisy Freeman* in the distance. The derrick barge and the tug *Elwood* may also be seen

OIL FROM BELOW THE OCEAN FLOOR

By C. L. ROBERTS

OIL has been found in burning deserts, waste hills, fever-ridden jungles, cultivated lands where derricks supplant orange groves, and in the frozen steppes of the northland. Under the most favorable conditions drilling for oil is fraught with many difficulties and uncertainties. Consider, then, the problem of sinking a well beneath the ocean bed far from shore; the drilling being attended by legal and physical difficulties which at first glance would appear insurmountable.

The conditions surrounding this latest achievement of oil engineering were tersely described to the contractors, Robinson-Roberts Company of Los Angeles, by the owners of the permit to drill:

"You are to build the foundations for an oil derrick in the Pacific Ocean off shore from the Elwood field, in Santa Barbara County, California. Construction must take care of several things, chiefly prevention of pollution of the ocean by mud, oil, or other waste material; and provision must be made for controlling heavy gas pressure.

"The beach bordering our lease is backed by precipitous cliffs 200 feet or more in height and is so narrow that it is completely submerged at high tide. All shore land above the high-tide line is controlled by our opposition who are patrolling it with armed guards with orders to arrest trespassers.

"Last, but not least, you have just three months to complete the contract and 'spud in' the well or we will lose our permit."

Investigation disclosed that under a recent California law, drilling permits were being granted on state-controlled tide lands along the coast line. Preference was given to littoral owners but through a slip of some sort the permit in this instance had been given to a company that did not have shore lands and wells in this vicinity. The littoral owners sought to block the permitees and keep them from drilling within the time limit specified, hoping thus to compel the permit to lapse, when they would be in a position to apply for a new drilling right themselves.

THE prize at stake was an untold amount of high gravity oil, the type of crude which is the life blood of the industry. It has a high gasoline content and its discovery always is followed by a stampede.

Faced with this problem the contractors were required to pioneer, using methods of construction never tried before, and meeting conditions, the effect of which could not be foretold. Illustrative of this was the first question presented—that of wharf construction leading from the beach to the site of the derrick foundations. It was discovered that the ocean floor was a shale bed with no sand covering. This eliminated the possibility of using round wooden piling, but something had to be found that could be driven into this foundation and still have the structural qualities of the wooden piling.

Decision fell on steel, and what is known as the "H" column was selected. This type of piling has since been found to have the double virtue of being able to penetrate the shale and to resist by sheer weight the flotation action of the ocean.

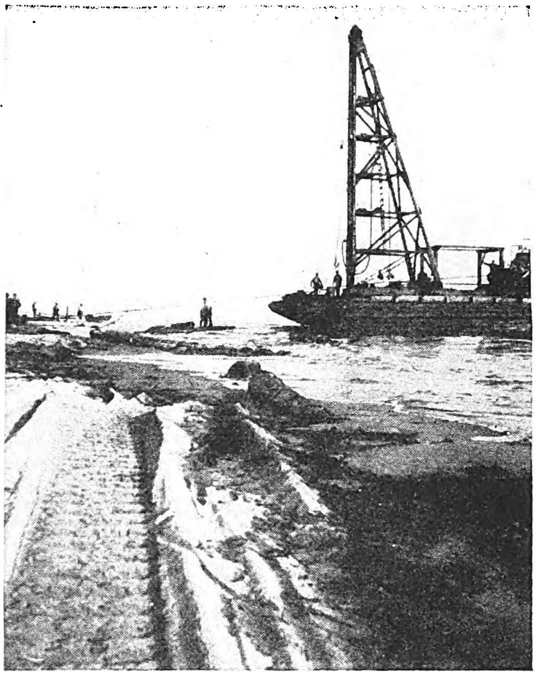
The anchoring of the derrick, which on land is done with guy wires, was the next problem. It was solved by designing a foundation consisting of five concrete-filled cofferdams. Four of these were placed at the corners of a square and upon these the legs of the derrick were to rest. The fifth, larger than the others, was in the center and was to support the drilling machinery. Here also the question of pollution was disposed of. Under the permit any fouling of the ocean waters meant the loss of drilling rights. This central cofferdam was hollowed out and a steel diaphragm connecting with the four foundations was so constructed hat it sloped toward the center, thus catching oil drippings from the machinery, mud from the well, and things of like nature.

However, the two greatest problems were yet to be solved. The first meant working out new methods of construction where all contact with shore was cut off; and the second, obtaining an adequate supply of water for machinery and men.

Purchase of the steamer *Mahukona*, a wartime vessel, and her outfitting to carry supplies enough for the job and to house the workers, was decided upon as the answer to the first of these questions. On June 5 the steamer was placed in drydock in San Francisco and 10 days later she dropped anchor off Elwood. In the meantime she had been converted into a floating hotel and warehouse. Every available space was utilized, and a boat with quarters for a normal crew of 25 now housed 150 men, while every article necessary to the construction of wharf and derrick was stored aboard.

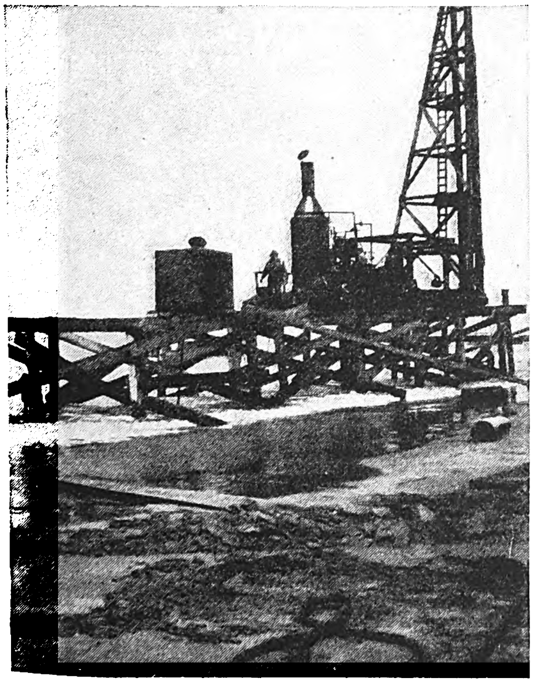
A WORD as to life on that ship will be apropos here, as it is indicative of the difficulties encountered. Anchored within sight of shore, its passengers were unable to set foot on land for diversion or entertainment. Every man was keyed up to high tension, working against time in the effort to complete the contract successfully. Three shifts of men ate, slept, and took their leisure hours in this restricted area so that one man's breakfast was another's lunch and the third's dinner. Men were sleeping, lounging about, or working, according to their employment hours. Beds were made and slept in, only to be remade immediately to make way for the next crew of sleepers. Meals were prepared in a galley eight feet by eight feet and the stove never got cold, for as soon as one meal had been served, the cook began preparation of the next.

With anchorage moorings prepared for the steamer, a derrick barge, two lighters, and two small launches, the actual work of attacking the first construction began. It was determined to build a small wharf on the beach to keep the machinery above high water. A load of short steel piles was sent ashore, through the surf in a skiff. Then the fun began, for it was some time before it was found that, to row a boat ashore through the breakers, we had to turn around and back her in. To this maneuver, sea authorities do not agree, even such a one as Richard H. Dana in his "Two Years Before the Mast," but it proved correct for us. It took several upsets before the lesson was learned but after that we always kept the bow seaward and thus escaped wettings.


Beaching the barge which carried the pile driver. Her hoisting engine pulled her in

THE short steel beams were placed upright in the sand by hand and a platform rigged on these posts. A water tank was floated ashore and rolled up on the small wharf. Then the barge came in with water tanks aboard and a man was sent through the surf with a hose-line, and a supply of fresh water was pumped into the big tank. Oil drums were floated in, salvaged on the beach, and rolled up onto the platform. Next a Caterpillar tractor, equipped with a winch, was sent along the beach at low tide, walked onto the wharf, and the shore start had been made.

It was necessary to get a pile driver on shore to begin constructing the permanent pier. A driver had been built on one of the barges by use of the derrick-barge and ships' gear. It was found that low tides occurred at night and highwater at noon. The plan was to beach this barge at high tide, and float it again at some subsequent high tide. Such a procedure would be risky due to the nature of the ocean bed which was cut up with finlike reefs. To strike one of these would mean days of costly delay.


The pile driver on falsework in the surf after it was landed from the beached barge, ready to begin work

An anchor was run ashore and sunk in the beach. This was attached to the bow of the barge to hold her on her course, while port and starboard anchors, which had been placed a short distance from shore, were attached to her stern, their lines run to the drums of the driver's hoisting engine. A stern anchor held the aft end in line. With the engine started, the forward line was taken in and the aft lines paid out, thus hauling the barge onto the beach through the surf.

Once grounded, all lines were made fast. Then a wire cable was attached to the driver and run to the winch of the tractor. The tautness of this cable minimized the surging back and forth in the surf.

WITH carbide flares providing light for night work, with no rest for the men, and with every available hand on the job, a race began to get sufficient piling driven so that the driver could be pulled clear of the barge before the next high tide. Men worked in water to their waists. Any tools that were dropped were left as there was no such thing as groping about in the sea to recover lost articles. Hours of high speed work passed with no thought of rest, but the next high tide saw the pile-driver pulled clear and the barge re-floated. The first real battle had been won.

The abnormally high tide that had favored work with the barge and driver, brought disaster to the temporary wharf, which collapsed, throwing the fresh-water tank into the sea. The water was so polluted with salt that it could not be used in the boilers and thus the problem of fresh water became acute.

Water consumption for men, ship,

and job was about 25 tons a day. The capacity of the *Mahukona* was 500 tons, of which 375 were in the "wing tanks," triangular in shape and running fore and aft along both sides of the vessel. Unless the ship were heavily loaded, these could not be filled, or the boat would capsize. The nearest water supply was at San Pedro, 125 miles away with a cost of 300 dollars for a tow from that port. In addition the only water-barge available had a capacity of 90 tons which meant a towing expenditure every third or fourth day. The solution came with the chartering of the steamer *Daisy Freeman* which was used as a water carrier and for lumber storage.

ALL did not run smoothly on the job. What with water, tides, fog, crowded quarters, foaming boilers, and loss of carbide flares and tools overboard, there were plenty of problems that had to be met as they came up. The gasoline launch began slipping its clutch owing to the propeller being fouled in the kelp. A tug was chartered to replace it. This boat was caught in a surge, its tailshaft was twisted off, and it went ashore. The barge used to beach the first driver, and later used for a second driver which began work on another permit covered by the drilling operations, got adrift and struck a reef. Here was a tug ashore and a barge hung up on a reef. Troubles never came singly but seemed to pile up all at once.

The tug was pulled off but this left us with men ashore and no means of conveyance to the mother ship. A fishing boat, skippered by an Italian who could not understand English, was hired, thus affording temporary relief, but the menace of the barge remained.

Far out beyond low tide level—one of the completed oil derricks

Derelicts have a way of wandering at inopportune times and there was the danger that the barge would suddenly float and go crashing through the falsework, which would be such a serious setback in time that the contract would be lost. And float it did, at 3 o'clock one morning. Luckily, it cleared the workings and was blown up by dynamite to prevent it from endangering our construction work further.

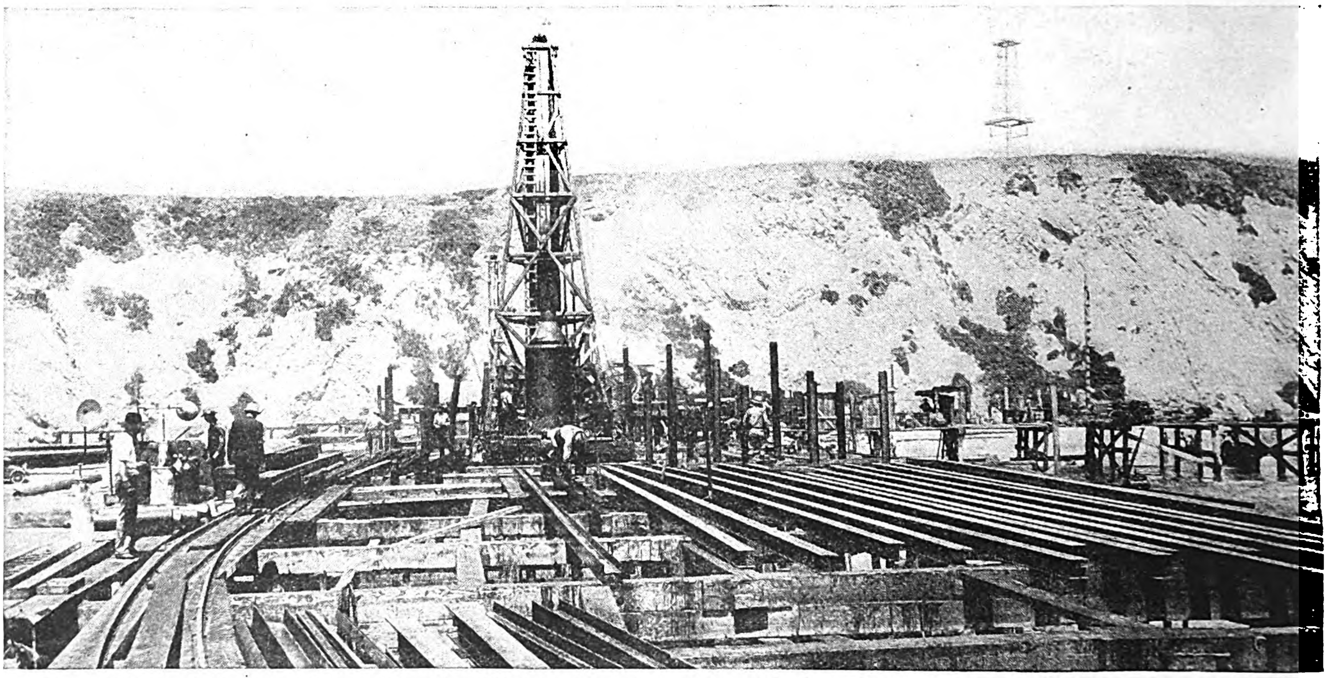
With work well started on the second permit, both jobs swung along at a good clip. Most of the material used was floated ashore and for over a month there was not a man on the job who was not wet from head to foot every hour of the working day. The genial steward, asking one of the men if there was anything dry on him, received the laconic answer: "Yeah, my hat." Yet, despite such handicaps, we progressed.

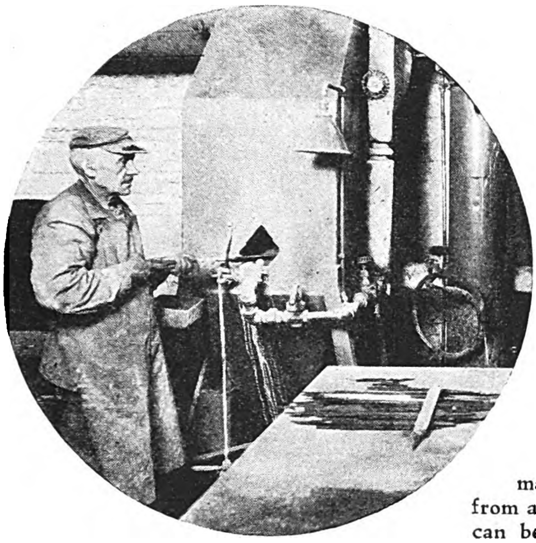
WITH the falsework driven seaward to the end of the dock, the pile driver headed ashore and took up the work of driving steel piling. The derrick barge was brought into play, being anchored in the surf. Her 100-foot boom swung load after load from the barge to the wharf and despite the lifting of the surf, which increased the arc of the boom, only one sling-load was lost overboard.

By this time divers were employed to retrieve tools and materials that might fall from the wharf or from the cofferdams where the work of erecting the steel derrick was under way.

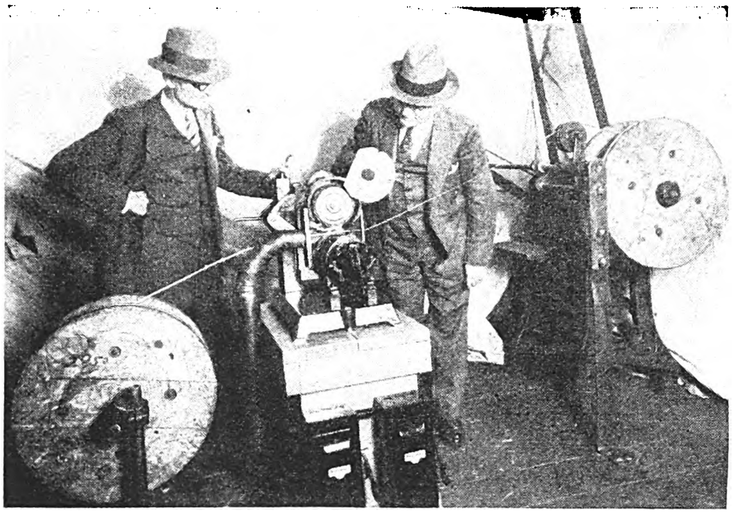
It was on August 10, less than two months from the time the *Mahukona* had set sail from San Francisco, that the first dock was ready, derrick erected and everything prepared for the spudding in. The second dock was completed 10 days later. The labor and effort this cost and the trying conditions under which it was accomplished beggar description. The joint cost was approximately 400,000 dollars.

Achievement brought a two-fold satisfaction. Pioneering methods in oil drilling had proved successful, obstacles that seemed insurmountable had been overcome, and oil in good flow was struck without further trouble.


One of the steel wharves under construction. Heavy steel and timber work were necessary. This view shows the character of the cliffs above the work and a producing well on the mesa above the beach. The pile driver is driving the "H" beams



Reclaiming used files by the steam sand-blast method. Approximately 15,000 files a month are reclaimed at the East Pittsburgh plant alone



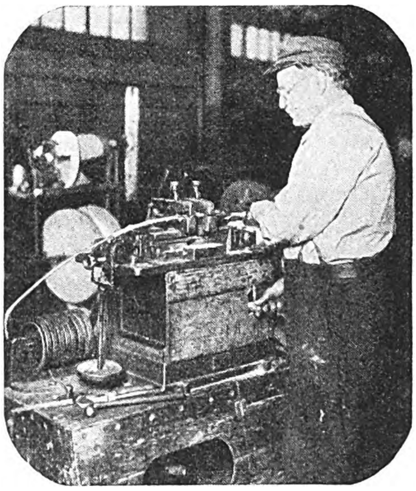
Above: A cable skinning machine removing the covering from a copper cable so that the metal can be used over again. Formerly, damaged wire became worthless scrap

Used carbon paper can be rejuvenated three or four times by passing over an electrically heated cylinder. The saving is worth while

WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY
WASTE

The portable exhibit is shown all over the plants and is one of many such presentations carried around on trucks

Feet can be welded on discarded calcium carbide containers and so make perfectly good waste cans for the shops. Why buy new waste cans?



Right: Short ends of material make a real waste problem. This electrical butt-welding set makes "big ones out of little ones." The scrap pile is cut down still more

FACTORY WASTES TURNED TO PROFITS

INDUSTRIALISTS have long been worried by two problems which are always present. One is safety and the other is waste. Some of the factory wastes are unavoidable, but there are others that a little care will prevent, particularly with commonplace items which are often overlooked on account of their apparent insignificance. Competition, especially in the form of foreign made goods produced by cheap labor, is steadily becoming keener and if we want to hold our premier position by producing, as we have done in the past, at costs that will allow us to compete, we must eliminate the demon waste. Manufacturers are co-operating with the great engineering societies to bring this home to the employees by posters, actual examples of waste, and by a clever system of rewards for suggestions. The results of the campaign for waste prevention are far-reaching. The Oakland Motor Car Company saved 542,000 dollars in about a year as a result of suggestions. We illustrate some of the things done at the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

SCATTERED LIGHT AND THE RAMAN EFFECT

By **R. W. WOOD, LL.D.**
Foreign Member of the Royal Society
Professor of Experimental Physics at Johns Hopkins University
Contributing Editor, *Scientific American*

IF we are sitting in a darkened room and a beam of sunlight filters in through a chink in the shutters, it is a matter of common observation that the beam is itself invisible from the side, unless there is smoke or fine dust particles in the air. But when a whistle blast enters a room through a hole in the wall, the waves spread out, filling the entire room uniformly, and the ear hears the sound in one place as well as in another. We may explain this action of sound by considering the vibrating air, in the aperture in the wall, as itself a source of sound, which sends out waves uniformly in all directions.

This difference in the behavior of light and sound we express by saying that light is propagated rectilinearly or in straight lines, while sound is not, and it was precisely this difference in behavior that was raised as an objection to the wave theory of light when it was first stated in definite form by Huygens in 1678. The difficulty was cleared up by Fresnel who proved mathematically that, in the case of the extremely short waves of light, rectilinear propagation and the formation of shadows were due to interference. In other words we may consider that secondary waves of light start out laterally from every point on the beam of sunlight, just as we considered the sound as radiating from the aperture, but if we calculate their combined effects at any point outside of the beam, the resultant is zero, or complete darkness.

WE need not go into the proof of this, but it can be shown mathematically that, at all points within the shadow, radiations from any point in the illuminated region are destroyed by other radiations from some other point, the two sets of disturbances arriving half a wavelength apart and destroying each other. This is known as the Fresnel-Huygens principle.

Very high pitched sounds behave somewhat like light, evidence of "shadows" frequently being observed, while in the case of the very high frequency waves from vibrating quartz plates, such as were employed by Langevin for submarine signaling (see article "Sounds that Burn," SCIENTIFIC AMERICAN, March 1928) the "sound" can be projected through the water to a great distance, like the beam of a search light. Here the Fresnel-Huygens principle operates to destroy the spread in lateral directions. If any material particles, such as minute specks of dust, are suspended in the air traversed by the beam of light, each particle scatters light into the shadow, and if very small indeed, the particles scatter blue light more powerfully than red or yellow. In other words the light diverted into the region of shadow is rich in radiation at the short wavelength end of the spectrum. The selective scattering of blue light can be seen by holding a lighted cigarette or cigar in a beam of sunlight, and viewing the smoke against a dark background. In general there will be several filaments of smoke rising, some white, in which the particles are comparatively large, and some blue in which they are smaller.

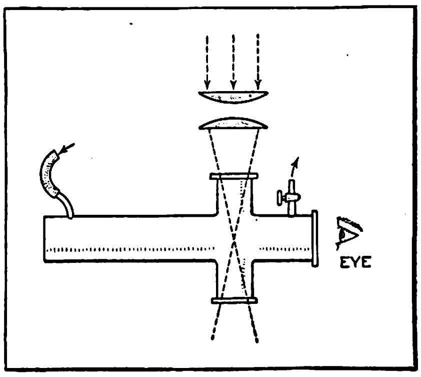


Figure 1

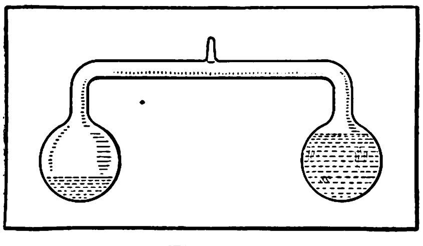


Figure 2

The blue color of the sky was formerly thought to be due to a similar scattering of light by very small dust particles suspended in the air of the upper atmosphere, but Lord Rayleigh's calculations indicated that the scattering in this case was due to the actual molecules of air. Many years elapsed before this scattering of light by pure dust-free gases was detected in the laboratory by Lord Rayleigh's son (the present Lord Rayleigh) and independently and at about the same time by Cabannes, a French physicist. Sunlight was focused by a lens at the center of a black tube, through a window in the wall, and a very blue cone of luminosity was observed through a glass window in the end of the tube, which was filled with air filtered through cotton-wool to remove dust particles. (Figure 1).

SIMILAR results were obtained with other pure gases, even with hydrogen, the scattering power of which was many times less than that of air, while that of ether vapor was much greater. Some experiments were made by the writer at East Hampton, New York, with a view of comparing the intensity of the light of the blue sky with the intensity scattered in the laboratory by dust-free air. Sunlight was concentrated by a "reading-glass" lens six inches in diameter, at the center of a black tube, similar to that of Lord Rayleigh, and the blue cone seen in the tube was matched against a bit of blue sky reflected in a small mirror of black glass, which reflects 4 percent, through a very narrow slit in the rim of a large disk of black cardboard, rotating at high velocity in a dark room. In this way the intensity of the sky light was reduced to that shown in the tube. The total amount of air directly above us is the equivalent of an ocean of air of uniform density at atmospheric pressure five miles deep. This thickness of air, illuminated by normal sunlight, forms the blue sky. In the laboratory the layer illuminated was less than one eighth of an inch in thickness but the illumination at the focus of the lens was about 1400 times that of normal sunlight. The two could be matched by making the slit in the disk sufficiently narrow, and calculations showed that the blue sky could be fully accounted for by molecular scattering of light by the air.

A similar scattering was observed in pure distilled water, freed from suspended motes by repeated distillation *in vacuo* without ebulition in a double bulb, as shown in Figure 2. The bulb containing the liquid should be heated to only 15 or 20 degrees above room temperature, or one bulb may be immersed in ice and the other kept at room temperature. After about one quarter of the liquid has passed over, this is shaken about in the bulb and then poured back into the other bulb, carrying with it any motes which may have adhered to the walls. After two or three repetitions of this process, nearly the whole of the liquid is distilled over, and it will now be found to be "optically clean"; that is, it will show no bright specks when sunlight is focused at the center, but only the pale blue cone of light scattered by the water molecules. It must be viewed against a black background.

NOW a very striking thing is shown in the case of scattering by a liquid and its vapor. We might very reasonably expect the scattering of the light to be proportional to the number of molecules present, and as there are roughly 1000 times as many molecules in a given volume of liquid as in an equal volume of its vapor at atmospheric pressure, we might look for an intensity 1000 times as great in the liquid as in the vapor. As a matter of fact we observe an intensity less than 50 times that of the vapor.

This is, however, precisely in accord with the theory, for in the liquid we have a nearer approach to a continuous medium and if the medium were perfectly continuous and structureless there could be no scattering, for in this case the secondary waves would destroy each other, just as they do when no material medium at all is present and they originate in the vibrating "ether," the hypothetical "medium," the vibrations of which constitute light.

This means that, in the case of the liquid, "interference" is taking place between the scattered radiations, and the lateral diffusion of light by the molecules is partially prevented. Transparent crystals, such as quartz, scatter still less light since the molecules are arranged in a perfectly regular manner on a so-called "lattice," and this condition approaches the condition of a continuous medium from a mathematical standpoint; at all events there are no variations in density from point to point such as occur in a liquid as a result of thermic agitation or the to-and-fro oscillation of the molecules which constitutes heat.

The absence of scattering in the case of a crystal lattice can be beautifully shown with a thin flake of mica. Both surfaces should be freshly cleaved, which can be most easily accomplished by rubbing the edge of a thin plate with the side of a needle until it is flattened, and then inserting the point between the layers of the mica. If a flake prepared in this way is attached to the edge of a carefully cleaned cover-glass, such as is used for microscope slides, the strong scattering of the glass, as contrasted with the absence of scattering by the mica, can be shown by focusing sunlight first on one plate and then on the other, viewing them against a dark background. It was formerly supposed that no change of color was produced by the scattering; or, speaking more accurately, no change of wavelength in the case of the blue smoke or blue sky. There is an apparent change of color, to be sure, but the scattered blue light was originally present in the white light, and the color is not produced by a change in the length of the light waves.

In 1923 Smeckal predicted from the modern quantum theory of light that if a medium was powerfully illuminated with monochromatic light—that is, light of a single wavelength, analogous to a pure musical tone—there should be present in the scattered light, faint traces of other monochromatic radiations and that a "spectrum" would be characteristic of the substance illuminated.

FIVE years elapsed before this prediction was verified by Sir C. V. Raman, the distinguished Indian physicist of the University of Calcutta; and at very nearly the same time by Landsberg and Mandelstamm, the former working with various liquids, and the latter with crystalline quartz.

The arrangement used by Raman is shown in Figure 3. The light from a horizontal mercury arc-lamp (through a draftsman's error, a carbon arc is shown) was focused at the center of a spherical flask filled with benzene or any other liquid, and the spectroscope pointed at the illuminated region at the focus. Exposures of many hours were necessary to secure a photograph of the spectrum, owing to the faintness of the light. Numerous bright lines were found in the case of every liquid examined. In the majority of cases the new lines were of longer wavelength than that of the exciting light—that is, they were on the red side of the spectrum lines of the mercury arc, but in the case of some liquids, such as carbon tetrachloride and chloroform, lines of shorter wavelength were found on the violet side of the same lines.

At first sight it might appear as if this was merely a case of fluorescence, but Raman found a remarkable relation between the wavelengths of the new lines and that of the exciting radiation, which is quite different from anything observed in the case of the phenomenon of fluorescence.

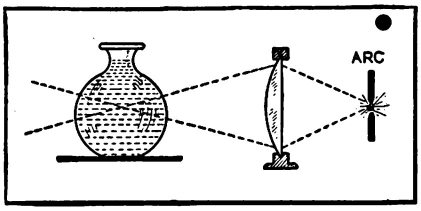


Figure 3

In the first place he found that the arrangement of the spectrum lines in the groups excited by the various mercury radiations was exactly similar. For example, carbon tetrachloride gives a spectrum shown by diagram in Figure 4, the two mercury lines being indicated by arrows. The lines to the left of the mercury lines are of shorter wavelength than that of the exciting line and are called "anti-Stokes lines," being exceptions to a supposed law formulated by Sir George Stokes, that, in the case of fluorescence, only radiations of wavelength longer than that of the exciting light could be emitted. The relative spacing is the same to the right and left of the exciting mercury line except that it is reversed. Secondly, he found a very remarkable relation between these new lines and the absorption bands of the substances in the remote infra-red region of the spectrum. If the frequencies of vibration of the Raman lines are subtracted from the frequency of the exciting light the numbers obtained represent the frequencies of the infra-red absorption bands which are found experimentally only with considerable difficulty.

WE thus have a very simple and direct method of investigating the infra-red absorption of substances by means of visible light, and of securing data on the structure of complex molecules. The matter has turned out to be somewhat more complicated than was at first supposed, for not all Raman lines have infra-red absorption bands associated with them, and some infra-red bands are not represented by Raman lines, but the theory is being gradually worked out.

The original and simpler theory, as first given by Raman, explaining the formation of anti-Stokes lines, is as follows: The quantum theory of light regards a beam of monochromatic light, say the green light of the mercury arc,

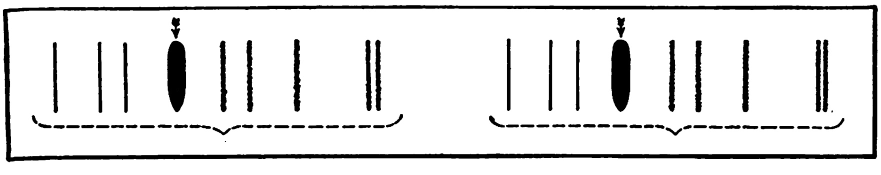


Figure 4

as made up of discreet "packets" of energy, all of the same magnitude, called "light quanta." As the beam diverges in space these quanta merely get farther apart, without suffering any loss of energy. The energy content of a light quantum increases progressively as we pass from the red to the violet and ultra-violet.

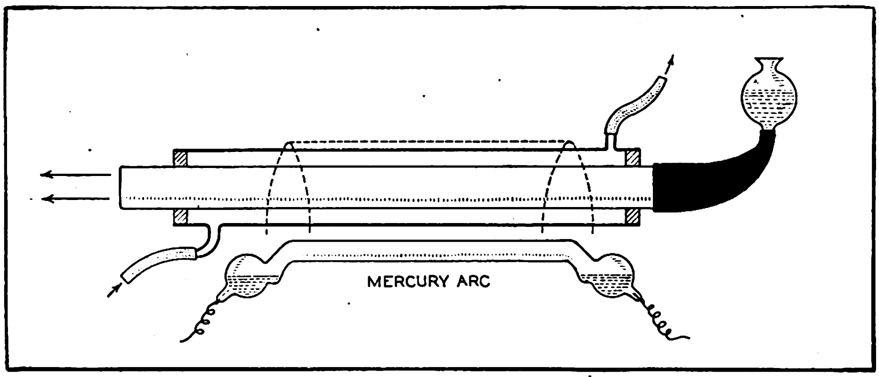


Figure 5

When now one of these quanta enters the benzene, one of three things may happen. It may be diverted from its original direction without loss of energy, giving the line of unmodified wavelength in the Raman spectrum. It may give up some of its energy to a benzene molecule, and emerge from the medium with diminished energy, giving a line on the red side of the exciting line. Or it may abstract a certain definite amount of energy from a molecule already in an excited state—that is, in vibration as a result of temperature—and emerge with increased energy, giving an anti-Stokes line. It is found that the intensity of these anti-Stokes lines increases as the temperature of the medium is raised, as more molecules are then in excited states.

The method of illumination employed by Raman is very inefficient as only a small percentage of the light of the lamp is utilized. The arrangement now universally used is the one described by the writer shortly after Raman's first publication; the liquid under investigation is contained in a glass tube provided at one end with a window of glass fused to the tube, or with a flattened bulb, the other end being drawn off obliquely and painted black. This tube may be surrounded with a second tube in which water circulates to prevent overheating, and the arc is brought up as close to the tube as possible, as shown in the drawing above (Figure 5).

A HALF cylinder of polished aluminum placed over the tubes still further augments the illumination. The scattered light is photographed with a spectroscope pointed down the tube toward the black cone at the farther end. A still further improvement is to use a large glass tube filled with an absorbing liquid which cuts out the light of all but one of the mercury lines, and, acting as a cylindrical lens at the same time, focuses the light on the tube containing the liquid. In this way it is possible to photograph the stronger Raman lines in a few minutes.

A helium "vapor lamp" has also been used by the writer for the excitation of Raman spectra. With a special filter, consisting of a tube of glass colored black with nickel oxide, which surrounded a tube filled with benzene, both being mounted beside the arc and completely surrounded by a cylinder of highly polished sheet aluminum, the Raman spectrum excited by the strong ultra-violet helium line 3888 was obtained.

Three spectra of benzene are reproduced in Figure 6, the upper two by the mercury, and the lower by the helium, arc. They are reproduced as "negatives"; that is, the bright spectrum lines come out dark. The upper one was made with the mercury arc light filtered through a tube containing a saturated solution of a salt of praseodynium, which absorbs the continuous spectrum of the arc in the region where the Raman lines appear and permits the fainter lines to record themselves. The excitation in this case is by the triple mercury line 4358 at the left, and also by 4046 and 4077, which lie still farther to the left and do not appear. The black area at the extreme left is the (over exposed) image of the light of the 4358 triple line scattered without change of wavelength with an intensity of about 500 times that of the strongest Raman line. Lines numbered 1 to 6 inclusive, are excited by 4358, and lines *a* and *b* by 4046 and 4077, *a* and *b* being the same Raman line as 6 by the other excitation. The two lines to the left of 3 are identical with 3, being excited by the two faint companions of 4358, shown as double arrows above the spectrum. Two other fainter mercury lines show to the left of 6. Line 5 is double.

The middle spectrum was made with a quinine filter, which absorbed 4046-4077, and lines *a* and *b* are absent.

The lower spectrum was taken with helium excitation, and is the simplest of the three, as the exciting line 3888 is single. Two faint helium lines have been marked out by covering over on the print.

These are probably the best Raman spectrum photographs that have been made up to the present. Raman spectra have also been made of gases at atmospheric pressure by Rasetti, the writer, and others.

THE first gas studied was hydrochloric acid, contained in a large glass tube about six feet in length mounted in contact with a Cooper Hewitt mercury arc of the same dimensions, the two being surrounded by a hollow cylinder of polished aluminum. The light of the arc, imprisoned by this reflector, was beaten back and forth through the gas tube, securing the maximum intensity of illumination. The spectroscope was pointed so as to "look down" the entire length of the gas tube through a bulb of thin glass blown on the end. With an exposure of only 24 hours a strong Raman line was obtained which was shown by calculation to be associated with the infra-red absorption band of the gas, previously discovered, while the exciting mercury line, scattered without change of wavelength, was bordered on each side by regularly spaced lines which can be shown to be the result of rotation of the hydrochloric acid molecules.

This very important discovery by Professor Raman is opening up a wide field of investigation and throwing new light upon the theory of molecular structure.

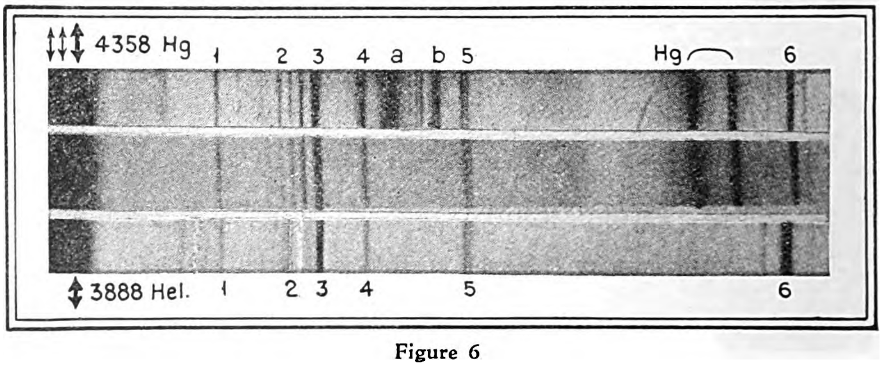


Figure 6

AN ATOM OF LUTECIUM

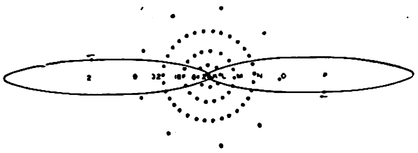
By NELL RAY CLARKE

FOR the first time the atomic structure of an atom of lutecium has been plotted, this having been accomplished by Dr. William F. Meggers of the Bureau of Standards. The arrangement of the electrons in an atom of lutecium as plotted by Dr. Meggers suggests the nose and wings of an airplane with a radial engine. To Dr. Meggers the arrangement of dots mathematically spaced gave a great deal of satisfaction. He said, "The thrill and satisfaction derived from this discovery may be compared with that accompanying the discovery of the ninth planet of our solar system. Indeed, the lutecium atom is pictured as a solar system with a nucleus, corresponding to the sun, surrounded by electrons which correspond to the planets. However, instead of merely nine major planets which are known to belong to the solar system, the lutecium atom has 71 planetary electrons."

FOR years Dr. Meggers has been working over the riddle presented by the group of elements known as the "rare earths," about which little or nothing is known. The mere names of these elements present for the layman as well as the scientist, perhaps, the most formidable array of unpronounceable words to be found in the English language. Try them out on yourself, if you don't believe it. Here they are—cerium, praesodymium, neodymium, illinium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutecium.

It is only within comparatively recent years that these elements have been isolated; lutecium was isolated in 1907 by the French chemist Urbain. They are for the most part very rare, and although a few of the more common ones have found commercial uses, the rest may be regarded at present as interesting chemical curiosities. They form a unique series of elements, with chemical and physical properties so closely similar that it is exceedingly difficult and laborious to separate them from one another.

A few years ago, the Bureau of Standards purchased for experimental purposes a tiny tube of lutecium oxide from the Welsbach Laboratories in Vienna, almost the only place in the world where it is available. Up to that time, no one had ever worked out the structure of the atoms of a single one of these rare earths. But Dr. Meggers decided to try it, following the lines of the Bohr theory. This had often been attempted before, but Dr. Meggers and his assistant, Mr. Bourbon Scribner, are the first to succeed.



Bohr model of lutecium atom. Orbits of two of the 71 electrons are shown. Diameter of atom is approximately one 50,000,000 inch

According to Bohr's theory, the atoms, or smallest units of the different chemical elements, are conceived as being built up of positive and negative units of electrical charge, called protons and electrons, respectively. Beginning with hydrogen, which consists of one proton and one electron, the successive addition of protons and electrons explains the structure of heavier and more complex atoms, until the end of the list is reached with uranium which has 92 outer electrons.

First Dr. Meggers had to get the spectrum of lutecium. To do this he impaled some of the lutecium oxide on a piece of wire and passed a current of 220 volts through it to get the spectrum of the neutral atoms. Then by exciting the spark to 40,000 volts he was able to remove one of the electrons from the atom, which gave the lines of the spectrum from the atoms of lutecium with one electron off. Later he got the lines of lutecium with two electrons off; these are in the ultra-violet end of the spectrum and therefore are not visible to the eye though they affect a photographic plate as does visible light.

He found that there are 200 lines in the spectrum of neutral lutecium and 450 lines in the spectrum of lutecium atoms lacking one electron. The illustration shows only a few inches of the spectrum; the whole spectrum measures from eight to ten feet in length. The position of each of the lines relative to known wave-lengths in the iron spectrum was measured—a task almost incomprehensible to the layman because of the infinite pains it required.

THE results of the calculations which revealed the regularities among spectrum lines and disclosed the structure of the atom he set down in tiny figures arranged in neat rows. There were enough of them to cover a sheet of paper as large as two card table tops. The graphs he drew to illustrate and explain his work are more complicated than the geometrical designs President Hoover draws during his interviews or while telephoning.

By studying these results Dr. Meggers obtained the solution of the problem of just the exact position of each electron in the atom of lutecium. He is now working upon calculations which will enable him to plot the atomic structure of some of the other rare earths. The spectra of ytterbium, the one being studied at the present time, will be more complicated than those of lutecium, but the atomic structure will be some integral part of the atomic structure of lutecium.

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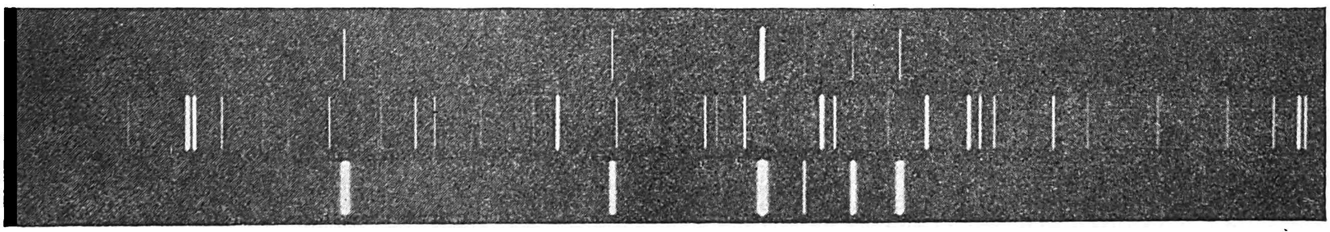
A Mexican savant believes he has succeeded in creating living substance, protoplasm, from chemicals. In an early number an account of his intriguing experiments will be described.
—The Editor.



A portion of the spectrum of lutecium. The top spectrum is of the neutral atoms; the middle one is an iron spectrum ("comparison spectrum"); and the bottom is the spectrum of lutecium with one of the planetary electrons removed

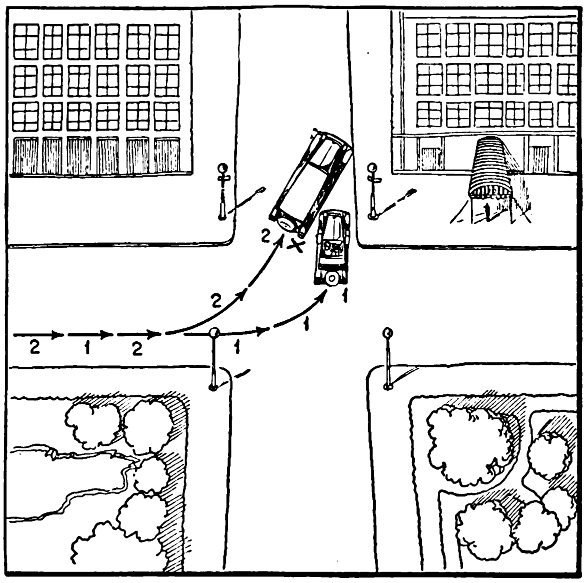
SCIENTIFIC CRIMINOLOGY—
THE PISTOL WITNESS

As a fitting sequel to his article in our October issue, Mr. Gorman has set forth in these pages an actual case taken from the New York police records, in which it is shown how the study of firearms and ammunition is applied in every-day police work. He makes no pretense of telling a mystery story; he gives a bald statement of fact.—*The Editor.*

By STANLEY F. GORMAN

Lecturer on Bullet and Firearm Identification,
Police College, City of New York

With the roar of hard pressed engines, a heavy sedan and a powerful coupé whirled around the corner racing side by side. The sedan suddenly spurted ahead and swung diagonally across in front of the coupé. With a screeching of brakes a collision was avoided and the two cars stopped close to the curb. From the coupé, now in the rear, leaped a man with a gun in his hand. The left-hand door of the sedan opened and a second man, also with a gun in his hand, stepped forth. Shots were fired and a man was seen to leap back into the coupé, back away from the sedan, and speed away from the scene.



Scene of the deed. The cars are shown in their relative positions at the time of the fatal shooting

The exact details of what occurred at this recent homicide in New York were beclouded by different versions rendered by different witnesses. According to some, the man in the sedan started to get out the left-hand door, hesitated, and then got out the right side. Others say that he emerged from the left-hand door. In any event, when the police arrived on the scene, the driver of the sedan was found crumpled in a heap directly behind the right-hand rear wheel of his car. It then remained for the police and detectives to make a thorough examination of the scene and from the facts obtainable from witnesses and clues, deduce the facts and bring the murderer to justice.

When the detective arrived on the scene of the crime he found that the driver of the sedan had been removed to the hospital as he was still alive and there were possibilities of saving his life. It developed, however, that shortly after entering the hospital he died. There was a group of about a hundred people surrounding the sedan and held back by the police in charge of a sergeant. The detective found upon questioning the police that the pistol which had been dropped by the driver of the sedan when he was wounded had been carefully picked up by the sergeant. This was done with a pair of pliers in order not to destroy any possible fingerprints. The weapon was placed on the floor of the sedan in the rear compartment so that it would be undisturbed until it could be examined.

Upon examining the gun, which was a 32-caliber automatic pistol, the detective noted that the safety catch was off the safe position, indicating that its carrier had it in readiness for use. With a screw driver the detective pushed the catch to the safe position and picked up the pistol, handling it by means of the screw driver placed through the trigger guard. He then examined it as carefully as possible under the circumstances and looked into the muzzle for powder smudges. He also smelled it for the odor of powder in an endeavor to determine whether or not the gun had recently been fired. It must be remembered that he could not determine whether or not the gun was loaded as this had to be done after the search for fingerprints was made; handling might destroy fingerprints which could be used as evidence. As far as the detective could determine, the weapon had not been discharged, for the barrel contained neither powder smudge nor discoloration and had no burned-powder odor. Furthermore, it was apparently quite wet with oil.

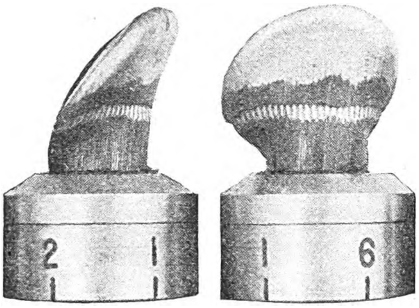
The firearm was then handed to the fingerprint expert who dusted one side carefully with white clay powder and examined the surface. The gun was then turned over and the other side dusted but no fingerprints were found that were distinct enough to be classified. This frequently is the case with pistols because of the difficulty of obtaining a distinct fingerprint on the checked surface of the grip. After the fingerprint examination it was possible to determine whether or not the pistol was loaded. The magazine was found to contain five 32-caliber cartridges, and a sixth cartridge was in the chamber. These cartridges, as well as the interior of the weapon, were covered with oil and an examination of the barrel confirmed the first-formed opinion that the gun had not been fired.

To return to the scene of the crime: The detective asked for any empty shells found nearby. The police had picked up a 25-caliber shell immediately behind the sedan but this did not completely satisfy the detective. He had been told by witnesses that four shots had been fired and since an automatic pistol ejects its shells immediately as each one is fired, there must be other shells in the vicinity. A careful search soon disclosed three more empty 25-caliber shells.

The next thing to attract the detective's attention was a back cushion, such as drivers frequently use, lying on the running board. Upon asking where it came from and where it was found he was informed that it was lying in the roadway under the running board immediately below the left front door. Apparently it had been dragged out by the victim when he opened the door to get out of the car. This served in great measure to refute the statement by certain witnesses that the driver of the sedan had left the car by means of the right-hand door. After asking a few more questions, the detective gave orders for measurements to be made of the exact position of the car relative to the curb and the nearby corner. A photographer was instructed to take pictures of the sedan from various positions, and also pictures of the entire block from the corner.

THE detective then went to work to examine the interior of the car for possible bullet holes, commenting upon the fact that, while no 32-caliber shells had been found, it was possible that a shot might have been fired by the driver of the coupé before the man in the sedan got out. His diligence was soon rewarded, for he found a small hole in the cloth lining on the inside of the left front door close to the handle. He carefully cut away the cloth and on tearing the lining he found a metal-patched 25-caliber bullet flattened against the door lock. It had distinct rifling marks and also appeared to have some blood on it when examined under the magnifying glass.

The detective now had in his possession the following knowledge: several conflicting stories told by witnesses; the fact that the back cushion had been found on the roadway under the left running board; the information that four 25-caliber shells had been found on the scene; and that a bullet had been lodged in the left front door of the car. His next procedure was to go to the hospital and examine the body of the driver of the sedan. It was found that a bullet had pierced the left wrist. This wound was accounted for by the bullet which had been found in the door of the car. There were three other wounds on the man's left side and when an autopsy was performed three 25-caliber bullets were removed from the body. Upon microscopic examination of these bullets it was found that each had six land and groove marks (see page 265 October 1930 issue of the SCIENTIFIC AMERICAN), the direction of which ran from left to right. Each bullet also had punched on it a small letter "w" indicating that it was made by the Winchester Repeating Arms Company. This small "w" linked the bullets with the shells which were all stamped with the mark of the same company.



Two views of the mushroomed 25-caliber bullet taken from the car

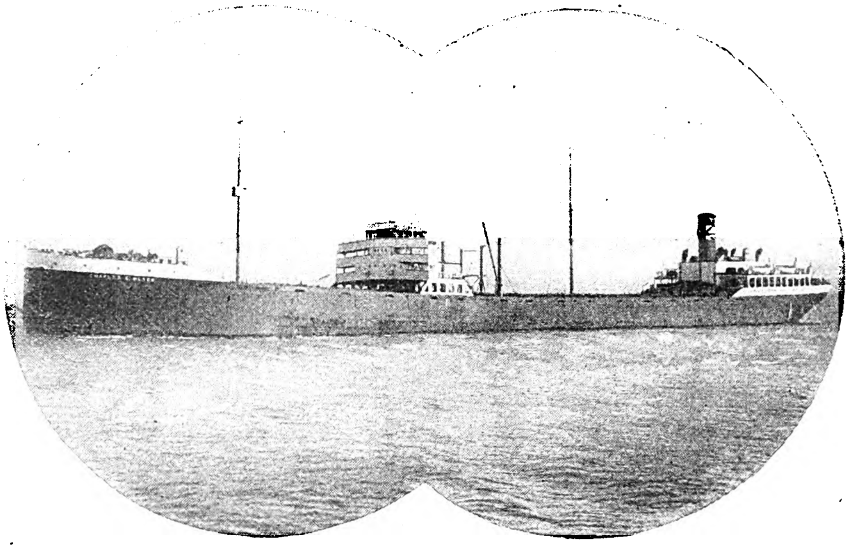
While all this work was going on and the police were busily engaged in building up a case, the driver of the coupé, fearing possible capture by the identification of the car which he drove, consulted with his attorney and decided to surrender himself. This he did, telling an apparently straightforward story of self defense. He claimed that the driver of the sedan had opened fire first, firing two shots at him. The driver of the coupé surrendered both his gun and his automobile. The car bore distinct scratches on the edge of the left-hand mudguard which coincided with scratches on the rear right-hand mudguard of the sedan. The pistol was a Spanish make 25-caliber automatic and was not loaded when surrendered but had powder smudges on the interior of the barrel. Furthermore a strong odor of powder indicated that the pistol had been discharged recently. The gun was turned over to the firearm expert and five test shots were fired into cotton waste. The bullets were recovered and an examination was made under a comparison microscope. It was determined beyond a doubt that the test shots, the three fatal bullets, and the bullet removed from the car door had all been fired from the same gun. (The methods used in reaching this conclusion were dealt with in detail in the October issue of the SCIENTIFIC AMERICAN.) It had already been determined, as described above, that the 32-caliber automatic had not been fired.

The evidence in this case was presented to the Grand Jury and its members were given all the facts determined by the scientific examination of the firearms. They failed to indict the defendant, on the ground that the driver of the sedan had evidently intended to shoot the driver of the coupé and that therefore the latter had acted in self defense. The members of the Grand Jury, however, expressed their interest in the preparation of the case and were deeply impressed by the scientific methods used by the Police Department in determining the facts.

IN order to complete the investigation and mark the case definitely "Closed" it was necessary to establish a motive. It developed that the driver of the coupé, several months prior to the commission of the crime, had delivered a large quantity of grapes to the other party, the value of which was 800 dollars. After repeated attempts to collect this debt, a summons to appear in court was served upon the purchaser of the grapes, who accepted the summons but gave a receipt, as it were, by striking his creditor in the face. The latter's dignity was severely hurt but he decided to use a more effective weapon than his fists. He therefore left as though he was completely defeated but planned a suitable revenge.

He drove directly to his office and took from his desk the 25-caliber automatic pistol. As he re-entered his car he noticed his debtor seated at the wheel of a sedan at a nearby corner. He realized then that he was in for trouble. Suddenly, so it appeared to the man in the coupé, the driver of the other car vanished. This apparent change in the situation reduced the vindictiveness of the driver of the coupé to fear, and he thought it a good opportunity to get away safely. He started away from the curb with a burst of speed and as he passed the sedan he saw his opponent straighten up from the seat where he had been hiding. The sedan too started off at great speed and the race ended as has been told. The customer paid the bill in full. It was he who staggered to the rear of the sedan with gun in hand and fell fatally wounded to the pavement.

The prisoners' pen in the photograph gallery at New York police headquarters. *Center:* Fileing out written records. *Extreme left:* Taking a set of fingerprints



The *Charles G. Black*, one of the largest tankers of the Standard Shipping Company's fleet. She has a tonnage of 20,500, and is 550 feet 3 inches long, 72 feet 2 inches beam

WHEN CRUDE OIL CROSSES THE SEAS

By HENRY W. HOUGH

MORE new merchant ships now are under construction throughout the world than at any time in recent years. The present total of 3,265,929 tons exceeds by more than 100,000 tons the level attained just prior to the World War. This notable peace-time revival in one of the world's greatest industries has been even more marked in the United States than in other maritime countries. The tonnage of new vessels under construction in American shipyards still is only about one eighth of that laid down in yards in Great Britain and Ireland, but during the last quarter, the United States advanced from fifth place to third, and now is hard on the heels of Germany, which holds second place in the tonnage of new ships being built.

Amid this quickening interest, particularly notable is the recent impetus in the construction of tank ships. The increase is attributed to the world-wide and ever-increasing demand for petroleum products and other bulk cargoes, such as creosote, molasses, coconut oil, turpentine, whale oil, and vegetable oils. By far the most important of these liquid cargoes is crude oil. Much gasoline, fuel oil, and other refined petroleum products also are transported in "tankers."

Of all the new tankers now under construction in America and abroad, perhaps the most interesting are the two new 18,000 ton ships being built at the Kearny, New Jersey, works of the Federal Shipbuilding and Dry Dock Company. These vessels are being constructed for the Standard Shipping Company, marine subsidiary of the Standard Oil Company of New Jersey, which owns and operates the world's largest tanker fleet. With the additional ships now being built, this great fleet will comprise 106 ships aggregating 1,105,528 tons, operating in all parts of the world but especially in American inter-coastal traffic.

The two new Standard tankers are said to represent the "last word" in design and equipment, and are expected to show a substantial saving in operating costs as well as in the initial investment. Their construction is being watched with interest by those interested in ships of this kind, because of a number of departures from standard design which are being incorporated.

THEY are 544 feet in length, 74 feet in width, and 40 feet in depth, with a draft, when loaded, of about 28 feet. They are single-screw ships, and will operate at an approximate speed of 11 knots per hour when loaded to capacity. Both are being powered with De Laval cross-compound steam turbines equipped with double-reduction gears of recently improved design, made by the same manufacturer.

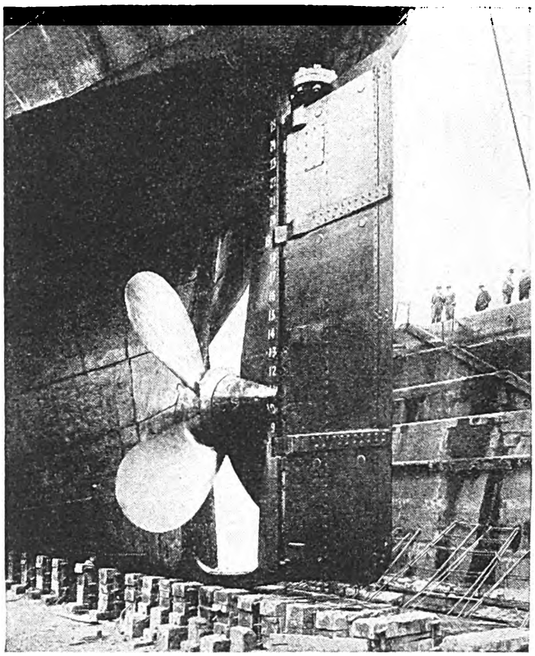
Oil-fired Babcock and Wilcox water-tube boilers will supply the turbines with superheated steam under 400 pounds pressure at 750 degrees, Fahrenheit, at the superheater outlet. All of the ship's auxiliary equipment will be operated electrically, including the cargo pumps and steering gear. Two 300-kilowatt turbo-generators will provide the electricity. These power plants follow the practice which has proved most satisfactory on land in central power station service, with turbines operated by steam at high pressures and high temperatures and the auxiliaries operated by electricity.

Perhaps the most interesting of the new features incorporated in these tankers is the revised arrangement of the boilers. Instead of placing the boilers in front of the turbines, as is the customary practice, they are located aft in the narrower part of the stern. The additional space made available by the new arrangement is of exceptional value in ships of this type, because of the tankers' characteristic location of the propulsive equipment in the stern, where the curving hull reduces the available space required for the various auxiliaries of the engine room.

In addition to increasing the space in the engine and boiler rooms, this arrangement permits the use of a flexible propeller shaft nearly three times the conventional length. A high degree of flexibility between the turbine and the propeller shaft is considered one of the paramount characteristics of an efficient marine power plant.

These new tankers are being equipped with the already famous "contra-rudder" and "contra-propeller." By using these stream-lined propeller hubs, stern-posts, and partially balanced rudders, an appreciable saving in fuel costs will be effected. At the former fuel consumption, the speed of ships is increased from 5 to 10 percent with this equipment. In addition, there is a reduction in torque on the rudder of from 30 to 40 percent, which reduces the strain on the steering gear and makes it possible to maneuver the ship more easily.

Tank ships are constructed with a number of compartments, formed by horizontal and longitudinal bulkheads.



Courtesy Th. Goldschmidt Corporation

Contra-rudder and contra-propeller, the stream-lined design of which saves much fuel

In the average tanker, the compartments are arranged as follows, working back from the bow: fore peak tank; fore hold for package freight and a tank for water ballast; cofferdam; cargo tanks; pump room; cargo tanks; cofferdam; bunker for fuel oil; space for boilers and machinery; and fresh water tanks. In addition to the deep cargo tanks, there are also "summer" tanks. These are long, shallow compartments situated above the deep tanks along the sides of the ship. They are used when carrying light cargo such as gasoline or naptha. Some tankers are built with two longitudinal bulkheads instead of one, forming a greater number of compartments of decreased width.

THE cargo pumps, usually located amidships, naturally vary in size and number according to the size of the ship. The output of each pump ranges from 150 to 400 tons per hour. The customary discharge pressure is between 50 and 100 pounds per square inch. In many installations, the ship's pumps are operated by steam, as are the winches, windlass, and other auxiliaries. In the new Federal-built tankers, all such equipment is electrically operated.

The pumps are used for unloading, "trimming," equalizing the cargo in the various tanks, and taking on and unloading water ballast when the ship is otherwise empty. When taking on a cargo, pumps on shore do the loading except in ports where gravity pressure can be used.

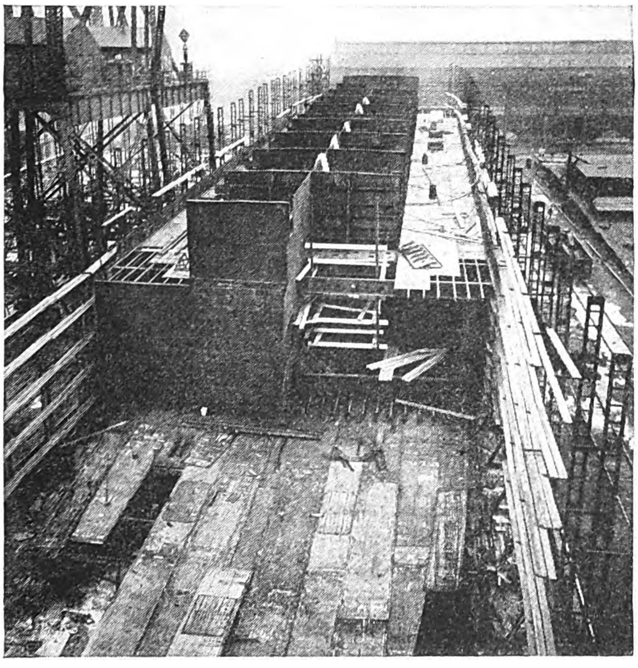
To load a ship properly with a liquid cargo is a task which requires real teamwork, good judgment, and long experience. Should the officer who is supervising the loading fail to give the shore pumpman the signal at just the right moment, the tanks may take on the appearance of miniature gushers. Cleaning the deck is not a pleasant task, after such an occurrence, and of course to lose oil is to lose money. More important, however, is the necessity of keeping the overflow from contaminating the water near the loading dock. To pour oil on the waters is an unpardonable offense in any port.

It requires only five or six hours to load or unload the largest of the oil tankers, some of which have a capacity up to 150,000 barrels. Consequently, ships of this type are able to spend practically all their time at sea, with waste time reduced to a minimum.

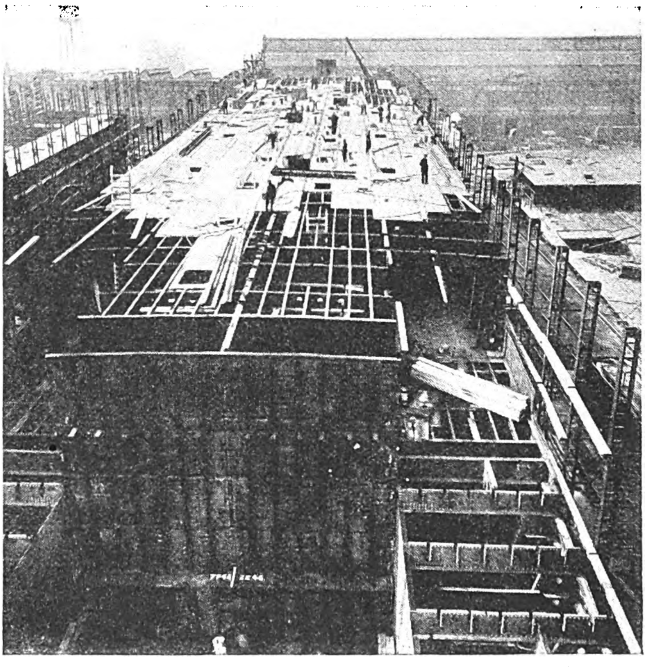
American oil was transported across the Atlantic ocean as long ago as 1861. Before the days of steamships, tankers were busily crossing the seven seas.

For a long time, domestic transportation of petroleum and its products was handled almost exclusively by river barges and railway tank cars. With the construction of extensive underground pipe-line systems, it seemed that oil could be transported almost any distance by that method. Economy, however, added another chapter to the story.

The longest of the oil pipe-lines was a 1700-mile trunk line extending from the mid-continent fields to Bayonne, New Jersey. Originally it was an oil line, transporting the raw material from the oil fields to refineries on the eastern seaboard. Now it transports gasoline—the finished product—from the eastern refineries to one of the most important consuming areas in the middle-west. Thus the order of supply is reversed, for the oil companies have found it more economical to supply their eastern refineries with crude oil brought by tanker from pipe-line terminals at ports in Texas, Louisiana, California, Mexico and elsewhere—a task for which these new tankers will soon be launched—and pipe the finished product into the interior. "The old order changeth, yielding place to the new."



Construction of cargo tanks of a new Standard tanker, with longitudinal and horizontal bulk-heads in place



Later view of construction of tanker with tanks partially covered with plates, and apertures for filling and emptying

TRAVELING HOME FOR 'PHONE LINEMEN

By C. W. GEIGER

No longer does the lineman whose duties take him to the wide open spaces and the sagebrush wastes of Nevada have to shiver through long nights in zero weather. No longer does the truck driver have to haul water 14 miles to camp. No longer—ah, well, the old-timer who did his hitch in '14 when they built the T-C lead shakes his head and mutters something about times not being what they used to be. He mutters something about the coming generation getting softer, or having it soft, or some such remark that betrays a bit of wistful reminiscence rather than envy.

These comfortable, clean berths are a vast improvement over the camp quarters formerly used

For today telephone men in the sagebrush country are residing in "private" cars. They are real, honest-to-goodness private cars. These cars were purchased by the Pacific Telephone and Telegraph Company from the Southern Pacific Railroad Company and remodeled under the supervision of the telephone company.

For many months construction crews from California have been "farmed out" on the desert. With the completion of each job, however, a new one was devised, for work in the Silver State is no longer a seasonal activity, and the growth of the telephone business has demanded all-year activities.

When it is 10 degrees below zero, Nevadans consider it a light frost, so with the ever-increasing demand for telephone circuits, some steps had to be taken to provide adequate living quarters for Californians engaged in desert work. When it was definitely decided what was required, the Supervisor of Supplies of the Pacific Telephone Company began negotiations with the Southern Pacific Railroad Company and, as a result, the linemen now have a complete "home sweet home" of seven cars, comprising material, water, commissary, kitchen and dining, recreation, sleeping, and foreman's cars. The whole unit will take care of 40 men.

The Threlkeld Commissary Company, which provides the meals, occupies one car, remodeled to provide a commissary and sleeping quarters for the Chinese cook and the waiter. From this car the kitchen help can walk into the dining car, which has been rebuilt to provide a kitchen the full width of the car with an adjacent horseshoe counter.

Following the dining car is the recreation or club car, which is equipped with a radio and tables for cards and reading. What was formerly the kitchen of this car, when it was in active service on the railroad, has been remodeled into a bathroom de luxe, featuring heating arrangements better than some bachelors have at home. Forty minutes before the "gang" gets in the car to "ablute," the "Chief Steward" starts the works and then—hot water for everyone. For the more fastidious, there are tub and shower baths.

After the recreation car comes one of the sleeping cars, which is provided with double deck berths the full length of the car. The next car is the foreman's car, equipped with single berth cots, and, located at one end, the foreman and clerk's sleeping and office quarters.

A two-kilowatt automatic lighting unit furnishes the electricity for lighting. When any light is turned on, it automatically starts the motor and instantaneous lighting is then furnished throughout the cars as required. Turning off the last light stops the motor. To provide water throughout the train, a pressure pump has been installed, hooked up with the lighting unit. This scheme gives water pressure equal to the usual city pressure.

The railroad car home is indeed a tribute to the efforts of the management of the telephone company to provide adequate protection and accommodations for those whose duty takes them to the barren wastes.

Another and similarly equipped special train with 80 men on board is being used in building a long-distance telephone line across the sands from Barstow to Las Vegas. The project, involving 826,000 dollars, will provide 85 simultaneous talking circuits between southern California, the Hoover Dam territory, and certain desert towns that have never yet had telephone service. The circuits will be extended later to Salt Lake City. Pressing telephone requirements have developed in this section of the west, and the specially equipped construction train departed as the best answer for the situation.

Included in the train are three sleeping cars, a dining car, a commissary car, a bath car, a supply car, and a water car. Although the men will be in the warm environs of the desert for several months, each day's toil will be forgotten in the 12 shower baths in the bath car.

The men have their own lighting system aboard, together with electric refrigeration. Ice cream sundaes on the fringes of Death Valley loom as possibilities, according to the head of the commissary department, who has planned to deliver approximately 20,500 meals to the hungry workers while en route.

Electric fans are also installed in each of the coaches. The dining car contains a table more than 60 feet long, capable of seating the entire personnel. The club car contains regular day-coach chairs, card tables, a phonograph, and other equipment to make the desert headquarters home-like. The train was purchased by the telephone company and the interiors of the coaches were refitted to suit the needs of the expedition.

These modern telephone pioneers began their activities just east of Barstow. Augmenting the telephone train are 10

AVIATION IN 1930

By PROF. ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University
Associate Editor, *Scientific American*

AIRSHIP enthusiasts have been greatly encouraged by the year's developments. In Akron, under the auspices of the Goodyear-Zeppelin Corporation, the 6,500,000 cubic-foot airship *Akron* is advancing rapidly. Seven main frames, and 18 intermediate frames are in position, representing 525 feet of the ship's total length of 785 feet. This dirigible has been called the "airship of 6,500,000 rivets"; stood on end it would be equivalent in height to a skyscraper of 80 stories.

Driving rivets in the airship is not the noisy process we associate with the construction of a skyscraper. The dural rivets, heat-treated in an electric furnace, are taken from the furnace, immediately quenched, and then simply squeezed into position by a manually operated tool.

The airship is to be delivered to the Navy Department in the spring of 1931. With its swiveling propellers, speed of 80 miles per hour, and unequalled dimensions, the *Akron* will mark a distinct epoch in airship development.

THERE are at present only two airship building corporations of importance in the United States. One of these, the Aircraft Development Corporation of Detroit, is actively pursuing its experiments with the metal-clad type of airship in which a thin metal covering, about eight thousandths of an inch in thickness, replaces the conventional rubberized fabric covering of today. The metal-clad airship built by this company and delivered to the Navy's Airship station at Lakehurst, has shown up excellently in service and has successfully demonstrated that the difficulties expected from the very thin metal covering are really non-existent.

It is understood that the duPonts, in conjunction with yet another lighter-than-air company, are producing a synthetic material which will replace the expensive goldbeaters' skin (made of animal entrails) and will reduce the permeability of the gas bags to helium to an almost negligible quantity.

Small airships for private or commercial use have been few in number to date. They have possibilities, however, and it is intriguing to learn that Captain Anton Heinen, the airship pilot employed by the Navy Department in the construction and operation of the *Shenandoah*, is planning to build a number of small airship yachts. These little airships are to be only 104 feet in length with a gas capacity of 39,600 cubic feet. They are designed to have a top speed of 65 miles per hour and are to cost less to operate than an automobile! The plans also call for the use of a detachable passenger car which can operate under its own power as an automobile. This of course would meet the great difficulty of transportation to the airport. It remains to be seen whether the technical difficulties involved in such independent operation can be overcome.

ALTHOUGH the general business depression during the past year has affected aviation adversely, the developments within the industry give promise of a bright future. On these pages Professor Klemin presents a brief yet thorough survey of the situation.—*The Editor.*

Still another encouraging feature of the airship situation is the fact that the proposed airship line between Spain and South America, under combined German, Spanish, and South American auspices, is apparently coming to a head. At any rate Captain Eckener, full of energy and enthusiasm after his successful voyage 'round the world, has definitely begun the construction of an airship for this service. The new airship, the *LZ-128*, is to be finished by the end of next summer. She is scheduled to be 815 feet in length, with a maximum diameter of 130 feet, and a displacement of 5,250,000 cubic feet. Four power gondolas are to be placed on each side of the airship, each equipped with two Maybach motors of 500 horsepower. The airship is planned to be used mainly for mail purposes and is not to be equipped with any degree of luxuriousness. The Spain-South America line is regarded as an even more promising field for the airship than the Germany-Lakehurst route, because the saving of time over the 17-day steamer service is likely to be overwhelming.

The British, on the other hand, are more than satisfied with the flight of the *R-100* from Cardington to Montreal and back. The voyage from east to west, beginning on July 29th, took 79 hours of flight, with eight hours delay due to repairs in flight. The return trip of 57 hours 5 minutes was very close to the record time of the *Graf Zeppelin*. The *R-100* navigated successfully through fog, and when it was encountered on the voyage also demonstrated the success of a very useful new device whereby water deposited on the cover was collected by a series of special drains leading to a cistern. More than two tons of water were collected in this manner in the course of one morning. This ship was constructed by the Airship Guarantee Company of which Commander Sir C. Dennis Burney is the guiding spirit. As the result of close analysis and of the experience achieved in this successful voyage, Commander Burney predicts large profits on the investment in a regular line.

THE trip of the *R-100* constitutes the eleventh crossing of the North Atlantic by airship, with some minor mishaps it is true, but with not a single fatality on any of the crossings. There would appear to be a good deal in favor of the opinion that the airship is a suitable medium for trans-oceanic travel.

The year has been marked by comparatively little news of helicopter development—with one outstanding exception, the announcement of completion of the Curtiss-Bleecker Helicopter.* The possibilities of the helicopter or direct lift type of aircraft are very great. It is obvious that the ability to rise vertically from a small plot of ground and to land at will in equally restricted territory is very valuable. While it is inconceivable that the helicopter should compete with the airplane for load carrying at high speed, it would be a very valuable auxiliary in air transport work. For military or naval air forces the helicopter's ability to hover over one spot would ensure accurate and deadly bombing. With these possibilities in mind much money and effort and ingenuity have been spent in all civilized countries on the production of a helicopter. Nowhere have really conclusive results been yet reached.

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*For a description of this helicopter see *Scientific American* September, 1930, page 214.

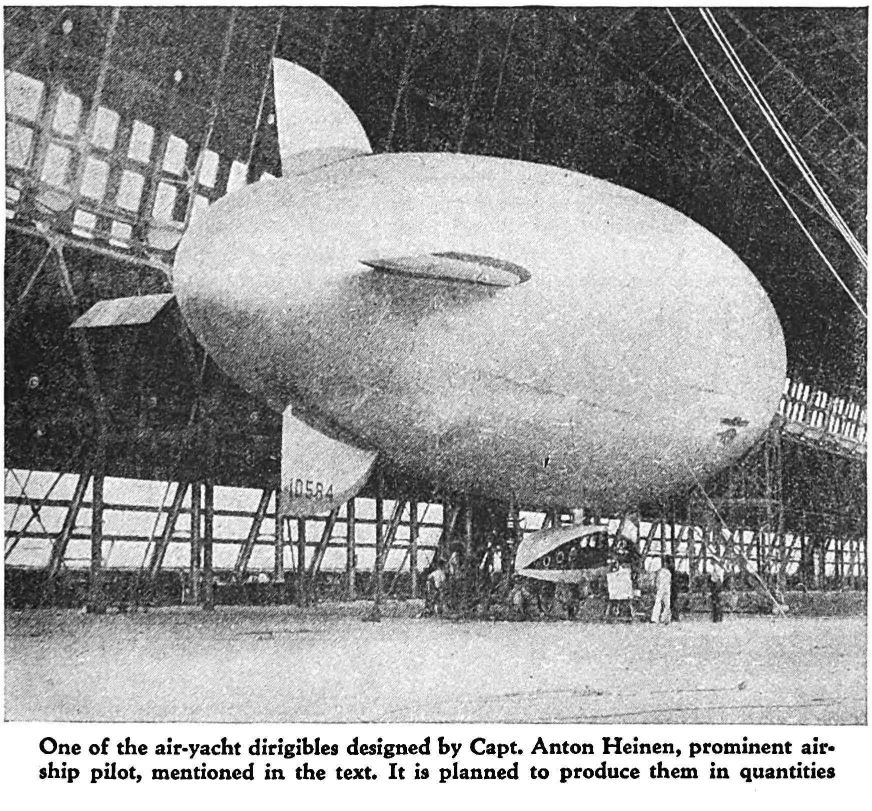
As aeronautics progresses more and more, it cannot be expected to provide us with so many thrilling novelties as in the past. Still there have been a good many novel developments even in this year of general aeronautical depression. One of the most striking is the provision of a parachute for the support of the entire plane, developed by the Russell Parachute Company and successfully tested on a Parks biplane of the Detroit Aircraft Corporation.†

On the first test, the ship landed in a tree, yet the only damage sustained was that of a broken propeller and a bent landing gear axle. There is no doubt that if the plane 'chute proves entirely practicable it will add greatly to the confidence of the traveling public.

At the same time manufacturers are not neglecting other ways of providing parachute facilities for the traveling public. For example quick-release parachutes have been successfully tried out in recent months. (See page 392, November, 1930, Scientific American.) The traveler is provided with a comfortable though sturdy jacket at the front of which there is a ring. The parachute is placed conveniently at hand in the cabin; a hook on the parachute can be attached to the ring in an instant. It is true that only a short time ago a girl of 16 jumping from a cabin plane forgot to pull the rip cord and was killed, and it is true that passengers as a group will not take readily to the parachute. Still its possibilities in emergencies are well worth experimenting with.

The only type of aircraft we can recall which may be classed as completely a novelty is the rotor seaplane recently built at Mamaroneck, New York. Considerable mystery attaches to the construction of this seaplane. Instead of the ordinary wings, two cylinders or rotors are placed above and on either side of the fuselage, and are turned by suitable gearing from an engine placed in the fuselage; a second engine drives a conventional propulsive propeller. When the rotors are turning and the seaplane as a whole is in forward motion the rotors give a powerful upward or lifting force. Their action is similar to that of the Flettner rotors used in the Flettner rotorship, *Buckau*. While the daily press grew quite excited about the possibilities of the rotor airplane, it must be remembered that while rotors are very powerful in lift, far more powerful than ordinary wings of the same area, they are also far less efficient. That a rotor airplane can be made to fly is quite likely. That a rotor airplane can be made reasonably efficient is very doubtful. (For a fuller description, see page 392, November, 1930, Scientific American.)

The year's activity in design, although somewhat curtailed by the general slump in aviation, has brought out several new types of planes. The Daniel Guggenheim Safe Aircraft Competition was instrumental in bringing out the Curtiss *Tanager*, the prize winning plane of the competition. This plane has brought several fine developments to the eyes of the designer, notably the slots, flaps, and floating aileron. The added lift and speed range due to the slot and flap combination has proved very encouraging. (For details of the *Tanager*, see page 232, March, 1930, Scientific American.)



One of the air-yacht dirigibles designed by Capt. Anton Heinen, prominent airship pilot, mentioned in the text. It is planned to produce them in quantities

In the light racing and sport plane field, the *Mystery S*, a low wing monoplane designed by the Travel Air Company, has created quite a stir. The *Mystery S* is a typical low wing monoplane streamlined to the highest possible degree. It has incorporated every known device for the reduction of drag such as tapered wings, wheel fairings, elliptical fuselage section, and filleting of all sharp corners. The streamlining of the fuselage is carried through to the rudder, the bottom of which conforms with the shape of the fuselage. The amount of external bracing has been cut to a minimum and where necessary it has been done through use of streamline wire. The landing gear of the *Mystery S* is of unique design.

The shock-absorber strut is a combination oil and spring type held in a vertical N Strut which is attached to a wing stub. Each unit of the landing gear is fastened to its own wing and the wing stub of the opposite side. Most of the wheel and mechanism are enclosed in a neat fairing. The plane attains speeds in excess of 200 miles per hour equipped with a special 400 horsepower Wright Whirlwind. Many of the small ship manufacturers have followed in the steps of the Travel Air Company and are developing small fast planes but this ship still remains as one of the swiftest and neatest of designs.

A DECIDED trend toward increasing the payload with increase in size of the ship has been confirmed by the construction of several large ships. There is the Junkers *G-38* which has undergone several successful flights at Dessau, Germany. Although the construction of the *G-38* is of usual Junkers metal type, the depth of wing is such that the power plants and cabin passenger accommodations are wholly contained within it. Propellers are mounted out in front of the wing on streamlined bosses and driven by extended shafts from the motors. The plane will carry 32 passengers together with a cargo of freight and mail. Passenger cabins in the wings are available.

In America, the Fokker Company has developed the *F-32*, a large monoplane of usual Fokker construction carrying 32 passengers and having a payload of 8700 pounds. The plane is driven by four motors in two tandem pairs mounted out under the wings. Passenger accommodations are very luxurious and are capable of being made up as a Pullman for night service.

The Commodore flying boats which have been constructed by the Consolidated Aircraft Company and put into service on southern routes of the N.Y.

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†For full description see *Scientific American Digest*, this issue.

R.B.A. Lines are also additions to the large plane class. These planes are luxuriously equipped for 20 passengers and can be made up for night service.

In the aerodynamics of the airplane there have been no revolutionary changes, but steady refinement and improvement. The ideal of the airplane designer is a flying wing, with everything enclosed as far as possible in the wing itself. The Northrup Company, of California, has carried us a step nearer this ideal. Northrup has designed a pusher airplane, very heavily tapered from root to tip, so that the root of the wing is quite thick, so thick in fact that the small nacelle in which crew and engine are placed is practically hidden in the wing. The Northrup *Flying Wing* is a pusher, with the propeller mounted behind the wing, and the tail surfaces carried on outriggers running from the wing. This is a decided step forward. (See page 389, May, 1930, SCIENTIFIC AMERICAN.)

Vincent J. Burnelli has continued his experimental work with a transport plane in which exceptional cabin space is provided. The Burnelli fuselage is twice as broad as the conventional fuselage, but it is given an airfoil form and thereby contributes to the lift. At the same time the two engines are mounted inside the fuselage, at its leading edge. It is claimed for the Burnelli principle that the relatively enormous passenger space is obtained without any sacrifice of aerodynamic efficiency.

THE Fokker Aircraft Corporation has also been working in the direction of the flying wing. A bomber recently tested has its cantilever wings of such thickness that the fuselage fairs completely into the wing at the root. At the same time the two Curtiss Conqueror engines also merge completely into the thick wing.

In the Boeing mail plane, the *Monomail*, a retractable chassis is another method of reducing resistance.

In discussing thick tapered wings, which provide such excellent spar depth to resist bending moments, it is often said that the drag of the thick wing must be greater than that of a thin wing with external bracing. We have the authority of R. J. Minshall of the Boeing Company for the statement that tapered wings are now available which have an intrinsic profile drag no greater than that of the thin wing of the past.

Another aerodynamic development which is meeting with increasing favor is the Townend ring. This is a simple ring a few inches in width, and of slight curvature along its width, which is made to surround the radial air-cooled engine. The Townend ring smoothes out the flow when broken up by the projecting engine cylinders and enables the air to keep streamline contact with the fuselage. The Townend ring achieves the same purpose as the somewhat more complicated Venturi cowling, and is much simpler to build.

In those landing gears which are not retractable, designers are making efforts to reduce resistance by putting "pants" or "spats" over the wheels or by using cantilever struts, just one strut to a wheel instead of the two or three struts previously employed. Some designers have tried fairings which enclose both struts and wheels. Another aerodynamic improvement consists in the use of fillets between wing and fuselage. Experiments at New York University have given an exact rule for the design of such fillets or fairings.

In general the airplane is rapidly approaching its ideal streamline form.

ONE of the most important problems engaging the attention of airplane designers to-day is that of metal covering instead of fabric covering for both the wings and fuselage of an airplane. Fabric covering has the disadvantage of poor maintenance and durability. Metal covering is unfortunately very heavy, even if the thinnest sheet is employed. Since the airplane is under very strict weight limitations, it is only desirable to use metal covering provided the covering itself contributes to the strength. Unfortunately thin metal sheet will not develop anything like its theoretical strength because of local failure termed "crinkling" when the sheet is in compression. The Navy Department and the Army Air Corps are both giving much attention to the problem of the metal-covered fuselage, and in time disconnected efforts of various designers should lead to more accurate knowledge.

The large airplane of the future should have a structure similar in some respects to the structure of the ocean liner, in which the metal plating is already so thick that it can be confidently taken into account in the calculations of strength.

One of the most marked tendencies in the aircraft engine development for the year was the increasing number of inverted, in-line, air-cooled engines of the lower horsepower range which appeared. At both the St. Louis and the Detroit aircraft shows this type of engine was well represented.

Among the newer ones of this type we have the Chevrolair D-6, a six in-line, manufactured by the Chevrolair Motors, Inc. The engine is rated at 170 horsepower at 2000 revolutions per minute. Another of the interesting engines of the inverted type is the Hi-Drive Ensign engine manufactured by the American Cirrus Company. This is equipped with a DePalma super-charger and is rated at 110 horsepower at 2100 revolutions per minute.

THE Fairchild Aviation Corporation have also introduced an inverted six in-line of 110 horsepower.

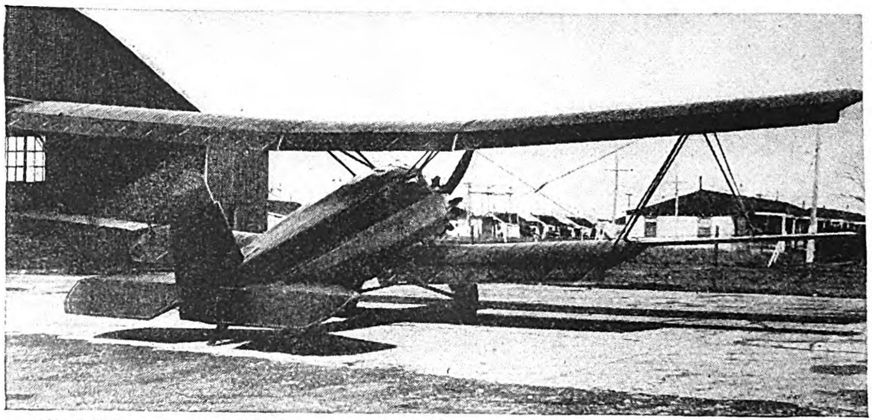
Engines of this type (inverted in-line) are somewhat heavier than radials of the same horsepower, but their greater simplicity, easier accessibility, better stream-lining and vision qualities are making them more and more popular.

The Packard Diesel, over its first trial stages, is apparently finding acceptance among the aircraft designers and builders. Several transports, including Ford tri-motor and others, have offered planes using this engine.

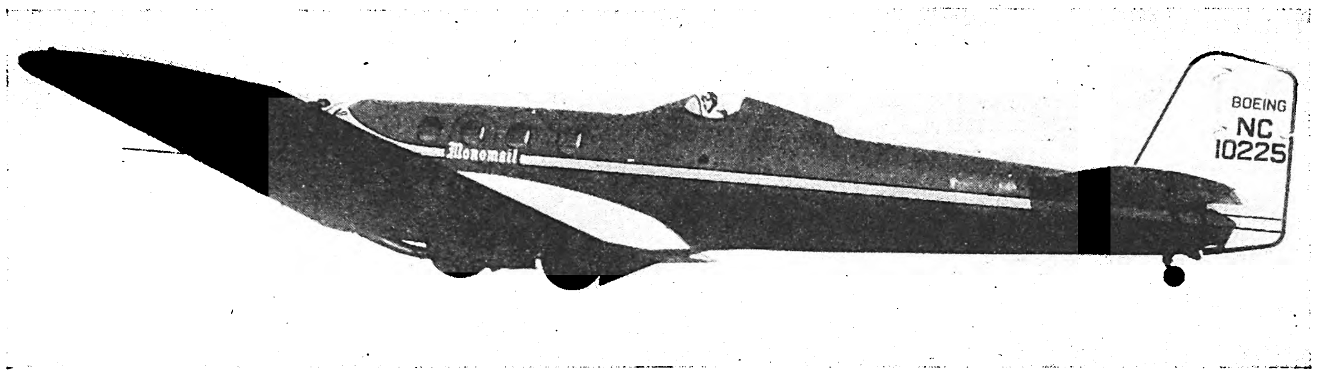
The L-head engine so popular in the automotive field, has lately entered aviation. The MacClatchie Manufacturing Company has placed a seven cylinder, radial, L-head engine on the market. The difficulty of cooling these L-head air-cooled engines has apparently been overcome in this engine. It develops 150 horsepower at 1900 revolutions per minute and weighs 400 pounds.

Another interesting development among the aviation engines is the increasing number of two-cycle engines that are making their appearance. Several small motors on this principle, of about 30 horsepower, designed for the light plane, have been developed.

The two-cycle engine undoubtedly has great possibilities in the air-



A striking view of the *Tanager*. The floating ailerons and the wing flaps are plainly visible. This particular plane was destroyed by fire while on the ground



The retractable landing gear on the *Monomail* is said to add 25 miles per hour to the plane's speed

craft field. This is especially true in regard to Diesels. The two-cycle Diesel offers many advantages over the four-cycle gas or oil engine or the present two-cycle gasoline engine. The present two-cycle design has four disadvantages: poor scavenging, delicate mixture control, low volumetric efficiency, poor fuel economy. The so-called "solid injection" of fuel would probably remedy this. The four-cycle Diesel has the disadvantages of weight, high consumption of lubricating oil, and mechanical complications.

THE year has witnessed remarkable record-breaking performances. The re-fueling flight of the Army plane *Question Mark* ushered in a contest to see which plane could stay aloft the longest. Notable among the many flights was that of the Hunter Brothers at Chicago who stayed up for 553 hours in a Stinson *Detroiter.*

Their record was broken by the former record holding team of O'Brien and Jackson who regained their title by staying in the air some 743 hours in a Curtiss *Robin* plane. These flights proved beyond all doubt the feasibility of long, refueling flights.

Two other record breaking flights were made during the year. The first of these was that of Lieut. Apollo Soucek of the United States Navy who reached an altitude of 43,166 feet in a Wright *Apache* plane. The Navy personnel had been experimenting for more than a year on improving the performance of the plane and no factor was overlooked which might raise the ceiling of the plane. When a study of the research data is complete the flight will assume a greater meaning to aviation.

The second flight was that of Capt. Hawks who put up a new trans-continental record in his 12¼ hour coast-to-coast flight. The flight was made in a Travel Air *Mystery S*, the actual air time being 11½ hours, three quarters of an hour being consumed in three refueling stops.

One of the reasons for the disappointing showing of the aviation industry this year is the slow growth of private flying. The reasons are easy to find. In spite of the results of the Guggenheim Safe Aircraft Competition, few manufacturers have sought to embody in their airplane designs the latest aerodynamic safety devices. Well-informed opinion is that while planes are much safer than they used to be, they are still far from the ideal.

Airports and fields are much more numerous than they used to be, but still far from being immediately accessible. A plane is expensive to purchase and expensive to maintain. All these obstacles will disappear, but they have not disappeared as yet. The position of the private plane owner is not at all that of the automobile owner but rather that of the motor-boat owner a few years ago, who had to exercise skill, knowledge, and determination to derive pleasure from his craft.

A RECENT survey of the situation by *Aviation* gives a very fair picture of existing conditions. The typical private plane owner of to-day is a man in his early thirties, with an average income of about 8000 dollars a year. There is no typical occupation for the plane owner. He may be an advertising man, a junior executive, a broker, publisher, or salesman. He flies because he likes it.

Those men who purchase airplanes from a business point of view seem to find their investment a disappointing one. The average monthly flying time is only 13 hours and 24 minutes or about 160 hours a year. Flying is generally a matter of Saturday afternoons and Sundays. Some owners turn their craft over to professional pilots for passenger-carrying work during the week in order to defray expenses. Crack-ups are fortunately few. The enthusiasts who fly for pleasure know their business as a rule and they are not under compulsion to fly in all weathers as are air-mail pilots, for example. With this short flying time per year, and the rapid obsolescence of the modern plane, the question of "trade-ins" will certainly bother the trade in the very near future.

Owners find the maintenance of their craft quite onerous; as it is always necessary to inspect control wires, gas lines, landing gear, and so on, some 28.6 percent of the owners employ professional help.

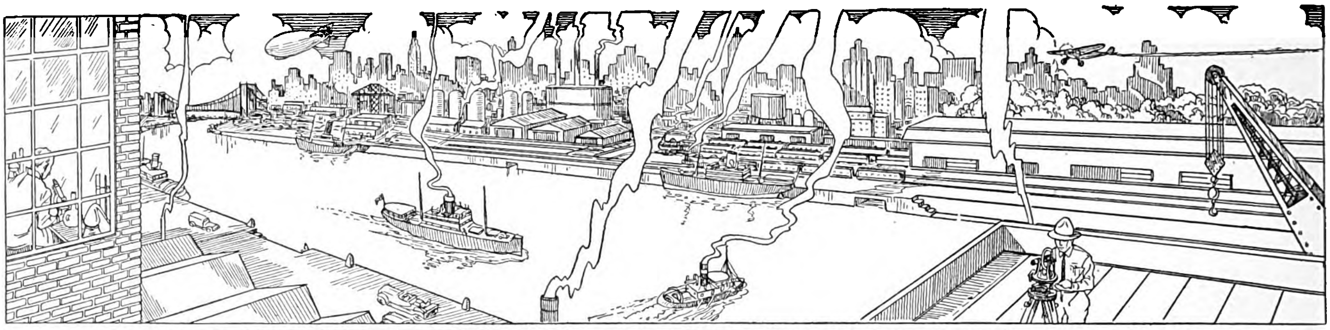
The most popular type of privately owned plane is the three-seater open cockpit machine, with an air-cooled engine of between 150 and 225 horsepower. It is expected that the cabin plane will take the place of a good many of the open cockpit machines, and manufacturers are anticipating this change in demand. In spite of the fascination of the flying boat and amphibion, few private owners purchase such craft. The drawback is in expense. It is gratifying to see that a few manufacturers are turning their attention to inexpensive amphibions.

Aviation country clubs are a splendid social outlet, but the expenses of membership added to the flying expenses have checked the growth of this type of organization. The most promising line of attack would be the formation of flying clubs on the English model clubs where inexpensive, low-powered machines are employed, general expenses are restricted to essentials, and no attempt is made to provide a luxurious social atmosphere. The many English flying clubs have of course been fostered by direct government subsidy.

THE present status of aviation safety is naturally a matter of considerable public interest. Perhaps the most authoritative statement on the subject yet issued is the Report of Committee on Aviation Statistics of the Actuarial Society of America, which was compiled with the co-operation of many governmental and private agencies. It is impossible to present even in summary the findings of this report, which deals with every aspect of the subject, but the comparison with railroads will give a graphic view of the situation.

The Accident Bulletin of the Interstate Commerce Commission for the year 1928 shows a rate of .003 passengers killed per million railroad passenger miles. Only about one fifth of these

(*Please turn to page* 488)



THE SCIENTIFIC AMERICAN DIGEST

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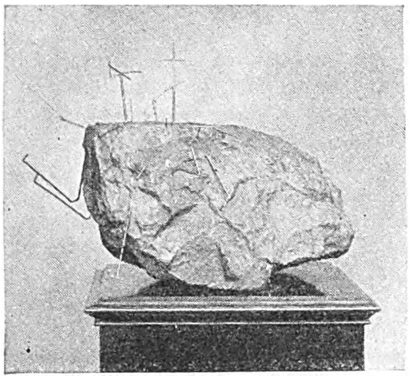
HUGE LODESTONE SPECIMEN

An extraordinary specimen of lodestone, weighing more than 400 pounds, and possessing unusually powerful magnetic strength, has been placed on exhibition in the department of geology at Field Museum of Natural History. The huge natural magnet comes from the Wasatch Mountains in Utah.



The average boy who likes to mystify his friends would give his last cent for a small piece of this 400-pound natural magnet from Utah

Lodestone led to the invention of the magnetic compass by the Chinese in the 12th Century. It is one variety of the mineral magnetite which has the property of attracting iron and other metals. A steel needle placed in contact with a lodestone will in a short while become so magnetized that, if free to move, it will point toward the north pole. It was observance of this fact that suggested the compass.

The attraction of the lodestone for iron was known hundreds of years before the polarity of the mineral was discovered, according to Dr. Oliver C. Farrington, curator of geology at the museum.

"Thales of Miletus (630-550 B.C.) mentions this power of lodestone as do a number of the later Grecian sages," states Dr. Farrington. "There is a fable that the discovery of the lodestone was made by a Cretan shepherd who noticed that his iron-pegged sandals and iron-shod crook clung to the earth. Digging into the ground he found lodestone.

"In classical times and during the middle ages, extravagant tales based upon a misconception of the power of lodestone were current. There were stories of magnetic domes which held statues of iron and even of brass suspended in the air, and there were accounts of mountains of lodestones which drew all the iron nails from ships which ventured near them, so that vessels sailing those seas were obliged to use wooden pegs for nails.

"Discovery of the compass has been attributed to many peoples of Europe and Asia. Many accounts of the early use of the compass are now believed to be mythical. One of these credits the Chinese emperor Hoan-ti with constructing in the year 2637 B.C. a chariot on which was a female figure which always pointed south, and there are other Chinese accounts of the use of these 'chariots of the south' at various times antedating the Christian era. Some European authors seem to indicate an occasional use of the compass as early as the 3rd Century but the first authentic records of its use do not antedate the 12th Century. Shortly after this time the compass came into general use by mariners. The first compasses were magnetized steel needles which were fastened to chips and reeds and floated on water."

◆

THE CHEMISTRY OF RIPE OLIVES

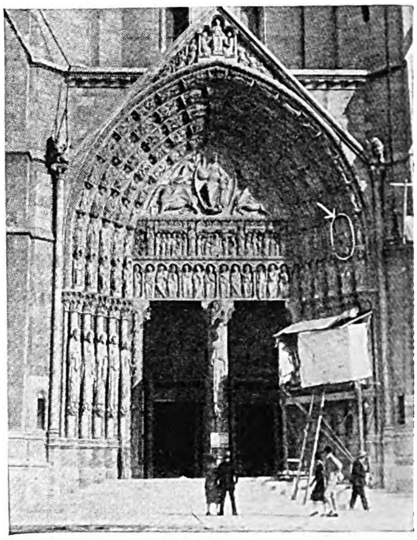
We have often heard that one has to cultivate a taste for olives, but while we readily confess to a weakness for the more common green olive, we have never been able to get up much enthusiasm for the ripe, or purple, variety. A possible explanation for this prejudice came to our attention recently in reading an article in *Industrial and Engineering Chemistry* by James G. Vail, vice-president of the Philadelphia Quartz Company. Mr. Vail informs us that ripe olives are treated in a solution of caustic soda before they are considered fit to eat. Now, any chemist can tell you that when you treat olive oil with caustic soda you get castile soap. With that fact in mind, it suddenly dawned on us why we never cared for ripe olives.

Actually, of course, if any soap is produced by this caustic treatment it is only in infinitesimal amounts. The subject is of interest, however, because Mr. Vail has discovered that a sodium silicate solution, which will not saponify the oil of the olives, seems to serve just as well as the customary caustic soda. Indeed, by using silicate solution, the olives may be allowed to ripen further on the tree and still yield a firm texture. The flavor of the fruit treated by the new process is said to be better. —*A. E. B.*

◆

EINSTEIN, LIVING IMMORTAL

Not that Einstein "needs the publicity"; or that the fact that most men of science regard him as the greatest scientist, fit to rank with Newton, really requires constant reiteration; but because the editors from time to time receive communications from persons who either request confirmation of his high standing in science or, as sometimes occurs, wish to have their private opinion confirmed that he is a "faker" (as one rather excitable anti-Einsteinian repeatedly put it), attention is called to the recent tribute of the Riverside Church in New York which has chosen to include a carved figure of Einstein with those of the world's very greatest on the tympanum of the doorway of its new edifice.



A white oval has been marked on this illustration to show the location of the carved statue of Dr. Einstein over the main portal of the Riverside Church, New York City

Einstein is the only living person thus to be honored. The action of this church brackets his name with those of Socrates, Plato, Aristotle, Descartes, Spinoza, and Kant, the philosophers; Moses, Buddha, Saint Francis of Assisi, Luther, and Calvin, the religious leaders; and Galileo, Kepler, Newton, Faraday, Darwin, and Pasteur, the greatest scientists of all time.

The vast majority of men of science will concur in this selection. We believe that the statement of the physicist Heyl, that the majority of men of science qualified to judge—the physicists and astrophysicists—tentatively accept the Einstein Theory, will bear up under unbiased investigation.

Perhaps the fact that the newspapers have "made so much of" Einstein has tended to confuse some of the people. Certainly, at any rate, there is enough precedent—newspapers taking charlatans seriously—to make this kind of judgment seem plausible. But in this case the newspapers are right. Whoever permits himself to believe that Einstein is not looked up to by men of science should stop taking seriously the vitriolic phrases of a few superheated anti-Einstein cranks and should go among men of science where they are likely to obtain a new orientation.

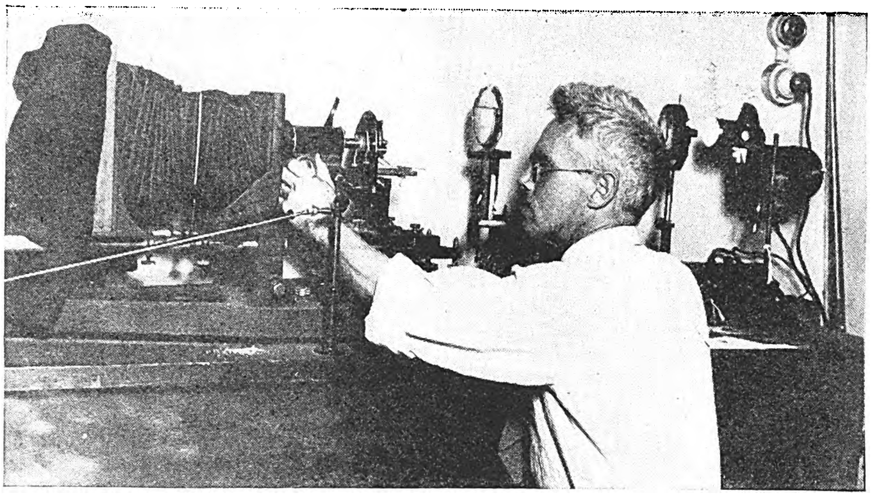
Another naïve question sometimes is asked: "Is Einstein really Jewish?" Einstein is a Jew.

EXPERT FINDS WAY TO PHOTOGRAPH SMALLEST LIFE

THE tedious work on the part of artists in illustrating minute forms of animal and plant life which can only be seen through a microscope, has finally been overcome by J. G. Pratt, scientific photographer for the United States Department of Agriculture.

Heretofore biological subjects could only be photographed satisfactorily from 10 to 15 times their natural size, which was not sufficient, and such subjects have always been drawn by artists, requiring hours of labor looking through a microscope, with little assurance that the resulting illustration was true to nature.

The difficulties encountered in photography at high magnification have been the flatness of field and the lack of proper illumination. Above 10 or 15 diameters the exposures are so long as to be impractical, and the short focus lenses required do not give sufficient depth of focus. That is, if a tiny insect were magnified sufficiently to see what it looks like, only a portion of its back would be sharply defined, the rest being hazy and distorted.



Mr. Pratt at work on his new equipment for photographing small life

After years of research Mr. Pratt has just developed a lighting device which is many hundreds of times stronger than sunlight, and also lenses which give great depth of focus, making possible the photography of animal and plant subjects up to as high as 300 diameters.

Mr. Pratt states that photo-micrography at such extreme magnification has heretofore been confined to metallurgy, on subjects which are flat and reflect a great amount of light; and that the new development should revolutionize the illustrating of biological subjects, which have considerable depth and reflect little or no light. He says that where previously the exposures for a magnification of 10 diameters took several minutes, only a few seconds are required for as much as 200 diameters with the present lighting device.

ULTRA-VIOLET TRANSMITTING GLASSES

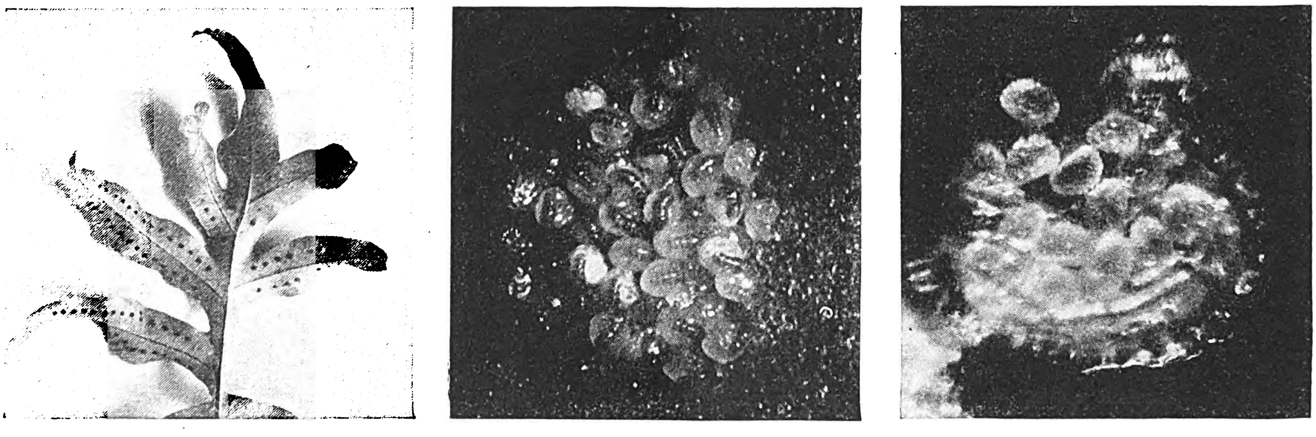
THE Council on Physical Therapy of the American Medical Association has made available a study of the value of glass of various types for transmitting ultra-violet rays. Dr. W. W. Coblenz of the Bureau of Standards in Washington, who is a member of the Council, points out again that ordinary window glass cuts off the ultra-violet rays, transmitting only 1 to 2 percent and being completely opaque to radiation of the shorter wavelengths. The maximum value of ultra-violet rays appears to be in the wavelengths from 297 to 302 millimicrons. Only a weak effect, if any, is obtained with longer wavelengths.

So far as the prevention of rickets is concerned, only window glass which has a transmission of 30 percent or higher of wavelengths of 302 millimicrons will give protection. It is understood also that the amount of ultra-violet received from ordinary sunlight is modified by altitude, latitude, time of day, the season of the year, and the amount of smoke. Obviously therefore only glass that will transmit ultra-violet freely is of any use. In the ordinary home it is perhaps better to do without window glass altogether for the room in which the child is to be sunned, and to use instead some sort of substitute.

The various devices for producing ultra-violet rays have been standardized by the Council on Physical Therapy of the American Medical Association, and inquiries concerning any special variety of lamp are answered with statements as to actual virtues in providing ultra-violet.—*M. F.*

CHILDISH DRAWINGS ON WALL OF ROMAN HOUSE

ONE family of ancient Rome would no doubt be greatly entertained if it could see archeologists of 1930 poring over the scrawled drawings made on the walls of their house. The drawings, recently discovered, are such as children of ancient

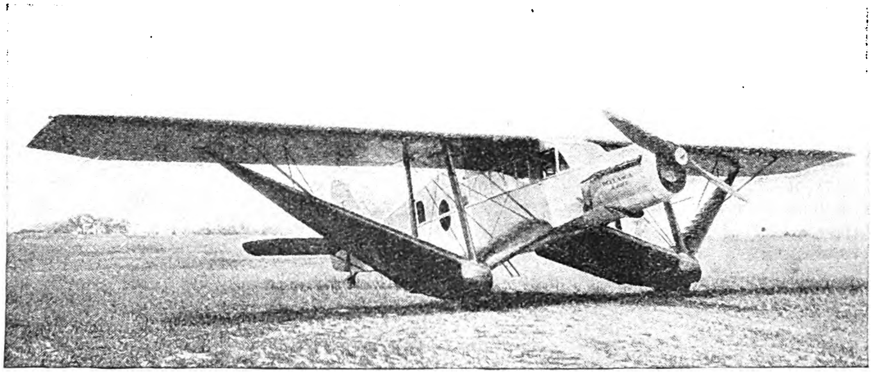


At the left is shown the frond of a fern with its fruit dots or spore clusters. In the center is a single fruit dot magnified 30 times. The small band resembling a worm on each spore case is known as the annulus. At the right: single spore case magnified 200 times, as the annulus is contracting and scattering the spores. All were photographed by Mr. Pratt

Rome, or any other time and place, enjoy scribbling on a handy piece of clean wall space.

The house of these wall decorations stood in the famous Appian Way about the time the Roman Republic became the Empire of Rome. Its ruins have lain buried beneath almost 40 feet of earth, and a Church of San Sebastian stands over the site.

Prof. Francesco Fornari, Roman archeologist who has been studying the mural sketches, sees in some of them pictures of fighting gladiators armed with shields, spears, and swords. Another sketch is believed to show an individual being burned. Rows of long and short lines, rising before this person, indicate flames, and there are soldier-like figures on each side who appear to be stirring up the flames with their spears. It is considered likely that the drawings were made by the children of some Roman fighter's household.



The Bellanca *Airbus* has a novel system of wing trussing

Other parts of the walls are adorned with frescoes done by more professional hands. —*Science Service.*

THE BELLANCA "AIRBUS"

G. BELLANCA of the Bellanca Aircraft Corporation is a designer who can be relied upon to produce original and worth-while modifications from standard practice.

For the designer of transport airplanes, there are two outstanding problems at the moment. One is to give the operator a greater payload for a given horsepower, thus making operations more economical—but without reducing speeds. The other is to provide him with a craft which will enable him to take full advantage of the Watres Bill, under which the Postmaster General can hire space in passenger-carrying planes, and which, therefore, necessitates the construction of planes to carry both mail and passengers.

The Bellanca *Airbus* certainly appears to meet these requirements by excellency and originality of design.

The main wing, mounted on top of the cabin, is similar to that of a conventional braced-wing monoplane with the exception that each wing is divided into two panels. The inner or center section panels of the upper wing, in conjunction with the lower stub wings, form the inner bay and are joined together by struts of round, chrome-molybdenum steel tubing, faired with balsa wood. From the outer end of each stub wing another lifting surface called the auxiliary wing goes up to meet the outer panel of the upper wing.

What is remarkable in this system of wing construction is that both the stub wing and the auxiliary wings serve a number of purposes. The auxiliary wing serves to brace the upper wing like ordinary struts, but also provides lift. The lower stub wings are even more useful. They provide lift, form conveniently a part of the landing gear structure, and also contain the waterproof metal-lined mail compartments which have a capacity of approximately 60 cubic feet, and which, placed in the stubs, do not encroach on the passenger compartment. The advantages of this peculiar wing system are obvious. The auxiliary wings do not just introduce air resistance when performing their bracing function; they lift and carry load. The stubs carry load, yet they give ideal support to the landing gear. There is a general gain in efficiency.

The landing gear of the *Airbus* also represents a departure from conventional practice. The wheels go into recesses at those ends of the stub wings where the auxiliary wings join. The wheels are cushioned and kept in their proper position by oleo struts; the struts are attached to beams running from front to rear of the landing gear recesses. The wheels disappear almost completely into the stubs, yet at the same time they are well below the fuselage of the plane. This type of landing gear, therefore, attains many of the advantages of the retractable landing gear without its mechanical complication.

The control system introduces a wrinkle, not new perhaps, but interesting. Each aileron is separately connected to the control wheel, so that if one aileron becomes inoperative, there is the other to count upon.

In the passenger cabin, there is another minor yet useful idea. The passenger seats on each side of the cabin are on a platform 12 inches high. This leaves a sunken aisle down the middle, permitting a tall man to stand erect. The baggage is conveniently stored beneath the platforms on which the seats rest.

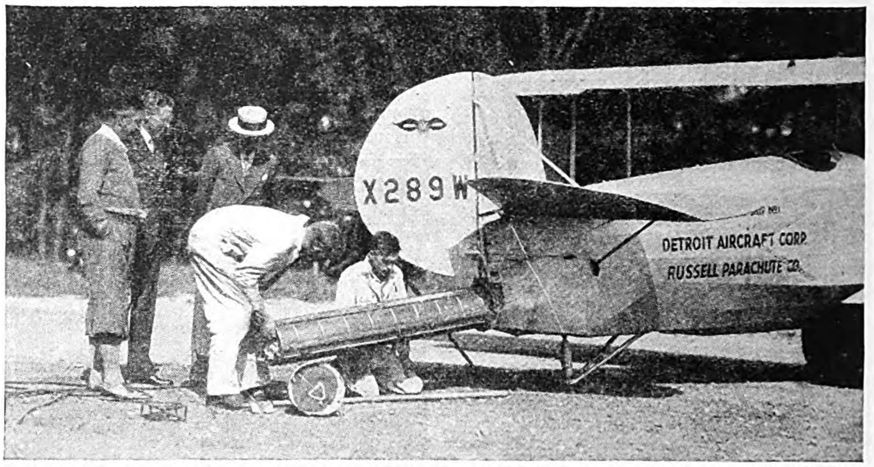
With a Curtiss Conqueror 600 horsepower engine, with 4000 to 4500 useful load —say 10 passengers, 250 pounds of baggage, some 1000 pounds of mail, and 200 gallons of gas—the high speed is 147 miles per hour, the cruising speed 125 miles per hour.—*A. K.*

AN AIRPLANE PARACHUTE

MUCH thought and effort have been expended on the design and use of parachutes for passenger service. Recently we described in these columns a quickly-detachable and attachable parachute for passenger use. There always remains the question, no matter how easy the use of the parachute may be made for the passenger, of whether the average passenger will have the presence of mind to avail himself of this device or whether he will pull the rip cord neither too early nor too late. Many authorities are of the opinion that the better plan is to provide a parachute for the entire plane. The Russell Parachute Company has developed such a "ship parachute," as it is frequently called, and, with the co-operation of the Detroit Aircraft Corporation, has recently tested out the apparatus on a Parks two-seater biplane of about 1800 pounds gross weight.

Aviation describes the apparatus in somewhat greater detail than the reports of the Russell Parachute Company itself:

"Except for a control lever in the cockpit, four suspension cables attached to the plane's center section, and, of course, the control lever cable, the entire device is enclosed in a metal tube, made scarcely noticeable by being faired into the bottom of the fuselage. The tube is about 11 inches in diameter and extends from a point directly below the center section to a point below the rudder hinge line.



Loading the airplane parachute in the tail of the fuselage. The pilot 'chute which is contained in the cup pulls the large 60-foot 'chute from the cylinder

"The 'chute, 60 feet in diameter, is folded inside a metal container, or 'split can' located all the way forward in the tube. The 'can,' which is round, has an inch clearance between it and the inside wall of the tube. Runners inside the tube hold the 'can' in exact center. The four suspension cables extending from the lower shroud lines of the 'chute to the plane's center section are run out of the forward end of the can, through guides located between the can and the inside walls of the tube to a streamlined cap on the after end of the tube. They then extend through an opening in the cap, thence to guides located near the top of the rudder post, after which they are carried to the plane's center section by means of additional guides on the back of the fuselage. Between the streamlined cap and guide atop the rudder post, two cables extend along the two sides of the fuselage to prevent the parachute cables fouling on the tail surfaces.

"The pilot's control cables extend directly from the cockpit to the cone-shaped cap which is attached to an 18-foot pilot or 'drag' 'chute. Operation of the device is as follows: When the pilot lifts his lever in the cockpit, the cone-shaped cap flies off the tube, releasing the drag 'chute. By means of the drag cable, the small 'chute pulls the split can containing the large parachute out of the tube. Upon being released from the tube the split can opens and releases the large 'chute, which pulls the cables from their guides, thereby suspending the plane from its center section by means of the four suspension cables."

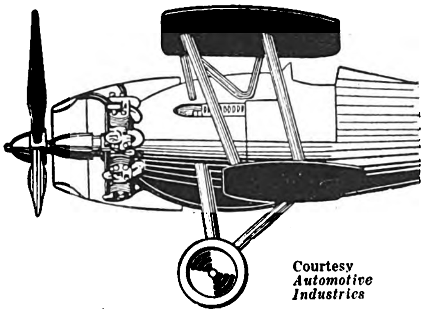
The whole apparatus weighs only 100 pounds, and it is claimed that it will right the airplane from any difficult position and bring it down at a speed of 16 feet a second, which will mean a rough but perfectly safe landing.

On the first test, the Parks biplane landed in a tree under conditions approximating those that would be encountered during emergency use. The only damage sustained was a broken propeller and a bent axle. Further tests will be awaited with interest.—*A. K.*

COWLING-IN THE RADIAL ENGINE

THE great objection to the radial air-cooled engine is that the projecting cylinders not only have large resistance themselves, but that they also break up the streamline flow over the fuselage and thereby introduce still more "parasite" resistance.

A. H. R. Fedden in a paper before the Institution of Mechanical Engineers (of England) visualizes a completely cowled-in radial engine, shown diagramatically in the accompanying sketch. The cowling is of streamlined form itself, and blends with the streamline design of the rest of the fuselage. The propeller is of necessity mounted on a shaft extending somewhat farther from the engine than in the conventional type of engine. Through a circular hole at the front end of the cowling only enough air is admitted to cool the motor. The cooling air then passes through a circumferential gap, behind the engine, and at exit combines, with minimum disturbance, with the main flow around the fuselage.


Courtesy *Automotive Industries*

Fedden's conception of a cowled-in, radial, air-cooled engine to correct objectionable features of this type

Certainly such cowling-in should be decidedly beneficial to the over-all performance of the airplane, and we do not see that it offers any insuperable difficulties of a mechanical character.—*A. K.*

FLEXIBLE-WING PLANE

WE append two photographs of the Waterman "fool-proof" plane built in Los Angeles. The complete technical details are not yet available, but the principles of the invention will be deduced from our photographs.

The outer portion of the wings is not rigidly connected to the airplane. It is rather hinged about the wing stubs adjoining the fuselage and controlled by the action of the two struts which can slide in and out of the hydraulic cylinder mounted on each side of the fuselage. By means of this hydraulic adjustment, the dihedral, or V, of the wings can be changed at will and therefore the lateral stability of the plane can be varied to suit flying conditions or the pilot's preference.

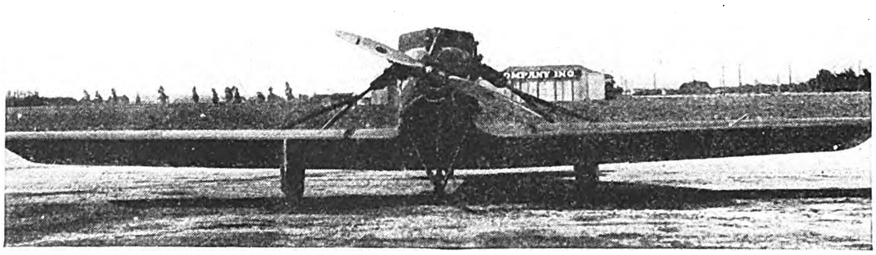
We believe, but we are not quite sure, that when the V is increased, the angle of incidence of the outer portion of the wing is somewhat increased. This means that the wings can be set at the angle most appropriate for high speed, for cruising, or for climbing.

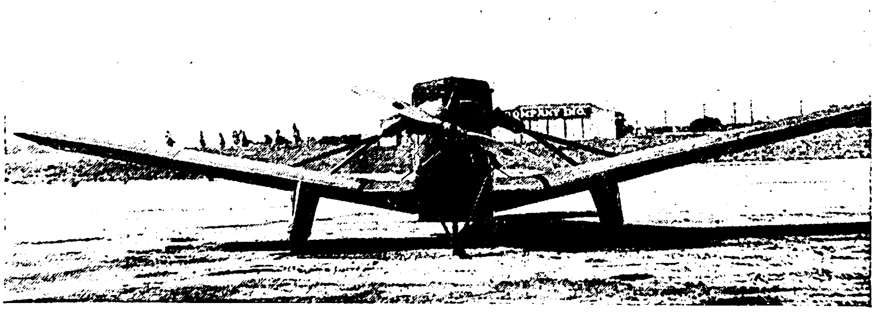
The movement of the piston in the cylinder is controlled by the pilot, but the wings are also slightly automatic in action and therefore respond to gusts striking the airplane. If the wind gust is such as to tend to raise the left wing, then the left wing will yield, thereby decreasing the effect of the gust. If the gust strikes both portions of the wings from below, both wings will yield and the load will be relieved. This might tend to make flying in "bumpy" weather slightly more comfortable. That it will add to the structural strength is doubtful.

When flying, even in rough weather, the loads due to gusts are small in comparison with the loads which the pilot can impose himself in landing the plane; and raising the outer portion of the wings lowers the machine considerably relative to the ground. This brings into play a huge skid at the front end of the machine. The skid grazing the ground acts as a powerful brake and as the center of gravity has been loaded there is no tendency for the plane to turn over on its nose.

Against these theoretical advantages are to be set the complications of the device. Complete theoretical and practical investigation of the device would be necessary before its value could be determined. But Mr. Waterman has flown his craft safely across the continent and back and that is worth considering.—*A. K.*

At right: The Waterman "fool-proof" plane in which the wings yield against the restraint of hydraulic cylinders to give less "bumpiness" in gusty weather. **Below:** The same plane with its wings raised



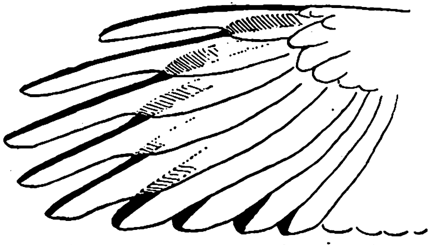


SAFETY DEVICES IN BIRDS' WINGS

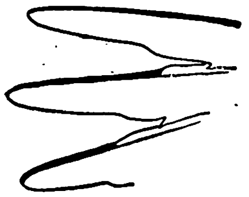
BIRDS are the result of the survival of the fittest through countless ages of flying; we have been flying for only some 27 years. Perhaps we have yet to learn many flying secrets from them. Lieutenant R. R. Graham, writing in a recent issue of *British Birds*, certainly makes a strong case for the possibility of such lessons. (Another exposition on the same subject appeared on page 386, November 1930, *Scientific American*. Editor.)

Nature has provided birds of many species with separating flight feathers. A notable example is the wing of the buzzard, seen from below in one of the appended sketches.

The separating flight feathers of the buzzard present what the ornithologists call "emargination." The separating feather is reduced in width from a broad base to a much narrower tip. The result of this arrangement is that when the wing is fully spread, the outer parts of the feathers do not overlap, and gaps or "slots" form between them as is apparent in the same sketch. The feathers radiate or spread out from a fairly small center. Without this emargination the slots would be narrow at the base. With emargination the slots are of a fair width, even at their inner extremities.



***Above:* The under surface of the right wing tip of a buzzard. *Below:* The lower surface of a song-thrush's right wing-tip, with the slots more than fully opened. Gaps appear beyond inner limits of slots**



The feathers are worth a little further study. In the flight feathers of a partridge not only is there some degree of emargination; there is also more width of web behind than in front of the shaft. In aerodynamical parlance the center of pressure of the feathers is behind the shaft.

The result of this "construction" is that when the flight feathers open, they twist upwards at the rear edge (a fact fully confirmed by actual photographs). The flight feathers then offer a series of fair slots, *with the incidence of the flight feathers smaller than the incidence of the main wing.*

Surely the flight feathers are in close analogy to the Handley Page multi-slot.

When the bird wishes to descend steeply, he sets his main wing to a large angle with the wind. The main wing is "stalled," loses lift, and acts as a brake. The slotted tips are not stalled and still give lift, and hence there is also lateral control still available. In other words the bird is an airplane or glider which can make a steep, stalled descent, with perfect control.

Of course, as Lieutenant Graham points out, the bird has one point of superiority which is difficult for us to imitate. If the stalled descent is too rapid in a vertical direction, there is danger that the bird will strike ground or water too rapidly. He then flaps his wing back and forth and secures lift by a few strokes just before alighting. A mechanical embodiment of this practically horizontal movement of the flight feathers would be very difficult for us to secure.

Among other wonders of bird "construction" described is a very interesting safety device. A bird's wing tip, with feathers loose from one another, can be drawn so far apart in our hands that gaps appear beyond the inner limits of the slots and barbs are torn apart from each other. This is the case for the song-thrush's wing tip. But when an effort is made to spread the feathers while pressed together, it is found that they will open thus far and no farther. Examination of the feather surfaces with a microscope indicates that the effect is brought about by thousands of tiny hooks which stand out above the main surfaces and engage with the ribbed under surface of the broad part of the overlapping feather.

This is certainly a complete vindication of the value of the Handley Page slot, if the birds are to be credited with knowing something about flying!

MAJOR WILLIAM C. OCKER

WE are very pleased to announce that, after proof of the article "Instrument Flying to Combat Fog," on page 430, had been finally okayed, we received word that its author, William C. Ocker, had been promoted from the grade of Captain to that of Major, Air Corps, United States Army. It was too late to make this change under his name in the byline of the article.

Major Ocker's promotion indicates a rendering of recognition for his splendid ability by the Chief of the Air Corps and therefore gives to his article an even greater authoritativeness, if that is possible.

99.99 PERCENT PURE ZINC

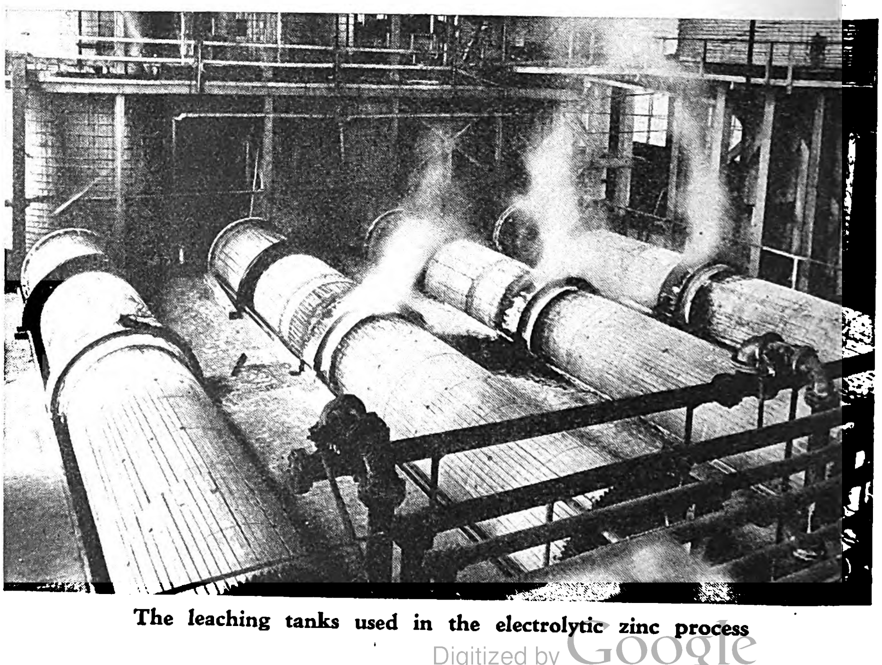
ELECTRO-CHEMISTS of the Evans-Wallower Zinc Company in St. Louis have exceeded the famous record of a well-known soap, advertised as 99.44 percent pure, by developing a process for the production of zinc which is actually 99.99 percent pure. The process is an electrolytic one—the zinc being extracted by dissolving the ore in acid and electrolyzing the resulting solution to extract the pure zinc. Metal of this purity has remarkable properties, being very ductile and possessing high tensile strength. At 350 degrees Centigrade it can be extruded quite readily and drawn into wire.

The process used in this new plant is described by Charles W. Cuno in a recent issue of *Industrial and Engineering Chemistry*. The zinc ore, known as concentrate, contains zinc sulfide and small amounts of cadmium, copper, and iron. The ore is first dried and roasted and then passed through magnetic separators which divide the material into two parts—one high in iron content and the other very low in iron content. The magnetic material which contains the more insoluble zinc is treated with dilute sulfuric acid, in specially designed leaching tanks. The ore is tumbled around in these leachers until the insoluble zinc compounds have been decomposed, after which the non-magnetic portion of the ore is added. During the first stage of the leaching operation, the iron dissolves and is later precipitated as the charge neutralizes the acid. When the leaching operation is complete, the solution and residue are filtered, thus removing the insoluble residue of iron, silica, lead, gold, and silver. The residue is dried and shipped to a lead smelter for the recovery of its metal values.—*A. E. B.*

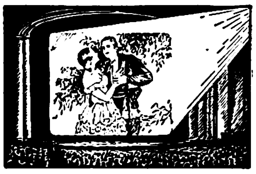
SOUTH CAROLINA VEGETABLES

THE state of South Carolina is taking seriously the question of the mineral content of its vegetables. A foundation has been established with a research laboratory and enough evidence has already been accumulated to arouse propaganda for California packers to move to South Carolina. The California fruit growers have emphasized the importance of California oranges as a source of vitamin C. The South Carolina Food Research Laboratory counters with a comparative statement showing that California oranges provide 70.5 parts per million of iron as contrasted with 160 parts per million in South Carolina tomatoes; they contain 7.6 parts per million of manganese as contrasted with 26.7 parts per million in South Carolina tomatoes and the oranges contain 4.75 parts per million of copper with 15.3 in tomatoes. Little has been claimed for California oranges so far as concerns their iodine content, but the South Carolina tomatoes contain 166.5 parts per million of this valuable mineral.

The South Carolina authorities, led by Dr. William Weston, recommend South Carolina tomato juice as superior to California orange juice for the growing infant. In their experiments on the feeding of infants, the South Carolina Food Research Laboratory has emphasized particularly



The leaching tanks used in the electrolytic zinc process



heroes must not lisp!

"My thweet" lisped from the screen would mar the star's romantic appeal. But that is something you don't hear in the theatres which have Western Electric talking picture equipment.

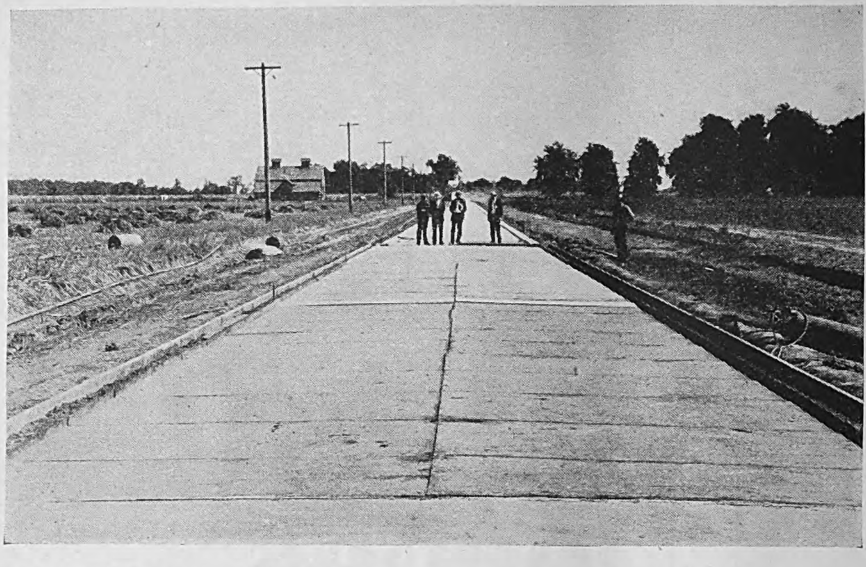
To reproduce the letter 'S' was but one of many difficulties in the way of giving you talking pictures at their best. Western Electric was able to solve these problems by reason of its 50 years' experience in making Bell telephones and other voice transmission apparatus.

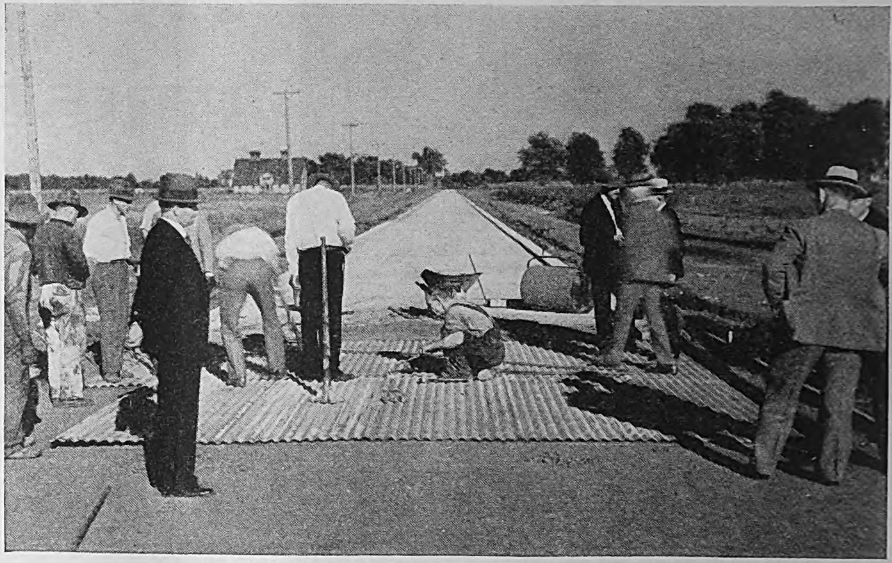
All over this country, and indeed the world, a discriminating public flocks to Western Electric equipped theatres—one more proof of this company's leadership in *sound.*

Western Electric

Makers of your Bell Telephone *and leaders in the development of* Sound Transmission

THE WESTERN ELECTRIC SOUND SYSTEM GIVES YOU TALKING PICTURES AT THEIR BEST IN OVER 6,500 THEATRES





The blue annealed sheet-iron section of the base for the new experimental iron base highway. The middle cut shows the section where corrugated iron was used as the base, corrugations running parallel to the road. *At bottom:* Brick surface was laid according to regular practice. The road was finished after the accompanying article was written

the value of carrot top and lettuce concentrates. These seem to be especially valuable as a source of iodine, manganese, iron, and copper.

The relationship of manganese, copper, and iron to anemia has already been emphasized in many publications. Much has been written of the value of liver in control of anemia. The South Carolina authorities urge oysters as of interest in this connection.—*M. F.*

◆

TRANSPACIFIC SPEED RECORD

A THIRD record was shattered when the Canadian Pacific liner *Empress of Japan*, completing her first voyage from Japan to Canada, docked from Vancouver, Victoria, and Honolulu at Yokohama recently. The elapsed time for the trip from Honolulu to Yokohama was 6 days, 19 hours, 43 minutes, or about 20 hours faster than the previous record held by the N.Y.K. liner *Chichibu Maru*.

During her Pacific lifetime of only a few months, the new Canadian Pacific liner has broken the record for each leg of the voyage.

◆

IRON BASE FOR EXPERIMENTAL HIGHWAY

A CONTRACT for an experimental pavement with an iron base and curb has been placed for 150 feet of pavement, on the Grand Avenue Connection, near Springfield, Illinois, with the Rochester road, (State Highway, Sagamon county.) The roadway to be laid this month will be the first test of three different designs. The iron base and curb will be laid on a levelled highway, says a report which discusses the design of this highway, which may revolutionize the building of roadways.

As explained by the engineers, the road will have a carefully rolled and prepared sub-grade on which the iron base and curb will be laid. Next will follow a mastic sand cushion upon which will be placed a layer of two and one half inch or three inch brick with asphaltic filler poured into the interstices between the bricks. The result, it is declared, will be an indestructible base with a smooth riding surface built into the structure with sufficient flexibility to meet temperature changes without breaks or cracks.

The iron base will consist of three 50-foot sections. One will be blue annealed flat sheets and the other two galvanized and corrugated sheets. The corrugations in one 50-foot section will be parallel to the road and in the other they will be transverse. The flat iron base will be ¼ inch thick, and the corrugated galvanized will be 10 gage.

The three types mentioned above will be tested under actual conditions. If they prove successful under traffic conditions, great progress will have been made in highway construction, is the belief of engineers. Such a roadway will not only be flexible, but should eliminate cracking and permanent deformation. The use of rust-resisting materials will insure durability. The iron base is Armco Ingot Iron and will be rolled and fabricated by The American Rolling Mill Company and the brick will be furnished by the Poston-Springfield Brick Company, of Springfield, Illinois. The National Paving Brick Manufacturers Association is co-operating in the test.

Mr. Mosely, the originator of the idea, recognizes that the success of the new metal highway depends to a large extent on the longevity of the metal used.

◆

CRYSTALLINE RUBBER CLEAR AS GLASS

CRUDE and refined rubber are known to consist principally of hydrocarbons. These hydrocarbons are mixed with smaller quantities of various impurities which can be removed only by a series of long and tedious operations. The highly purified rubber resulting from these operations is a clear, colorless, transparent, elastic solid, as clear and colorless, in fact, as the best plate glass. The problem of ascertaining the composition of this highly purified rubber has heretofore been exceedingly difficult because of the fact that two of the most useful processes ordinarily employed by the chemist—crystallization and distillation—could not be applied to the material.

A process has recently been developed at the United States Bureau of Standards by which this pure rubber can be repeatedly crystallized, thus opening the possibility of successfully fractionating it into its constituent hydrocarbons and eventually of determining the formulas of their molecules. The crystalline rubber obtained by this process, as seen under the microscope,

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Ethyl inspector purchasing actual sample of Ethyl Gasoline *from the pump*. In Ethyl laboratories this sample must meet all Ethyl requirements.

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ETHYL GASOLINE

Ice in the ship channel of a river "rotted" away and a clear channel being made with calcium chloride

consists of small transparent plates. As the crystallization process continues, these plates agglomerate into larger and larger clusters. The crystallization process is carried out by cooling a dilute solution of the highly purified rubber dissolved in ether to a temperature of about –80 degrees Centigrade.—*A. E. B.*

DESTROYING CHANNEL ICE

LAST winter a steamer loaded with valuable cargo was imprisoned in the ice of Lake La Barge near the headwaters of the Yukon River. With buckets and brooms the crew swabbed a strip, 29 miles long and 40 feet wide, of lamp-black and thinned refuse oil across the ice. And because black absorbs the sun's rays and retains heat, this strip in the course of a month cut a channel a foot deep as evenly as though it had been sawed. It continued to deepen and widen so that the boat was released from the ice one month ahead of its usual time.

At Morrisburg, Ontario, a steam ferry operated all last winter on schedule through a channel kept open with the aid of calcium chloride.

Here are typical examples of the results obtained by Dr. Howard T. Barnes, of McGill University, who is acknowledged as the world's leading exponent of the new science of ice engineering. He has discovered that calcium carbide, calcium chloride, sodium chloride, charcoal, lamp-black, and cinders will "speed up" the spring thaw of river, lake, and harbor by as much as one month. These materials "rot" and destroy surface ice in the most frigid temperatures, leaving it weakened to such an extent that when the sun swings northward in the spring, the ice melts quickly along these lines of least resistance and passes down stream in small cakes. By spreading these chemicals in a definite pattern over the ice with the aid of an ordinary road-spreader, young ice has been destroyed in a few minutes and channels kept open in proportion to the economic desirability of such work.

Dr. Barnes has also developed two very powerful weapons against icebergs and ice jams. One of these is thermit, which was first described in the press several years ago. Placed in shallow holes dug in the ice at strategic points, it is touched off either with a fuse or a small charge of flashlight powder. The iron oxide and aluminum powder, of which it is composed, instantly react by producing a temperature of 5000 degrees while streams of molten steel are shot through the ice in all directions. The surrounding ice is literally decomposed into its constituent elements of hydrogen and oxygen, the former being released as a flaming gas which often flares a hundred or more feet into the air.

By this means Dr. Barnes destroyed an immense ice jam in the St. Lawrence River which weighed more than 1,000,000 tons, only two 90-pound charges being employed. On another occasion he vanquished an iceberg which measured 500 feet at the water line with a single charge of 100 pounds.

Last winter the ice engineer perfected a new weapon called solite. It is equally as powerful as thermit, but needs neither fuse nor battery to touch it off. Loaded into bombs it can be dropped on otherwise inaccessible icebergs from speeding planes with no risk to the operator. The bombs are open at the top, and as they rush through broken ice a partial vacuum is formed in the hole which prevents the water from entering. When the bomb finally comes to rest the water rushes into the hole and automatically ignites the charge. Experiments conducted on the St. Lawrence River last winter and by the International Ice Patrol off the coast of Labrador last spring prove that solite is eminently successful in destroying both ice jams and icebergs.

BUTYL ALCOHOL FROM POTATO PULP

WASTE pulp from potato-flour factories will be used as a raw material for the bacteriological production of butyl alcohol and acetone by a process developed at the Dutch agricultural experiment station at Gronigen, according to a report from the commercial attaché at The Hague. The process is said to overcome the difficulties caused by the varying composition of the pulp and its usually strongly soured condition. Millions of pounds of pulp are available annually, and production using this patented process will be begun as soon as possible.—*A. E. B.*

THE STING OF THE HONEY BEE

THE sting of the honey bee is seldom considered to be of much importance, except when an entire swarm attacks a man; then he is likely to suffer greatly from manifestations of his disturbance. When a person is stung by a bee it is customary usually to apply solution of ammonia or of baking soda to the skin. Ordinarily this is sufficient to modify the local irritation, and little more is thought of the trouble.

Some studies recently completed in the Mayo Foundation indicate that the venom of the honey bee resembles that of the rattlesnake in several particulars. Both poisons when in contact with the blood break down the red blood cells; both poisons when injected into the arm promptly stop its action. Bee-sting poison is a stimulant of smooth muscle, such as is found in the heart and in the uterus and is a dangerous poison to the lining of the blood vessels. Obviously it is a potent substance and if taken into the body in sufficient quantity can produce death as can the venom of the rattlesnake.—*M. F.*

CAR SICKNESS

MANY people experience great discomfort when riding in trains or street cars. Many more become dizzy and uncomfortable in ships or airplanes. Physicians who have studied the subject are inclined to place the responsibility on the mechanism of the internal ear and on the eye. The tendency to car sickness seems to run in families. Dr. James E. Lebensohn points out that people most frequently disturbed usually avoid riding backward and favor the front seat of the automobile, where there is less jarring and where the view is less constricted. He points out also that when the land traveler gazes at the scenery, his eyes slowly follow the objects in the landscape which appear to be moving backward. As these objects pass out of the range of the vision, the eyes return to their normal position. Hence the eyes are constantly jerking, and this causes many to believe that the eyes are responsible for railroad sickness.

The chief symptoms of nausea are paleness, sweating, and goose flesh, most of these things being associated with nausea no matter how it is produced. In making a special study of the relationship of the eyes to car sickness, Doctor Lebensohn produced the jerking of the eyes that has been mentioned, known as optical nystagmus, and at the same time studied the changes that took place in the stomach. A cylinder marked in black and white was revolved before the patient's eyes to produce ocular nystagmus and cold water was thrown into the ear to produce labyrinth or internal ear nystagmus. At the same time the contractions of the empty stomach were measured by the movements of an instrument connected with a balloon swallowed and retained in the stomach.

Destroying an ice jam with 12 pounds of solite, the new chemical which is "touched off" by water

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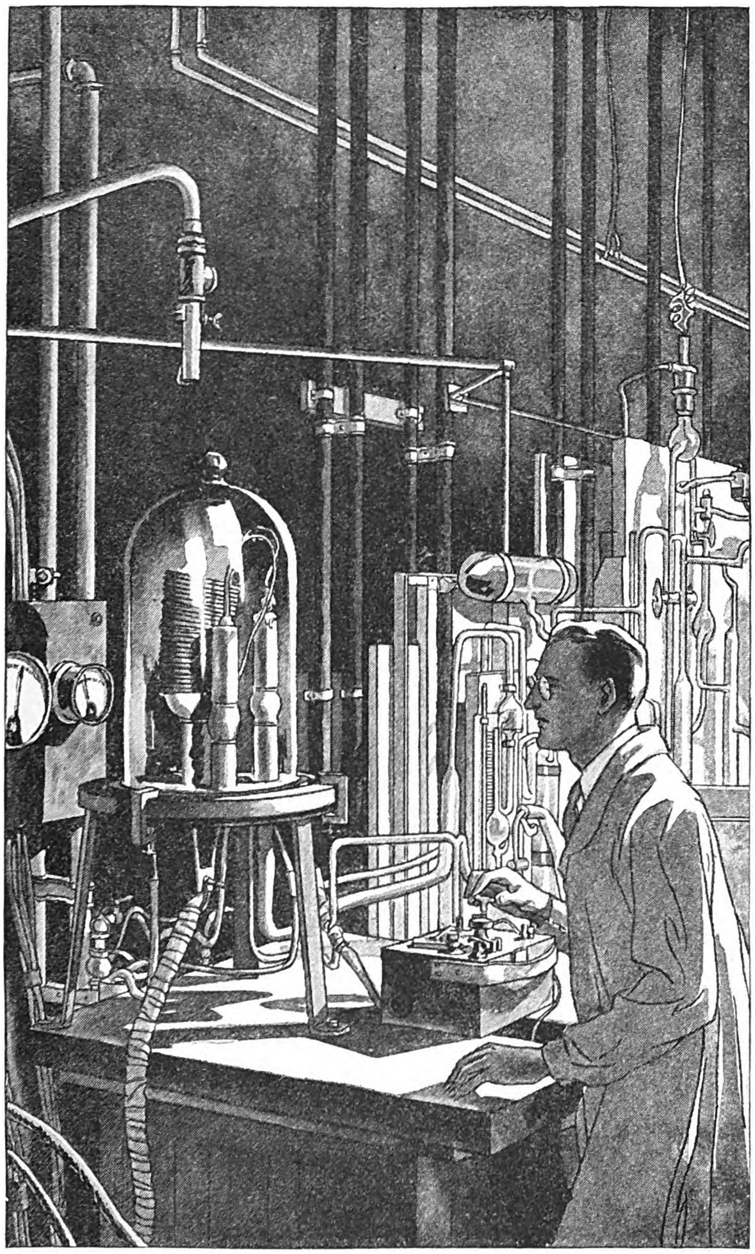

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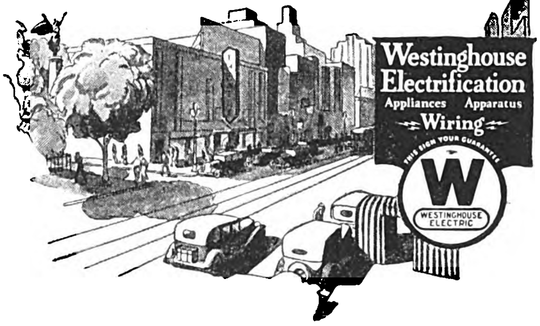


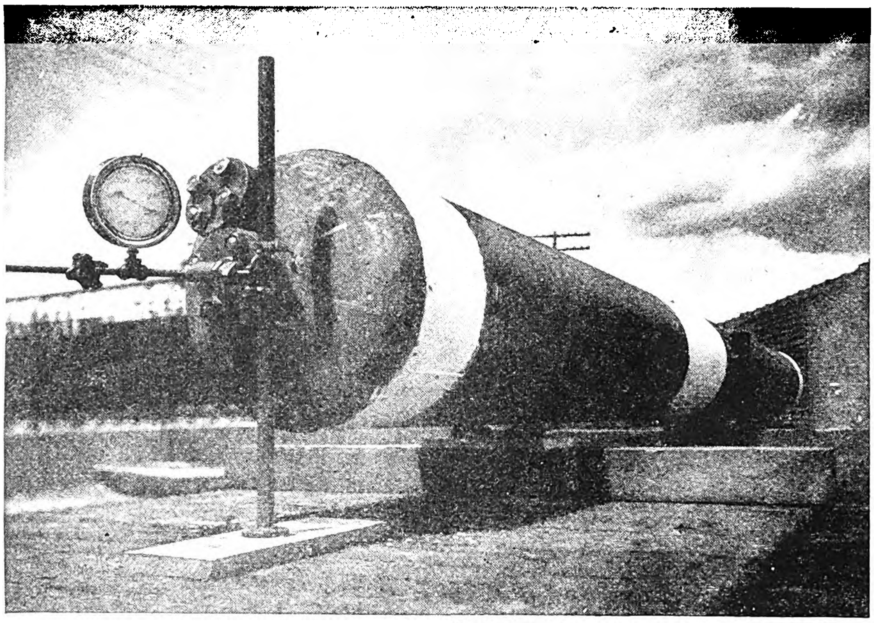
It was found that the effects on the eye produced little if any response in the stomach concerned with the maximum contractions associated with the production of labyrinth nystagmus. Hence Lebensohn is convinced that car sickness is due to the irritation of the mechanism in the internal ear, but he feels also that errors of refraction in the eyes and of muscle balance predispose a person to this malady. Such errors act as a depressant to the activity of the stomach and people with disturbances of vision are likely to have a lower resistance to nausea than those free from such disturbances.

The development of smoother roads and easier riding in automobiles is making car sickness less common. Dr. Lebensohn states that it is best not to go hungry when traveling, as an empty stomach is particularly sensitive to depressing influences. He recommends also that errors of refraction and of muscle imbalance should be corrected.—*M. F.*

HIGH PRESSURE TECHNOLOGY REQUIRES POWERFUL APPARATUS

PROBABLY the most lively topics of discussion among present-day chemical engineers are the several new processes in synthetic chemistry which utilize high pressures and high temperatures. By employing pressures and temperatures heretofore deemed impractical, the chemist has developed commercial processes for the fixation of atmospheric nitrogen, the hydrogenation of oil, and the synthesis of methyl alcohol. From the theoretical standpoint, there is nothing particularly new about these developments but it is only within the last few years that equipment suitable for the severe service required by the new technology has become available. New alloy steels of extremely high tensile strength and corrosion-resisting properties have been developed to meet the demands of high pressure technology. It has also been discovered that welded joints in steel pipes and tanks can be made sufficiently strong to withstand the severe conditions imposed.

What is said to be the most severe test to which a welded container has ever been subjected was performed recently on a welded tank by the A. O. Smith Corporation of Milwaukee, Wisconsin. One of our photographs shows the tank, which is 33 feet long, with 3½-inch walls, and an inside diameter of 26 inches, being subjected to a pressure of 10,000 pounds per square inch without any sign of failure.—*A. E. B.*



Welded reaction chamber for a new synthetic process, being tested at the high pressure of 10,000 pounds per square inch without a sign of failure. The working pressure which this cylinder must withstand when in operation is 500 pounds

QUICK-FREEZING CANNED FRESH PEACHES

WHAT promises to be the first step in the establishment of an important new food industry has just been completed by Tom Huston of Columbus, Georgia, already widely known as "The Peanut King" and as an outstanding example of the South's younger generation of business leaders. While other organizations and individuals throughout the country have been experimenting, without notable success, in the application of the quick-freezing process to fresh fruits, Mr. Huston has organized Tom Huston Frozen Foods, Inc., built a 100,000-dollar plant at Montezuma, Georgia, the first of its kind in the world, and has completed a successful season of freezing fresh, tree-ripened Georgia peaches in commercial quantities.

Although for some years it has been a fairly common practice in the Pacific Northwest to freeze strawberries and a few other berries grown in that area, these products have been prepared for use chiefly by ice cream manufacturers, confectioners, and bakers. The Georgia plant represents the first step toward placing frozen fresh fruits on the market for family consumption, and for the entire year round. As such it is of outstanding importance to both consumer and grower, promising the former a new line of healthful and appetizing food products, and the latter a broader, more profitable, and better stabilized market.

Essentially, the process is the same as that which has recently been applied to the quick-freezing of fresh meats. By this method it is possible to imprison the original flavor in the fruit without that breaking down of the cells which accompanies ordinary freezing—a more difficult problem in the case of fruits than meats, since the cells are more delicate. The peaches are allowed to ripen on the trees. They are frozen within a few hours of reaching the plant, which is in the heart of the Georgia peach belt. Thus they have an opportunity to reach their full perfection of flavor, and no opportunity to lose any of it during transportation or while in storage.

Practically all of the fruit is brought from within a radius of about 15 miles of Montezuma. The fuzz and skin are first removed by a special process, after which a belt conveyor carries the peaches to tables where they are split in half, pitted, and carefully inspected. They are then run through slicing machines and down a belt conveyor to other tables where the slices are packed in quarter-pound containers, and a little sugar syrup is added. The containers are capped by machine and then pass through the freezing tunnels where the temperature is 35 degrees below zero. The entire process is completed under the most rigorously sanitary conditions.

The filled containers are kept in a cold

Georgia peaches, to be frozen in the cartons on the conveyor in front of the girl workers, have a sugar syrup added to them from the rubber hose overhead

Arctic clothing in Georgia! In the cold rooms where peaches are preserved by the quick-freezing method, the workmen have to be so clothed against the intense cold

room until ready for shipment. To maintain the necessary degree of cold, they are passed to the refrigerator cars through a portable, insulated tunnel. In the warehouse, hotel, restaurant, club, or drug store they are kept constantly at low temperature.

THE CONSTITUTION AND GASTRO-INTESTINAL DISEASE

IN the beginning of modern medicine, that is to say at the time when Hippocrates first introduced accurate observation as the basis of scientific study, attention was paid to the constitution of the human being and his structure in relationship to the disorders from which he might be likely to suffer. Indeed, the Greek teachers classified human types according to various characteristics. Persons of certain types, they asserted, were likely to suffer with certain diseases. The conception was favorably received and guided medicine until approximately the 13th Century, when the beginnings of modern research focused attention not so much on the human being as a whole as on individual tissues and structures and disorders. In more recent years it has come to be realized that medicine must be much more concerned with the human being as a whole. It is recognized that heredity and constitution are of vital importance in understanding the nature of man.

In his chairman's address before the section on diseases of the stomach and intestines at the last annual session of the American Medical Association in Detroit, Dr. Julius Friedenwald gave special attention to the human constitution in its relationship to gastro-intestinal disorders. He called attention to the fact that workers throughout the world are now concerning themselves with this point of view. He mentioned particularly the work of George Draper and his constitutional clinic at the Presbyterian Hospital in New York and the work carried out by Raymond Pearl and his co-workers in the division of human genetics in the constitutional clinic in Johns Hopkins Hospital. Individuals have been measured with relation to the

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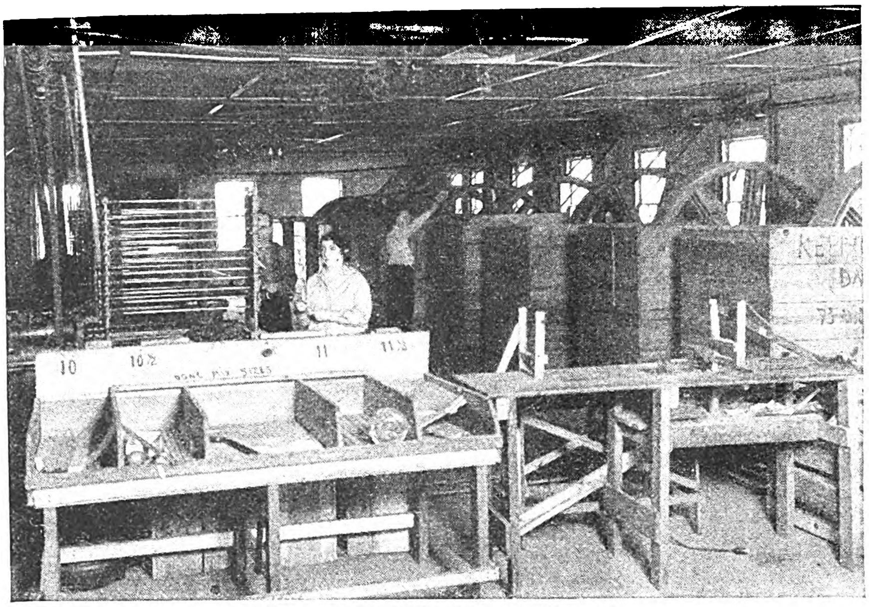


Where glass is spun into fine "wool"

various diseases from which they have suffered, the records of their ancestors have been investigated, and it is now realized that the heredity and the constitution of the individual are of utmost importance in the diagnosis and treatment of disease. The mouth may contain extra teeth or be deficient, the palate may fail to close and there may be hare-lip. Tongue-tie may be manifested through several generations. Various forms of indigestion have been associated with certain temperaments. Hypertonus of the stomach is associated with hyperacidity and lower tonus of the stomach is associated with lessened acidity.

Individuals of the heavy athletic type with short chests and long abdomens are likely to have stomachs of increased tonus with the digestive organs high in the abdomen. The individual of frail physique with long chest and a short abdomen is likely to have a poor tone to the stomach and the stomach and intestines will be found low in the abdomen.

Draper found that people with narrow facial angles and forward slanting teeth were likely to have the navel in a lower location than normal, and were likely to be sufferers from ulcer of the stomach. People with gall-bladder irritations were of a steady and more continuous form of behavior, whereas those with ulcer of the stomach were unstable and react quickly to their environment.

Cancer of the gastro-intestinal tract has been shown by Professor Maud Slye to be inherited through many generations of mice, and she has shown the possibility of breeding cancer out of the group as well as breeding it in.

The greatest study of mankind is man, and it is important to realize that it is man as a whole that must be studied as well as the individual features.—*M. F.*

UNIQUE PLANT PRODUCES GLASS WOOL FOR STORAGE BATTERY PLATES

PRIOR to the World War, glass wool was imported almost entirely from Germany for the few specialized uses to which it was put in this country. At that time it was known best in the form of ink erasers and was also utilized somewhat in chemical laboratories as a filtering medium. About ten years ago a demand arose for glass wool on the part of storage battery manufacturers. Accordingly, a plant was built in Millville, N. J., in the heart of a glass producing region, for the manufacture of glass wool. This plant, the only one producing this material in the United States, was described in a recent issue of *Chemical and Metallurgical Engineering*.

Fundamentally, the process of manufacturing glass wool is simply that of heating a glass rod to the softening temperature and then drawing it out into a fine thread. While in slow rotation, the glass rod, which is about three-fourths of an inch in diameter, is constantly heated and softened at its extremity by a small, regulated gas flame. When the glass tip has reached the proper initial softness, an operator touches it with a cold rod and, having accumulated a small "gob" of molten glass, carries it about 15 feet to the top of a large rotating wheel and releases it there. The wheel takes charge from then on; the strand that has been pulled over this distance remains unbroken and is wound on the wheel.

In this unique plant of Friedrich and Dimmock, there are 12 batteries of glass rods and wheels installed. Within 3000 square feet of floor space, some 500 pounds of glass wool are produced daily.

The rod holders operating from one main shaft are mounted on a special iron structure. At one end the 12 horizontal rods are inserted in the centers of individual interlocking gears arranged in a vertical zigzag fashion; these gears transmit the desirable slow rotation. At the other end the rods project through and rest on holes in a vertical panel, which gradually retreats to the stationary end as the rods are used up. On the edge of this panel is fastened a narrow gas pipe, having 12 small jets which melt the protruding glass rods and follow them to their disappearance.

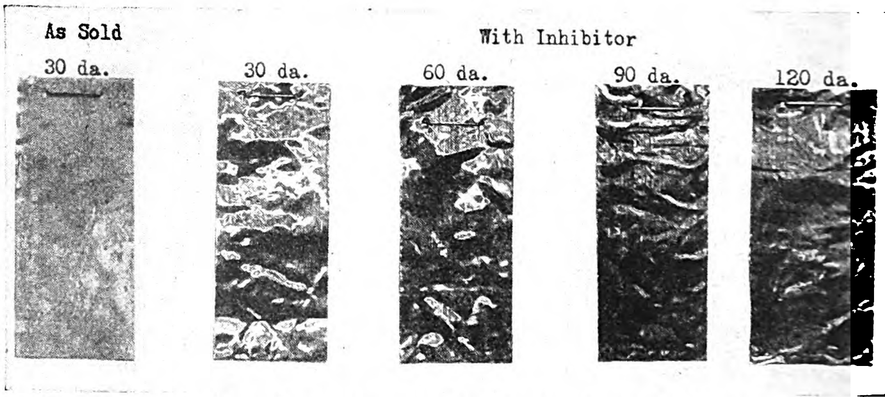
The noteworthy characteristic of this arrangement, shown in the illustration, is its automatic and inevitable synchronism. Once the operator has strung the 12 strands of each battery over their common wheel—a matter of a very few minutes—nothing further need be done until the rods have run out. That is to say, with a given motor speed, the gears will rotate the rods, the gas flame will melt the glass, and the winding wheel will draw the strands, all in a fixed correlation that will give a definite strand size. Thus, if the motor is slowed down, the whole process must adjust itself to produce a heavier strand. What may appear unusual, finally, is that no breakage of the thin glass strands occurs as they traverse the 15 feet of space between units.

The glass wool is finally stripped from the collecting wheels and either shipped in hanks or fabricated into battery insulating plates within the plant. The latter are made from uniform layers of wool that have been dipped in glue and dried in a convection chamber. They are shipped as porous plates with firm smooth sides. Glass wool is also used in filters and light diffusers, and recently as insulation for mechanical refrigerators.—*A. E. B.*

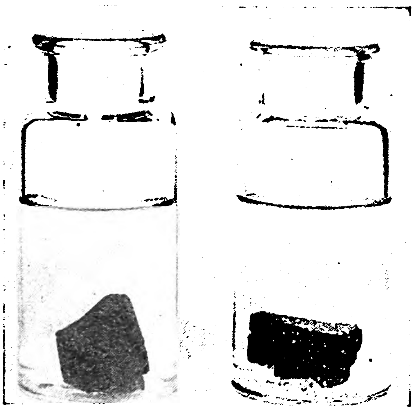
SODIUM SILICATE INHIBITS CORROSION

MANUFACTURERS of shaving soap and cosmetics are increasingly favorable to the use of collapsible tubes as containers for their products. However, one great technical difficulty has militated against the use of this convenient package —namely, the inevitable corrosion of the aluminum tube. Ordinary shaving creams with a soap base, and various alkaline cosmetics, will attack an aluminum tube and in many cases cause its failure within a few weeks, at temperatures well within the range of atmospheric exposures.

Mr. James G. Vail, Vice-President of the Philadelphia Quartz Company, writing in



Test sections cut from shaving cream tubes. The sample at the left shows a dull corroded surface after 30 days. The others show the brilliant surface of aluminum after several months when sodium silicate is used in cream as an inhibitor a recent issue of *Industrial and Engineering Chemistry* announces the discovery that the addition of less than 0.5 percent of sodium silicate to the soap will stop this corrosive action so completely that the metal remains bright after many months. Sodium silicate used for this purpose is known as an inhibitor and its effectiveness as a corrosion resister is clearly demonstrated in an accompanying photograph. The effect of much larger silicate additions than are needed to stop corrosion has been tested by supplying them for regular use to men who did not know their composition. Some noticed more abundant lather but no unfavorable criticism developed.



Effect of silicate treatment on brick exposed to sulfuric acid. The sample at the left was treated before immersion. That at the right was immersed without treatment. Note the deposit of decomposed brick that has settled to the bottom of the solution in the bottle at right

Another inhibiting effect of sodium silicate which is not yet thoroughly understood, is its power to impart resistance to acid corrosion to such materials as Portland cement or ordinary red brick. The surface of the cement or brick is coated with a dilute solution of sodium silicate which penetrates the pores and results in increased resistance to corrosion, abrasion, and penetration of oil and water.—*A. E. B.*

EAR-PHONE DERMATITIS

As more and more strange chemical substances come into industry, new cases of inflammation of the skin due to special sensitivity are reported. When Mah-Jongg became the popular American craze, innumerable cases of sensitivity to the Japanese lacquer used on the Mah-Jongg boxes or tiles were reported in medical literature. A few years ago specialists in diseases of the skin became aroused over the number of cases of people sensitive to the ink used in rotogravure sections of the newspapers.

Now Dr. J. J. Eller of New York reports the case of a man who had inflammation of the skin over both ears and covering the skin just in front of the ears. The patient had used radio ear-phones for two hours, following which his ears itched and burned and became slightly swollen. After several weeks the swelling gradually increased so that eventually both ears became twice their normal size and then the condition gradually subsided. Similar cases have been reported by other physicians.

(*Please turn to page* 482)

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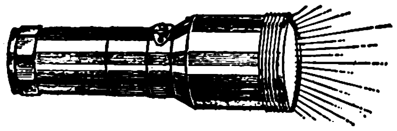

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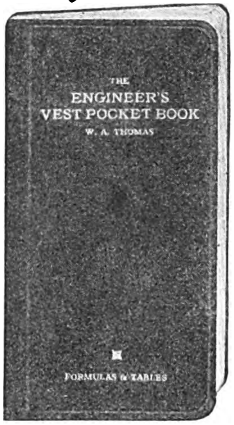

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THE AMATEUR ASTRONOMER

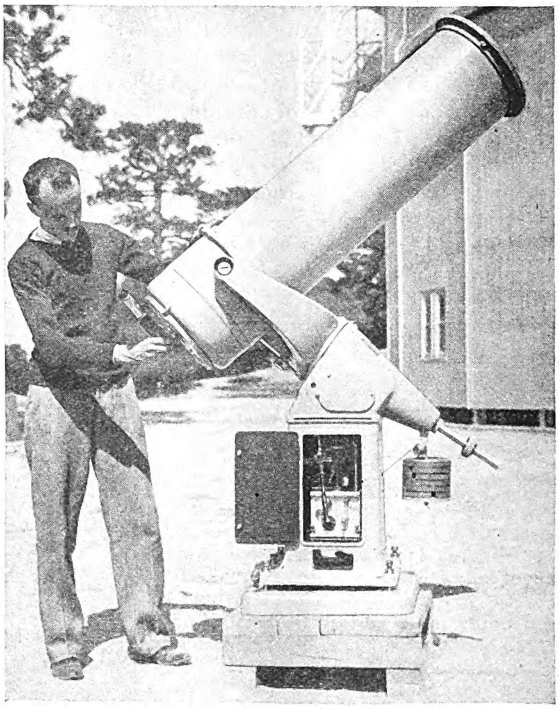
Conducted by ALBERT G. INGALLS

IN the October number, page 320, we reproduced a photograph of one of the four-inch refractors especially designed for the study of various proposed sites for the 200-inch telescope. We now show a photograph of one of two 12-inch Cassegrainian reflectors designed by Russell W. Porter, and approved by Dr. John A. Anderson in charge of the site investigation, for the same purpose. The photograph was sent us by Mr. Joseph O. Hickox of Mount Wilson Observatory. Accompanying it is the following comment:

"Several 12-inch reflecting telescopes have been made for the California Institute of Technology for the purpose of testing seeing conditions at the various sites being investigated for the location of the 200-inch telescope now in course of construction.

"The Pyrex mirrors for the 12-inch reflectors were figured in the optical shop of the Mount Wilson Observatory at Pasadena. The primary focus is five feet, but a Cassegrain focus is available which gives an equivalent focus of 20 feet. Eyepieces of 60, 320, and 480 power are used, the 'seeing' being judged by observing the separate of double stars, the diffraction pattern around stars, and the quality of the detail seen on the moon and planets.

"The mounting is of duralumin, the weight of the complete telescope being 235 pounds. It is provided with reading circles and slow-motion adjustments for right ascension and declination, and is driven by a clock actuated by a weight."



Cassegrainian for 200-inch site investigation

The photograph reproduced was shown to Russell W. Porter, designer of the telescope, who was induced to dictate the following additional comment: "The specifications laid down for this particular mounting were that it should be very rugged and stand rough treatment, as it was intended to be transferred from one site to another on the backs of pack mules or men, and to be easily separated into convenient units for .packing. These considerations made it desirable that all delicate parts be enclosed, as far as possible.

"The entire mounting is of duralumin castings; the tube is of sheet aluminum; the worm gear and adjusting screws of bronze. The only steel in the mounting is the lower bearing of the polar axis and the declination studs. These are chromium plated. The clock weights will drive the clock for 40 minutes before rewinding. The yoke, which is hollow, is especially rugged, and the declination arm and tangent screw are inside one of the arms. A slip ring at the upper end of the polar axis is divided into hour angles, allowing quick setting on any star in right ascension. Hand control in right ascension is by a removable key which engages the worm, whose end can be seen in the little hole on the base casting, just below the yoke.

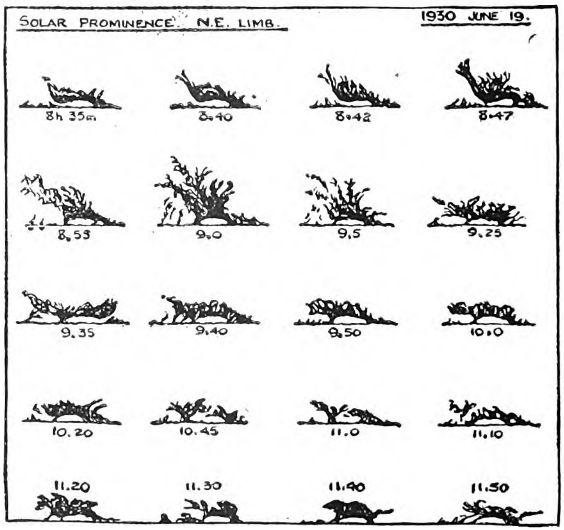
"The cell holding the 12-inch primary mirror is fastened to the casting at the lower end of the tube by a threaded joint making about a half turn. This is not visible on the photograph but lies about halfway between the declination stud and the bottom of the cell. This method of attachment allows the mirror to be removed for safe keeping and to go back again to a positive stop, thus preserving the alignment.

"The whole instrument was painted a light gray with a dull finish and worked down to a beautiful white finish.

"The two telescopes were made by Fred G. Henson of Pasadena. Preliminary tests of the instruments on close doubles showed that the optical surfaces exhausted the resolving power."

THE number of spectroheliosccopes attempted thus far is disappointing. Perhaps the insertion of the series of sketches shown on this page, which gives a concrete idea of what the amateur may expect to see with a spectrohelioscope, may serve to arouse further interest. These sketches were drawn from a solar prominence observed during the morning hours of June 19, 1930 by F. J. Sellers, F. R. A. S., and are reproduced from the *Journal of the British Astronomical Association.* Mr. Sellers points out that this prominence was not a large one, as prominences go, though it was very active. At 9 o'clock A.M. it had reached a height of about 30,000 miles, having risen at the rate of about 12 miles a second.

Seen through the spectrohelioscope these prominences are red and are a moving sight in more senses than one. There are plenty of them; Russell, Dugan and Stewart's "Astronomy" states that it is not at all unusual to find as many as 20 at once on the sun's limb. In 1916 (May 26) one was seen to reach the height of 500,000 miles, ascending at the rate of 20 miles a second. Can you imagine yourself sleeping late on a Sunday morning if you had a spectrohelioscope and could watch such stupendous cosmic events as these? Golf would not pull you away from the eyepiece, nor would motoring. No doubt when the dinner hour came your family would have to feed you forcibly.



Solar prominence seen through spectrohelioscope

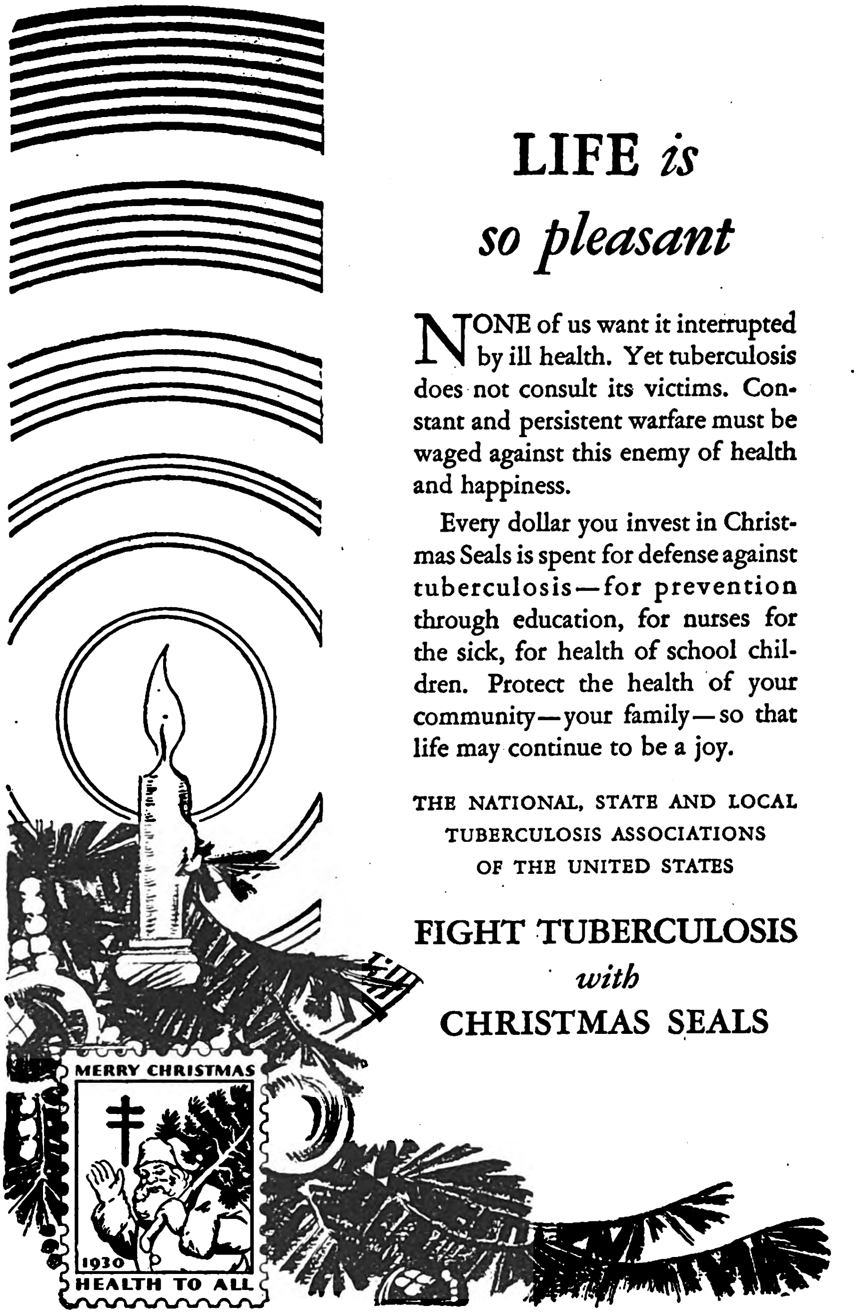
FOR some months we have known that Professor George W. Ritchey had secured the necessary financial backing to begin work on a large telescope of the Ritchey-Chrétien type. He now has made this fact public. He proposes to build a reflecting telescope, of aperture not yet announced, and Miami, Florida, has been selected tentatively as the site. Robert Henkel, Gar Wood, the speed boat builder (who long has been an enthusiastic amateur astronomer), and other Detroit people are his backers. G. H. Lutz ("A. T. M.," pages 243-244) will assist him.

The Ritchey-Chrétien telescope was described by Professor Ritchey in a long series of articles in the *Journal of the Royal Astronomical Society of Canada,* beginning with the May-June, 1928 number. It has a short focal ratio and resembles a Cassegrainian except that, instead of a parabola and hyperbola, a combination of new curves is used. This does away with the distortion of stars not in the center of the field, from which all existing reflecting telescopes now suffer. He also plans to use curved photographic plates accurately ground and polished to a sphere of long radius, since the image projected by the mirror or mirrors of a reflector is not flat but is curved or "dished." He has developed several other extreme refinements, all of which if successfully compounded in one instrument should bring about a striking advance in the technique of telescope making and use. [These mysterious curves have been described—mathematically—in the *Revue d'Optique* (Jan. and Feb. 1922). How to put them on glass never has been described. Don't ask us; we don't know. We asked Professor Ritchey once and his reply was that it is "simple," but he did not describe the method.]

CHICAGO now has an organized group of amateur astronomers and telescope makers, so W. L. Dennis, secretary of the Pickwick Society, 4653 Addison Street, Chicago, has advised us. The Pickwick Society is an established amateur scientific organization but its telescope making activities are new. Its membership includes the professional telescope maker John F. Mellish and Professor Philip Fox, Director of the Adler Planetarium, who will act as advisors. The Society already has a seven-inch, two eight-inch, and a ten-inch reflector. Its activities will center in the Planetarium where meetings will be held. Mr. Dennis asks us to enlist the support of all amateurs in the Chicago district. We wish more power to the Pickwickian elbows. What city is next?

WE learn that the Corning Glass Works (Corning, New York) now has available some standard Pyrex sight glasses which happen to be quite suitable for telescope mirrors. There are several sizes: 6 by ½ inch; 7¼ by ¾; and 9 by ¾. The prices are low. These disks seem pretty thin but should "get by" in nearly every case, as the 8 to 1 ratio usually specified allows a large factor of safety. They often contain bubbles but that can't be helped and these do little or no real harm.

TO complete this month's batch of odd items, here is one furnished by J. V. McAdam, Hastings-on-Hudson, New York. To avoid bubbles in a pitch lap, pour melted pitch on cold tool to half desired thickness and on face of cold mirror (first wet with rouge or soapy water) to equal thickness, and then lay the mirror disk on the other, pitch to pitch. Try it. Mr. McAdam also has modified the Rogers finder (see SCIENTIFIC AMERICAN instruction book "Amateur Telescope Making," page 232) by inserting a monocular in the side of the tube, pointed at a second prism mounted within the tube and in line with the main prism where it intercepts no extra light. An ingenious wrinkle. Although it requires a larger prism, it reduces the number of outside gadgets on the telescope and renders the instrument less vulnerable.



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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 479)

Ear-phones are made of two compositions: (1) A compound with phenol, similar to Bakelite; (2) A laconite compound which is a mixture of pure shellac, rosin, gum, mica filler, marble dust, and carbon black. Cases of inflammation of the skin have developed from both types of ear-phones.—*M. F.*

◆

SYNTHETIC PRODUCT FOR FIRE-PROOFING WOOD

AMONG the many new developments in chemistry disclosed at the recent meeting of the American Chemical Society was the announcement of a new series of compounds known as chlorinated diphenyls. These substances are derivatives of a new synthetic chemical diphenyl, described recently in these columns. Diphenyl is a milk-colored substance made by uniting two molecules of benzene and is used commercially as a substitute for steam for carrying heat in gasoline refining. By adding chlorine in various amounts to diphenyl, a series of derivatives is obtained, ranging in variety from a substance resembling water to light oils, thick syrupy substances, and a light, amber-colored solid.

In a paper describing this substance, C. H. Penning lists various commercial applications for the new compound, such as protective coatings, water-proofing, flame-proofing, molding, electric insulation, adhesives, printing inks, artificial leather, leather finishing, textile finishing, sealing waxes, and chewing gum.

"One of the first uses considered when the non-inflammability of the resinous form of chlorinated diphenyl was discovered was as a fireproofing agent for wood," Mr. Penning states. It was found that a practically fireproof product could be obtained, but at a cost considerably greater than when the common mineral salts such as ammonium phosphate, are used. The treated wood, however, instead of being brittle and lifeless, as is the case with the mineral salt processes, gains in strength, and is indeed a superior product.

The thick, oily varieties of chlorinated diphenyl promise to be valuable for their high dielectric constant and resistivity, and their low power factor. These insulating properties make them of great interest to manufacturers of electrical equipment.—*A. E. B.*

◆

CIGARETTE SMOKERS COMPETE WITH GAS

THE people of the United States smoked 127,400,000,000 cigarettes in 1929. If each smoker produced 3½ cubic feet of smoke from each cigarette, the aggregate smoke would just about equal the volume of manufactured gas used in the United States in the year.

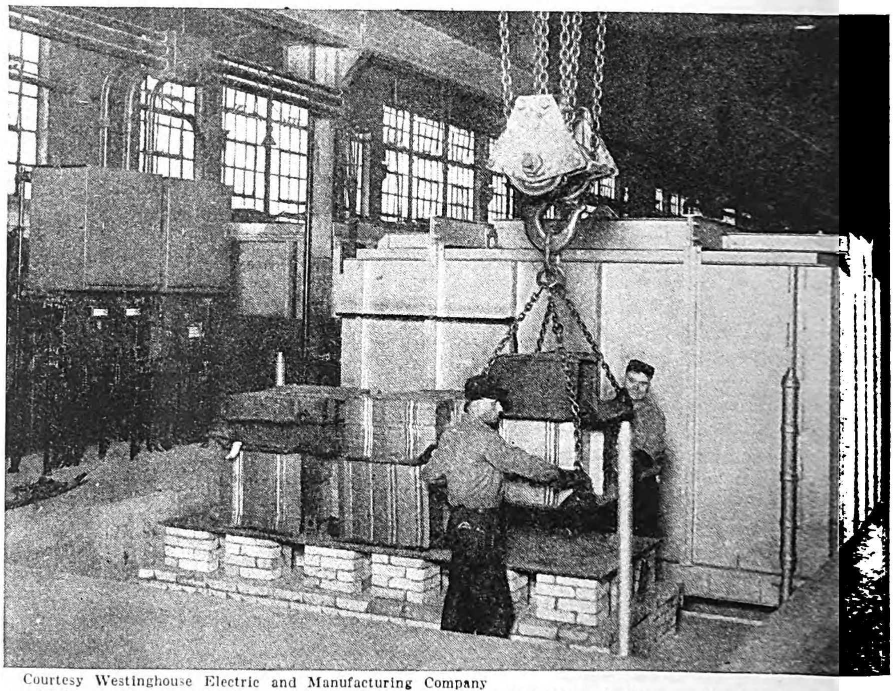
◆

BRITISH RIDE ON RUBBER BRICKS

RUBBER bricks have been used in slap-stick movie comedies for years, but in some parts of Great Britain the streets are now paved with them. In a report to the Sixth International Road Congress, held in Washington recently, a British delegation told of the success that rubber paving has had in London, Newcastle, Edinburgh, and Glasgow.

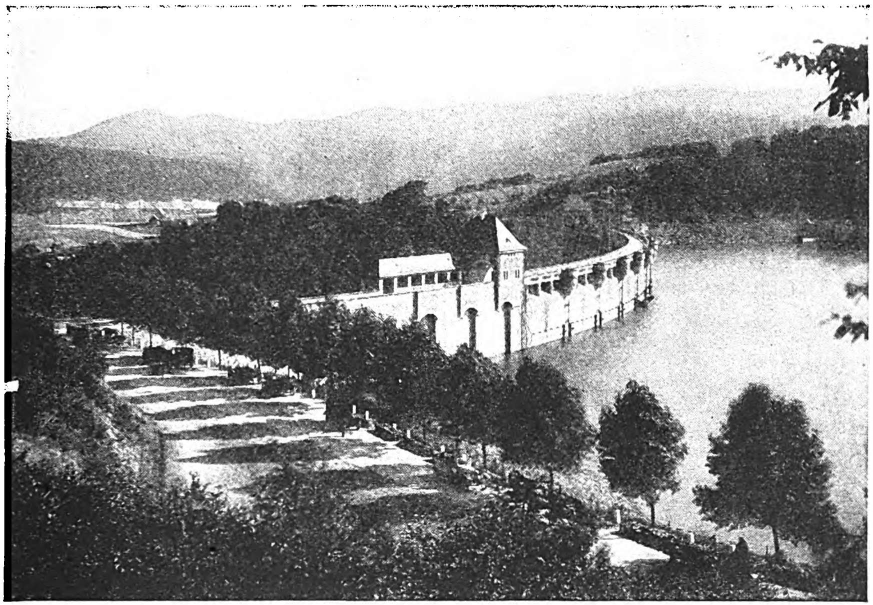
The first experiments to substitute rubber for brick and asphalt were made in 1913, it was stated. A rubber pavement in Glasgow, consisting of blocks of rubber 9 by 4½ by 1½ inches, was laid on a concrete base in 1923.

"Traffic in Glasgow is of the heaviest



Courtesy Westinghouse Electric and Manufacturing Company

Where "the mountain comes to Mahomet." This bell-type furnace is a recently developed time-saver for heat treating metal in great quantities. The metal to be treated is arranged on top of a base, of which a number are supplied, and a crane covers it with the inverted box-like lid which contains the electric furnace. A number of these furnaces may be operated at one time



Courtesy German Tourist Information Office

Europe's largest power dam forming the Eder Valley reservoir, near the famous health resort, Bad Wildungen. The beautiful lake formed by the impounded water is nearly 17 miles long, 5/8 of a mile wide at its widest point, and has an extreme depth of 137 feet. The sites of three villages were covered. The dam is nearly 150 feet high, 900 feet long at the bottom, and 1300 feet at the top. It has the fourfold purpose of maintaining water in the Weser for shipping, feeding the Mitteland Canal, preventing floods, and furnishing water for power

and most trying class," the report stated. "The cap of one block came away from its tread in 1925. This is the only defect reported. The paving is in good condition and shows no apparent wear after six years' use."

An installation in London was in New Bridge Street, which bears some of the city's heaviest traffic, with 17,623 vehicles, or 51,100 tons between 8 A.M. and 8 P.M., in addition to considerable night traffic. This was laid in 1926.

"After two years of wear, 416 blocks, or say 4 percent, were renewed, and now at the end of the third year approximately another 10 percent have to be renewed," the report stated. "The defects are in the nature of blisters and the subsequent peeling off of thin layers of the cap where blisters appeared. The layers stripped off in no case extend the full surface of a block and are about one fifth of an inch thick; the defects cause no inconvenience to traffic, but they collect dirt and are a blemish."

The paving costs about 22 dollars a square yard, laid without foundation, it was stated.—*Science Service.*

FISH-BONE IN THE LIVER

ORDINARILY a fish-bone seldom shows a shadow when the X ray is used to discover its presence in the human body. Occasionally, however, such a bone may be of such size and density as to be easily visible. Such was the case in a woman, 36 years of age, who had all of the symptoms of gall-bladder disease and who went to a hospital for that complaint. When an operation was performed on the gall-bladder, an abscess was found in the side of the liver and a large, thick fish-bone almost an inch long was removed with the matter from the abscess. Apparently when the woman swallowed the fish-bone it stuck in the wall of the small intestine, which then became adherent to the lower surface of the liver. The fish-bone passed through the wall of the intestines and on through the liver because some of the liver became adherent to the wall of the abdomen.

A careful study of the X ray plates made beforehand revealed the presence of the fish-bone as marked on the plate, although it had been overlooked previous to the operation.—*M. F.*

DISCOVER QUEER PROPERTY OF LIVE WIRES

DOES the passage of electricity through a copper wire cause a change in the properties of the metal? G. C. Oland and C. E. White proved to a recent meeting of the American Chemical Society that it does. The discovery was made by submerging a "live" wire and a "dead" one in an acid solution and measuring the amount of metal dissolved from each in a given time. It was found that less copper dissolved from the wire carrying current, either alternating or direct. Strangely enough, however, when lead, nickel, aluminum, or iron wire was used, the metal was attacked more readily while it was carrying a current.

Encouraged by this discovery, the chemists are continuing their experiments to discover the exact physical and chemical changes caused in a metal by the passage of electricity. Perhaps their work may eventually enable chemists to answer the question that has "stumped" physicists and electricians—what is electricity?—*A. E. B.*

BEETLES CHEW HOLES IN LEAD PIPES

THE supposition that metals can be injured by boring and gnawing insects has been confirmed recently by O. Bauer and O. Vollenbruck as a result of systematic experiments in the Kaiser Wilhelm Institut für Metallforschung and in the National

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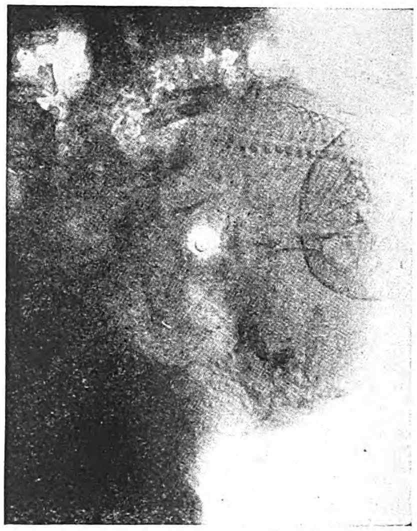
The animals that possess this peculiar metallic appetite are certain varieties of beetles and they are especially fond, it seems, of lead. Cases are on record where the insects have ruined lead, water, and gas pipes, tanks and cisterns, telephone cables, and lead stereotype plates. No attacks of the beetles on aluminum, zinc, or brass could be verified.—*A. E. B.*

DIAGNOSIS OF TRIPLETS BY THE X RAY

OBVIOUSLY it is of importance to diagnose the presence of twins and triplets before their birth. There are many ways in which the physician may do this. He can locate two heart beats, he can feel with his hands the outline of two heads and two spines, and there are various other ways by which he can gain information with his ordinary senses. When, however, there are three children present the situation becomes much more difficult. Hence it is that the X ray was warmly welcomed by the obstetrician as an aid in his work. Dr. Leo A. Rowden in the *British Journal of Radiology* presents the X-ray picture of a case in which, because of the large size of the abdomen, the presence of twins was suspected. Pictures taken from the front and from the side indicated the presence of triplets that lay in the abdomen in various positions. The three children were born on September 19; two of them arrived in the normal order and one reversed.—*M. F.*


Triplets revealed by the X ray

SMOKE-POT WIND INDICATORS

UNITED AIRPORTS of California is marketing with some success a smoke-pot wind indicator. The smoke pot uses cheap fuel oil, holds 25 gallons at a filling, and will produce smoke continuously for 12 to 15 hours without refilling. Any shade of smoke from black to white can be readily produced in accordance with local conditions. The smoke column is heavy and tends to roll along the ground for several hundred feet. Its nominal cost is worth considering. But the mere size of the column as compared with a wind cone or vane is more of an advantage. Also the column bends and veers with every gust and so gives the pilot a precise and instantaneous idea of what the air is doing on the ground.—*A. K.*

FOSSIL WOOD RESEMBLES MODERN PINE

A PIECE of petrified wood from Yellowstone National Park, so perfectly preserved that even the finest microscopic details are practically as clear under the high-power lens as those of modern wood, is described and illustrated in the *American Journal of Botany* by Prof. H. S. Conard of Grinnell College.

It was found in a region where the only previously described petrified woods were those of redwood trees, but its structure is more closely akin to that of one of the species of pine found in the park. Before it could be studied and photographed under the microscope, bits of it had to be ground down thinner than tissue paper, so that light would shine through.—*Science Service.*

OUTBOARD MOTOR AERATES FROZEN LAKES

OUTBOARD motors, advertised by manufacturers as a most valuable aid in transporting fishermen to the scene of their nimrod activities, take a new rôle in the winter—this time assisting the fish. This information was recently received by the Johnson Motor Company, Waukegan, Illinois, from a South Dakota dealer.

In one instance the state game warden called on W. T. Williams, Watertown, South Dakota, owner of an outboard motor, to save the fish suffocating under the ice in a small lake near Goodwin.

Mr. Williams built a stone-boat frame to set his motor in, and hung it at a tilt in a hole through the ice about three feet by six feet. In this position the propeller of the motor threw a heavy flow of water out and over the top of the ice. About 300 feet from the motor, he cut five holes about three feet in diameter, as shown in the accompanying sketch.

The motor was started and ran six days and nights constantly. About every six or eight hours the motor had to be moved back several feet because of the washing away of the ice.

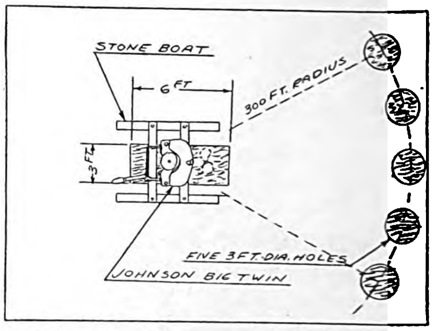


Diagram of how an outboard motor was used to aerate a frozen lake

During the six days a crew of fishermen seined 760 dollars' worth of scavenger fish from the lake, leaving an aerated lake with enough fresh water to save the game fish.

Several times after long continued cold spells, the state game and fish commission have aerated various lakes in this manner.

CURRENT BULLETIN BRIEFS

SHORT REVIEWS OF BULLETINS AND PAPERS ON SCIENTIFIC AND ALLIED SUBJECTS, AND WHERE TO GET THEM

STAPLE VITREOUS CHINA PLUMBING FIXTURES (Commercial Standards CS 20-30, Bureau of Standards) gives valuable diagrams (with sizes) of various plumbing fixtures. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

COPPER ELECTROTYPING (Circular of the Bureau of Standards, No. 387) gives an exceedingly valuable resumé of the process and will prove valuable to all who are in any way interested in plating. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

ANNUAL STATISTICAL REPORT OF THE AMERICAN IRON AND STEEL INSTITUTE FOR 1929 gives 129 pages of carefully prepared statistics, the tables being very authoritative. *American Iron and Steel Institute, 75 West Street, New York City.—$5.00.*

THE DIFFERENTIAL ANALYSIS OF STARCHES (Publication 275—Field Museum of Natural History, Botanical Series Vol. IX, No. 1) by James B. McNair. *Field Museum of Natural History, Chicago, Ill.—50 cents, plus postage.*

GROWING BLACK LOCUST TREES (Farmer's Bulletin, No. 1628, U. S. Department of Agriculture) by Wilbur R. Mattoon, tells how to grow trees for which there is a demand, particularly for fence posts, stakes, insulator pins, and tree nails. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

ENGLISH SPARROW CONTROL (Leaflet No. 61, U. S. Department of Agriculture) by E. R. Kalmbach gives economical and effective methods for local control of this pest. While the nestlings eat insects, this is only for ten or twelve days, whereupon they become confirmed vegetarians. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

DE FLOREZ MANUAL CONTROL SYSTEM (Bulletin No. 7520). With this system the operator can almost "feel" the movement of the distant control. The pamphlet tells how. *The Brown Instrument Co., Philadelphia, Pa.—Gratis.*

FIFTY COMMON PLANT GALLS OF THE CHICAGO AREA (Botany Leaflet 16, Field Museum of Natural History) by Carl F. Gronemann, while perhaps of local interest, gives excellent illustrations which are botanically correct. *Field Museum of Natural History, Chicago, Ill.—25 cents.*

PASSING THROUGH GERMANY is the title of a delightful little travel book of 225 pages, beautifully illustrated. It is not a guide book in the ordinary sense, but takes care of such subjects as the fine arts, vacation study, German politics, et cetera. This beautiful little book is sent for the cost of the postage which can be remitted by two international reply coupons which will cost ten cents.—*Terramare Office, Wilhelm Strasse 23, Berlin, S. W. 48, Germany.*

FUNDAMENTALS OF PATTERN DRAFTING FOR SHEET METAL SHOPS is an excellent little treatise on the subject and is well illustrated. *Publicity Department, The American Rolling Mill Co., Middletown, Ohio.—Gratis.*

HOW WE MAY GET VITAMIN A; B AND G; C; D (Extension Circulars, Extension Service of College of Agriculture, University of Wisconsin) are four little pamphlets giving radio talks by Mrs. May Raynolds of the Home Economics Department, University of Wisconsin. *College of Agriculture, University of Wisconsin, Madison, Wis.—5 cents each.*

WAYS AND MEANS TO TRAFFIC SAFETY gives the recommendations of National Conference on street and highway safety as summarized and approved by the Third National Conference, May 27-29, 1930. *National Conference on Street and Highway Safety, 1615 H. St., N. W. Washington, D. C.—Gratis.*

AERONAUTIC PUBLICATIONS (Aeronautics Bulletin No. 6, Aeronautics Branch, U. S. Department of Commerce) is a valuable pamphlet citing books and periodicals pertaining to aeronautics. It also gives a complete list of the Aeronautics Bulletins, 25 in number, which are sent free (with one exception) to interested parties. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

THE AERONAUTICS BRANCH, DEPARTMENT OF COMMERCE (Institute for Government Research, Service Monographs of the United States Government No. 61) by Laurence F. Schmeckebier, deals with the history, activities, and organization of this important branch of the government service. It contains much information unobtainable elsewhere. *The Brookings Institution, Washington, D. C.—$1.50.*

OBSERVATIONS ON THE POSSIBILITY OF METHYL CHLORIDE POISONING BY INGESTION WITH FOOD AND WATER, by W. P. Yant, H. W. Shoaf, and J. Chornyak. While there is no definite evidence that food poisoning has occurred or that this type of hazard exists with the refrigerants in current use, nevertheless, the possibility is a matter of concern to manufacturers of refrigerating devices and products, to health officials, and to the public. This detailed study will prove of service to all such persons. *The Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y.—Gratis.*

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OUR POINT OF VIEW

(*Continued from page* 429)

from laying off men or reducing wages. Nor is there much substance in the statement that this reduction does not add to the unemployed because men are not discharged until the end of their enlistment. There is a continuous outflow of men from the Navy and unless there is a corresponding intake, the average in the Navy quickly drops. Briefly stated, the Navy Department will draw upon the labor market for just 4800 less men after this reduction, and the ranks of the unemployed are swelled by exactly the same number.

We sympathize with the President's effort to reduce government expenditures in order to avoid raising the income tax; we are aware of the enormous strains put on the Treasury by the operations of the Farm Board, the building of Hoover Dam, the accelerated public-building and road program, and last, *but not least,* the increased cost of prohibition enforcement; we know that powerful interests would oppose any cuts in these expenditures, while there will be few in public place to protest a naval slash. Some of the President's advisers may think it is good politics to save at the expense of the Navy, but we know they are wrong and are confident that the great inert mass of unorganized Americans, patient though they be, will find a way to show their resentment of a continuous surrender of national interest to placate organized groups held together by fanatical, short-sighted, or selfish motives.

Continued Unrest In South America BRAZIL, the largest and most important of the South American states, is in the throes of a revolution that appears at this writing to be succeeding. Already more blood has been spilled in Brazil than in the "palace revolutions" of Argentina and Peru. Probably the fundamental cause of this revolt is the economic depression occasioned primarily by the low price of coffee, Brazil's great export commodity; the alleged cause is that President Luis was elected by gross frauds perpetrated under the protection of the army; unquestionably, the rather easy successes of the revolutionists in Peru and Argentina, followed by their rapid recognition as *de facto* governments by this country, encouraged the present outbreak in Brazil.

This present unstable condition throughout Central and South America, we feel sure, is being carefully considered by the State Department. In general the European powers follow our action in extending recognition to the revolutionary governments, so that our responsibility, though undefined, is immense. Usually our government views with disfavor any violent usurpation of authority, and in a treaty with the states of Central America agreed to withhold recognition from a government based on force. This agreement does not extend to states of South America, and obviously different conditions will require different methods of treatment.

Our investments in Central and South America are colossal. One expert estimates that we have a total investment of 6.000,000,000 dollars in these countries and an annual export trade to them of 1,000,000,000 dollars. Brazil alone takes 100,000,000 dollars of our exports annually; Argentina, 180,000,000 dollars; Cuba, 125,000,000 dollars; and Mexico, 115,000,000 dollars. Thus we have a large economic interest in our southern neighbors.

In addition to the revolution in Brazil, President Machado of Cuba has been authorized by the Cuban congress to suspend the constitutional guarantees in that country on account of threatened outbreaks in Havana. There are also fresh indications of unrest in Mexico. Former President Portes Gil, resigned as head of the National Revolutionary Party, and General Plutarco Calles, reputed strong man of Mexico, issued a warning that the Government must purge itself of disloyal factions. Presumably in response to this threat, Louis Leon, Secretary of Labor and Commerce, resigned and other cabinet retirements are rumored.

The Monroe Doctrine effectively prevents European intervention in South American affairs. It therefore carries a moral obligation on our part to exercise the stabilizing influence which would otherwise be exerted by the Great Powers of Europe. The extent and nature of our intervention in the affairs of our proud Spanish-American cousins can only be determined after careful consideration of the many factors involved; each situation that arises has to be considered on its own merits since no precise rules can be formulated that will cover the various crises that continually arise.

Americans will understand the delicate dilemmas that almost continually confront the Department of State if they will visualize the Latin-American situation as it actually exists and realize that republican institutions and representative governments are ill-adapted to the genius, habits, and mental outlook of the Central and South Americans of Spanish descent, who constitute the real ruling class in these countries and who are entirely unconvinced that the ballots of ignorant *mestizos* should decide the destinies of their countries. The great bulk of the peon population is content to leave the government in the hands of the small ruling class, and the so-called revolutions, for the most part, are merely struggles between certain cliques or oligarchies for power. The prevailing economic depression causes unrest, and the oligarchies out of power have simply taken advantage of it to seize the government.

Our interest lies in the orderly self-development of these countries. We can not force this development which must be a slow evolution; we can carefully avoid hindering this development by officious meddling with their domestic concerns, and we can by friendly counsel decrease the number of, and lessen the savage severity that sometimes marks, these revolutionary shifts of authority. And at all times we can protect these states from foreign intervention which would further complicate their already difficult problem.

It is a singularly fortunate fact that Mr. Hoover toured Latin-America prior to his inauguration. This visit, intended mainly as a gesture of our friendship for its people, has furnished him valuable first-hand information of conditions in this important and temporarily disturbed region. The President's personal knowledge of the situation will assist him to determine practical measures to be undertaken by the United States. And our President should not be hampered in his efforts by uninformed critics or partisan politicians.

The British Imperial Conference THE Imperial Conference composed of delegations from the self-governing dominions and India, opened in London with Premier MacDonald presiding. Many important questions will be considered by the Conference but the most interesting one was disposed of before the Conference met when a member of the British Government formally conceded the right of any British Dominion to secede from the Empire. It had been expected that Premier Hertzog of the Union of South Africa would assert the claim of his dominion to withdraw from the Empire voluntarily, and there were some that professed to believe the British government would contest the claim.

The attitude of the British Government in this matter is just one more instance that the British Empire differs fundamentally from all previous empires, for it is impossible to imagine any other ancient or modern empire permitting a province to pass from its control without a struggle.

The decision of the British Government is probably based on two primary considerations: (1) The inability of the loose-jointed Empire to coerce an unwilling dominion; (2) The unprofitableness of retaining a reluctant member in the Empire. Our successful revolution in 1776 changed the whole attitude of the British people towards their colonies, and the enormous military effort necessary to subdue the Boers in 1899 convinced the British people that it would be poor policy indeed to attempt to keep a dominion in the Empire against its will. The announcement of the government is but an official acknowledgement of an already tacitly accepted principle; none-the-less its formal admission marks an epoch in imperial politics.

In addition to the sentimental ties that bind the dominions to the United Kingdom, there is the very practical consideration that the British Navy and Army are always ready to defend the dominions from external aggression. An Australian or Canadian pays a small tax for the defense of the Empire compared to the tax paid by a resident of the United Kingdom. And we imagine the right to secede will remain in academic abeyance for a long time to come.

The Conference is seriously studying the possibilities of intra-Empire trade, and while the difficulties confronting the Conference are apparently insuperable, it is altogether probable that some measure of trade preference within the Empire will be evolved. It will have to take some shadowy form that will not frighten the Free-traders in the United Kingdom who violently oppose taxes on food, or the Protectionists in the Colonies, who are seeking to build up their factories. Whatever form it takes, any success obtained is almost bound to be at the expense of some of our trade with the United Kingdom and with the dominions. One reason for the British dislike of Briand's proposed United States of Europe was the economic union of continental Europe that would accompany such a development, and the adverse effect it would have on British trade. The struggle for world trade is increasing and is the secret source of many of the so-called policies of the great powers.

A Ray of Hope in China YOUNG Changsu Lin, ruler of Manchuria, took advantage of the exhaustion of the warring factions in Central China, and marched without opposition into Peking. Ostensibly he came to the support of the Nationalist government, the new capital of which is Nanking, which had entirely absorbed its energy in resisting rebellious war lords.

While outwardly the power still is in the hands of the Nationalists, actually it lies with Chang and his army. Manchuria has been enjoying law and order while the rest of China has been devastated by civil war; so far as Chang is able to extend his dominion, he will restore peace to the distracted Chinese. If the Nationalists can accommodate their somewhat visionary plans for a Chinese republic with Chang's personal ambitions, they may obtain the use of his army. This combination would enable them gradually to extend their authority throughout central China. But until there is a much stronger feeling of nationalism and patriotism in China than there is today, all ideas of establishing a unified Chinese republic are chimerical.

Chang's father was too ambitious personally to unite with other Chinese leaders, and it is more than probable that the son will prefer to play a lone hand. If so, his support of the Nationalist government will be of short duration. If, on the contrary, a basis of agreement can be found, a fairly stable government extending from Mukden to Shanghai, including Peking and Tientsin, could be set up. If autonomous governments are achieved by local chiefs in south and west China there would be a lull in the civil wars. In time, if unvexed by foreign interventions, these various Chinese provinces would be drawn into some loose form of confederation; and when roads and railways permit fairly rapid communication between its widely separated provinces, a real unification of China may be expected to begin.

MORE ABOUT PLUTO

(*Continued from page* 447)

keep near one another for almost half a revolution.

At such a time the mutual perturbations must be large, but it will be long enough in all conscience before they can be used to find the masses. Uranus and Pluto also come close to commensurability of periods, for the former completes its revolutions in 84.02 years and three times this is only 2.9 years greater than one revolution of Pluto. The planets therefore return to almost the same relative position after 250 years—during which interval Uranus catches up with Pluto twice.

Figure 3, which is very much like the last one, shows the positions of the planets. At the last conjunction in 1853 the distance of the planets was 30 astronomical units—about the greatest possible. At the next, in 1965, the distance will be only half as great. The perturbations then will be much larger than in the past century and should lead to a fairly good determination of Pluto's mass—*Paris, September 17th.*

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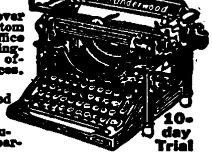

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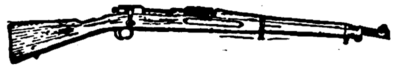

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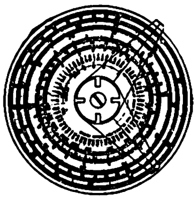

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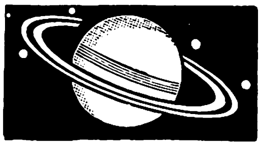

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AVIATION IN 1930

(*Continued from page* 465)

casualties took place in wrecks, but considering all of them the rate is approximately one death per 300,000,000 passenger miles. For the year 1929 there was a death rate among airway passengers of one death in 9000 flights. If an average trip of 300 miles is assumed, this develops into a rate of one death for each 2,700,000 passenger miles. The discrepancy in favor of the railroad is formidable, still not necessarily too formidable.

What is encouraging is that aviation, whether governmental, engineering, scientific, or operational, is fully aware of the importance of increasing safety. The methods of increasing safety are so numerous that they can only be presented in the briefest fashion. But perhaps the following will give a picture of the energy and comprehensiveness of to-day's effort towards safety improvement.

The Guggenheim Safe Aircraft Competition produced a plane, the *Tanager,* equipped with the famous Handley Page slot, which was able to come to rest in 100 feet after touching the ground.

The National Advisory Committee for Aeronautics has undertaken the systematic study of "spinning," that much dreaded cause of accidents, and is evolving valuable data which should enable designers to build planes immune from such troubles.

The Aeronautics Branch of the Department of Commerce has inaugurated a system of licensing airlines, and of licensing only those airlines which are satisfactory in personnel, equipment, and ground organization.

The perfection of radio communication between plane and airport, and the use of such communication by important airlines has arrived simultaneously with the provision of a nation-wide weather service.

Instrument manufacturers are bestirring themselves to produce instruments which will give reliable indication to the pilot in fog flying. At the same time the technique of fog flying is better understood, and systematically imparted in the training of reserve pilots. (See page 430, of this issue.)

The Bureau of Standards has perfected its system of radio beacons, and is now experimenting with a system which will enable the pilot to land safely in fog.

The insurance companies are inspecting planes and airlines and granting better rates to companies of more than usual status from the point of view of safety.

The Packard Diesel engine for aircraft, allowing the use of heavy fuel-oil, removes or diminishes the fire hazard.

The licensing of schools, and the licensing of transport pilots and ground mechanics is improving the status of the operating personnel.

Safety will come as a result of all such efforts, and their value is cumulative.

The aviation industry is at present undergoing a period of severe depression. Many of the smaller airplane manufacturers are closing down, others are retrenching severely on personnel and cutting down on production; two of the biggest holding companies have issued reports showing enormous losses both absolutely and in percentage of invested capital.

Using a hackneyed phrase, the industry is nevertheless sound. The present difficulties are partially due to the general depression now ruling in the United States, partially to the wave of optimistic enthusiasm which swept over the aviation industry soon after Lindbergh's flight. The manufacturers over-estimated the number of planes the public would buy. The schools over-estimated the number of students likely to enroll. The companies erecting airports over-estimated the growth of student instruction and of private flying, and underestimated the effects of competition in the form of municipal airports. With this enthusiasm there followed a period of over-capitalization, with the public putting up far more money than the industry could profitably employ, so that at the present time the average return on aviation investments is negligibly small.

Yet the industry is growing rapidly all the time. It is only the rate of growth which has been misjudged.

Several favorable factors are already at hand. The Aeronautical Chamber of Commerce reports that the production of new planes is falling slightly behind sales, which indicates that inventories are being slowly liquidated. Severe price reductions which have recently come into effect will hasten this process of liquidation.

Another favorable feature lies in the export of American aircraft. The American industry is exporting an increasing portion of its production. In 1929 nearly 14 percent of its total production value was exported, mainly to Central and South America. At the same time there was a change in the character of the exports. War material and small training planes have been replaced, as far as exports go, by large transport planes of far greater value. As a result of this change, the value of American aircraft exports has more than doubled in the last three years. Nor have exports fallen off substantially during 1930, the worst of all years. For the first six months of 1930 they have totalled 3,256,584 dollars against 3,589,196 dollars in the first six months of 1929.

Again, American air transport is growing rapidly and steadily. The merger of New York, Rio, Buenos Ayres Airlines with Pan-American has resulted in the formation of the largest and most powerful air transport system in the world. In a very few years it will connect every important port in Central and South America with the United States. Pan-American is not only carrying vast quantities of mail, but with the use of large and reliable flying boats or amphibions it is also transporting a larger and larger number of passengers. In the United States progress in air transport is equally rapid. The Aeronautical Chamber of Commerce reports that 133,000 passengers were carried by 29 major transport lines in the first six months of 1929. The poundage of freight and mail was equally impressive, showing 137,398 pounds, with 82,165 pounds carried in the second quarter. The Watres bill which will allow the Postmaster General to place contracts for mail on a space basis and will permit the carrying of mail on passenger airplanes will serve to stimulate the growth of air transport still further.

There is not the slightest doubt that aviation will rapidly work out of the slump and in a few years assume gigantic proportions.

BOOKS SELECTED BY THE EDITORS

ARTIFICIAL SUNLIGHT—*By M. Luckiesh, D.Sc., Dir. Lighting Research Lab., G. E. Co.*

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STUDIES IN THE LITERATURE OF NATURAL SCIENCE—
By Julian M. Drachman

THE author traces the effect of scientific writing—largely popular and semi-popular, such as that of Darwin, Tyndall, Proctor, Spencer, Eddington—on public opinion and changed public outlook, and therefore on our present age, the Age of Science. Readers who have made an intelligent effort to grasp the real significance of our age in world history will find this book a valuable addition to their library.—$4.20 postpaid—*A. G. I.*

KNOWING that often there is a name or names on the Christmas shopping list for which it is difficult to find something appropriate, we have this month in these pages given you a number of books suitable for Christmas gifts, both for the young and for the adult. We suggest that a well chosen book makes as gratifying a present as can be made.

In the past we have found that many of our readers like to have a cheery Christmas card slipped into the book they give, the donor's name being neatly typed thereon. Our Book Department will be glad to do this for you if you so desire. The whole makes a most acceptable and appropriate remembrance and if you act at once there is ample time to post even to a distance.—*Book Editor*

COMETS—*By C. P. Olivier, Dir. Astronomy, Univ. of Pa.*

THE well-known author of the standard work, "Meteors," foremost American authority on this branch of astronomy, now has written one on the very closely allied subject of comets. It is a popular book of 239 pages and discusses comets from every angle likely to interest all except the incurable mathematician; it is non-mathematical. There has been no such book and this one was needed.—$3.65 postpaid—*A. G. I.*

CLIMATE—*By C. E. P. Brooks, F. R. A. I.*

THIS small work contains descriptions of climates in different parts of the earth. Students of climatology might not find it dull, most others would because of its formal language and the fact that it is for the most part a compilation of statistical data.—$3.20 postpaid—*A. G. I.*

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CHEMICAL PATENT DEDICATED TO PUBLIC INVOLVED IN SUIT

A RECENT decision in a patent infringement suit brought by the Selden Company against the National Aniline and Chemical Company has attracted considerable interest in the chemical industry. Two patents were involved. The first patent covers a process for making phthalic anhydride, phthalic acid, benzoic acid, and naphthaquinones now used in a variety of industries—notably for the manufacture of dyes, medicinal products, plasticizers for nitrocellulose lacquers and artificial resins —and the second patent covers apparatus for carrying out the process, controlling the generating heat, and bringing about reactions of gases.

Both patents were granted without payment of statutory fees by the inventors under the act of March 3, 1883, which provides that any employee of the Government, other than of the Patent Office, may obtain a patent for an invention without payment of the fee required by law, provided that the inventor agrees that the patent when issued can be used by the Government or by anyone in the United States without payment of royalty.

When both inventions were conceived and perfected the patentees were employed as chemists in the United States Department of Agriculture and the evidence at the trial was clear that they considered they had dedicated their rights entirely to the public. However, before the patents had issued, they attempted to make an assignment to the Selden Company, who set up various defenses including some apparently conflicting decisions to justify their belief that they had a proper right under the patents and could prevent their infringement by others.

The court held, however, that the intention of the parties to dedicate their rights to the public was clear and that "the public" meant not only employees of the Government but the general public, and therefore the assignment to the Selden Company conveyed no rights, and everyone had an equal right to use the invention without payment to the inventors or any of their alleged assignees.—*A. E. B.*

UNUSED MARK DENIED REGISTRATION

IN *ex parte* Union Co-operative Insurance Association, First Assistant Commissioner Kinnan held that the Union Co-operative Insurance Association, of Washington, D.C., is not entitled to register, under the Act of 1905, as a trademark for printed books, pamphlets, circulars, and so forth, a mark consisting of the representation of a seal impressed in wax including concentric circles between which are written the words "Union Co-operative Insurance Association 1924" and within the inner circle the words "Union Life Insurance For Union Men, Their Families and Friends."

The ground of the decision is that there is no evidence presented that the matter above described was ever used as a trademark.

In his decision, after noting the statement of the examiner, that a large variety of specimens such as leaflets, post cards, and so forth, and a copy of a periodical entitled *Official Organ of the International Electrical Workers and Operators Published Monthly* had been filed; noting further that the alleged trademark appears on the inside of the cover of the periodical in connection with an advertisement of an insurance association and that this periodical contains general reading matter and many advertisements having nothing to do with insurance associations, the First Assistant Commissioner said:

"The various leaflets, post cards, and folders submitted as specimens are mere advertisements of insurance business, intermittently, irregularly, or sporadically issued and distributed indiscriminately without any thought of remuneration. The alleged mark is not, in consequence, used on these leaflets, post cards, and folders in connection with the sale of anything nor is it used in the journal as a name or device indicating the journal. The examiner has held that this use of the particular design is not a trademark use at all in connection with any of the specimens filed. His conclusion is deemed sound."

WHEAT PRODUCT TRADEMARKS

IN a recent decision, First Assistant Commissioner Kinnan held that the J. T. Fargason Grocer Company, of Memphis, Tennessee, is not entitled to register the term "Omega" as a trademark for macaroni, spaghetti, noodles, corn flakes, and rolled oats in view of the prior registration by the H. C. Cole Milling Company, of Chester, Illinois, of that term as a trademark for wheat flour and that the registration which the Fargason Company had obtained under the Act of 1905 should be cancelled.

The ground of the decision is that the goods of the parties are of the same descriptive properties and that the fact that the use by the Fargason Company was known to the officials of the Cole Company is no ground for refusing cancellation.

OLIVE OIL URGED AS MOTOR LUBRICANT

LUBRICATING oils and greases produced from olive oil in Spain are reported by Spanish experimenters to have shown satisfactory results in preliminary tests with motor vehicles and electric motors, according to a report from Consul Austin C. Brady at Malaga, made public by the Department of Commerce.

An appeal is being made to Spaniards to use the domestic product in place of imported mineral lubricants, imports of which are recorded at 64,022,232 pounds for 1928, a large share of which was supplied by the United States. Statistics of the Petroleum Monopoly place 1929 sales of mineral lubricants at 75,387,778 pounds.

PETITION FOR CANCELLATION DISMISSED

IN the case of the Texas Ichthyol Chemical Company *versus* Ichthyol-Gesellschaft, Cordes, Hermanni and Company, Cancellation No. 1085, First Assistant Commissioner Kinnan held that the petitioner for cancellation, the Texas Ichthyol Chemical Company (Texas Ammonium Ichthyolate Co., Substituted), of Burnet, Texas, was properly permitted to dismiss without prejudice its petition for cancellation.

In his decision the First Assistant Commissioner noted the arguments that had been presented and, after stating the appellant had set forth categorically the usual reasons that the federal courts have deemed persuasive in permitting, or refusing to permit, the plaintiff to dismiss the bill without prejudice, said:

"It may be said that none of the six reasons recited on page 12 of appellant's brief as having been relied upon by courts in denying similar motions is so far present in the case at bar as to justify the refusal of the petitioner's motion and the reversal of the decision of the examiner of interferences upon it. Clearly enough the appellant has sought no affirmative relief and nothing in the nature of a cross bill has been presented. It is not clear the appellant would be injured or prejudiced by the granting of the motion beyond the possible annoyance of renewed litigation.

"It is true such judgment would bar renewed proceedings of this character but the disposition of motions to discontinue has not, in equity proceedings, usually been influenced or determined by this consideration."

With reference to the argument that a question of public policy was involved and that the case was "ripe for decision" he said:

"It is not thought there is any public policy involved in the instant proceedings or, if there is any, it is too remote to be considered. As to the testimony being closed, the case being ready for final hearing, or, 'ripe for decision,' it is believed even if these matters are admitted to be true, they are not sufficient to bar the petitioner the grant of its motion to discontinue."

TOBACCO PIPE PRODUCTION LOWER

SMOKERS in the United States are forsaking the pipe, apparently, judging by production figures for last year, according to a statement Sept. 11 by the Assistant Chief Statistician of the Census of Manufactures, John F. Daly. The statement follows in full text:

That American smokers are forsaking the pipe, the historical, the original and probably the most leisurely manner of smoking, is indicated by census figures.

According to the preliminary census of manufacturers' statistics the production of tobacco pipes last year showed a decline of 25.1 percent as compared with the production in 1927. The total shipments or deliveries of tobacco pipes in 1929 by manufacturers in the United States were valued at 5,202,185 dollars, as against 6,946,576 dollars reported for 1927, the last preceding census year.

The pipe production in 1927 also represented a slight decline as compared with the 7,298,595 dollar total for 1925, and this in turn was materially lower than the 9,704,816 dollars reported for 1923.

Other figures on the industry for 1929 were also in keeping with those on production. Only 22 establishments were engaged primarily in the production of tobacco pipes last year, which number shows a decline of one as compared with 1927. The 22 manufacturers gave employment to 1667 wage earners, to whom they paid 1,994,057 dollars in wages, which represented decreases of 7.7 percent and 14.7 percent, respectively, as compared with 1807 wage earners and 2,278,537 dollars paid in wages in 1927.

For materials, containers, and electric current, the manufacturers paid 1,716,788 dollars, a decrease of 36.9 percent as compared with 2,722,706 dollars in 1927. The value added by manufacture (value of products, less cost of materials, and so forth) also showed a decline, being 3,751,898 dollars as against 4,551,100 dollars in 1927, a decrease of 17.6 percent.

Of the 5,202,185 dollars' worth of pipes produced last year, briar pipes totaled 4,530,464 dollars and corncob 556,031 dollars, while other pipes produced were valued at 115,690 dollars, and other products at 266,501 dollars.

DESCRIPTIVE MARKS DENIED

IN *ex parte* J. B. Martin Company, First Assistant Commissioner Kinnan held that the company is not entitled to register, under the Act of 1905, the word "Opalescent" as a trademark for silk velvets and velvets of silk and rayon, since this word is merely descriptive of the goods.

In his decision, after referring to the dictionary definition of the word "opalescent," the First Assistant Commissioner said:

"It is well known that the goods to which the applicant applies the notation, when considered as piece goods, are made in different colors and frequently possess the property of reflecting light at different angles with a kind of iridescence which, in some instances, may be fairly well termed 'opalescent.' The word is a common descriptive word in our language and any part of the public should be permitted to use it in connection with goods of this character and no one should be permitted its exclusive appropriation."

In another decision affecting the same company, Dr. Kinnan held that they are not entitled to register, under the Act of 1905, the term "Chinchilla" as a trademark for silk velvets and velvets made of silk and rayon, since the term also is merely descriptive of the goods.

In his decision, after noting that the examiner had relied upon certain decisions in support of his holding that the goods of the applicant are of the same descriptive properties as woolen piece goods or thick heavy cloth from which coats are frequently made, and noting applicant's argument that the name as defined in the dictionary is the name of a South American rodent or its fur and at the most would be merely descriptive of applicant's goods, the First Assistant Commissioner said:

"It is held, since this word has long been used to describe a fabric made somewhat in imitation of the fur of the animal, purchasers would be led to believe the applicant's goods were likewise made in imitation of the fur and would interpret the term as merely descriptive of the fabric. The term having been for so long a time applied to a fabric in a descriptive sense, it is deemed the applicant is properly held to be seeking registration of a mark which is merely descriptive of the character or quality of the goods."

RUBBER TIRES vs. RUBBER BELTING

FIRST Assistant Commissioner Kinnan recently held that the holding in a prior decision that C. Kenyon Company, Inc., of New York, New York, is not entitled to register a trademark for vehicle tires in view of a prior registration by the Goodyear Tire and Rubber Company of substantially the same mark upon belting, should be withdrawn in view of the registrant's statement that it had no objection to such registration and it was not deemed that there would be any confusion by the use of the mark on the different goods.

He further held that, since the refusal of registration had been made in the same decision in which the opposition to the registration had been dismissed, it was believed that, now that the mark was held registrable, the opposition should be reinstated to the extent that a new decision should be rendered which would give the opposer an opportunity to appeal if it so desired.

D. A. R. OPPOSES TRADEMARK

IN the case of National Society of the Daughters of the American Revolution *versus* T. Buettner and Company, Inc., First Assistant Commissioner Kinnan held that the latter is not entitled to register, as a trademark for fabrics upon which are stamped embroidery patterns, a mark consisting of the following notation, arranged as shown:

D
W E A V E
R

The ground of the decision is that the mark so suggests the name of the opposer as to be unregistrable.

In his decision he noted that the opposer organization is frequently referred to as "The D. A. R." and also noted the prohibition of the statute against the registration of names, and so forth, of any organization, and so forth, incorporated in any state and the provision of the Trademark Act that the word "states" includes the District of Columbia and that the opposer was incorporated in the District of Columbia.

He then said:

"In a proceeding where an opposer of this character is involved, public policy as well as the statute and the settled practice justifies waiving all doubts against the applicant. There appears to have been no satisfactory reason for making so prominent these letters "D A R" which it is a matter of common knowledge have come in substantially all parts of this country and among all classes to indicate the opposer society."

He then stated that irrespective of what might have been the applicant's intent: ". . . it is believed there is a probability of purchasers or customers attaching some significance to the use of these three letters and being misled into the belief that the opposer society indorsed or approved of the applicant's goods. Any such interpretation of the applicant's mark would damage the opposer since its name would be to that extent degraded to the level of commercial activities."

RUG ANCHORS

IT was recently held by First Assistant Commissioner Kinnan that The Hoover Company, of North Canton, Ohio, is not entitled to register the notation "Anchorug" as a trademark for a dressing to be applied to the back of a rug to prevent slipping and curling, in view of the prior adoption and use by the E. I. duPont de Nemours & Company, of Wilmington, Delaware, of the notation "Rug Anchor" as a trademark upon materials preventing rugs from slipping.

The ground of the decision is that the goods are of the same descriptive properties and the marks confusingly similar as applied thereto.

In his decision, after stating that the opposer had used the mark upon a sheet or mat, on one surface of which was placed an anti-slipping composition, the mat being adapted to be placed under a rug with the anti-slipping surface in engagement with the floor, while applicant's goods are in the nature of a liquid dressing to be applied to the rugs, and noting that the goods are physically unlike in appearance, the First Assistant Commissioner said:

"The goods of the parties would, clearly enough, not be confused by purchasers. They are, however, for the same general purpose of preventing by anti-slipping composition the slipping of the rug. In the one case the material is spread directly upon the rug and dries to a suitable consistency, while in the other case a similar composition as to function and purpose is spread upon the fabric, which in turn is made to engage the rug upon its other surface. It is deemed quite probable that anyone familiar with the opposer's goods, and seeing those of the applicant on the market, would be led to conclude the latter were produced by the opposer. That confusion of origin would result if the respective marks appeared in the same market upon the respective goods seems a fair conclusion."

With respect to the marks, he said:

"As to the marks themselves, that of the applicant is practically a mere reversal of the two words adopted by the opposer. There seems to be no reason why, if the applicant did not wish to obtain some advantage from opposer's commercial activities, the applicant selected a mark so nearly identical with that of the opposer."

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Lack of space makes it impossible to give many cross-references or to enter a given reference in more than one place. Each article is therefore entered where it is believed it will be most easily found. In every case, the general subject should be sought rather than the supposed specific title of an article. We call special attention to the classifications "Aviation," "Engineering," "Medicine," "Miscellaneous," etc., under which many items will be found, the location of which otherwise would be very puzzling.

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